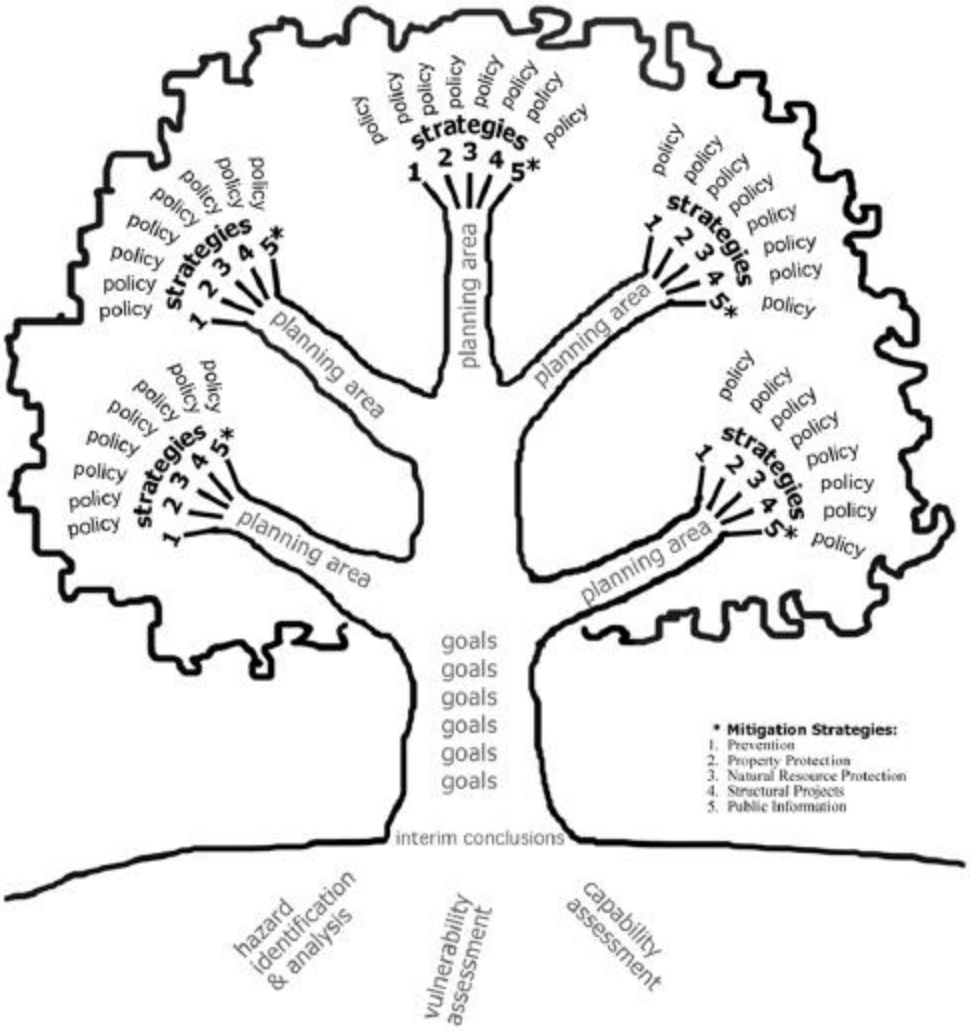
Tools & Techniques:

An Encylopedia of Strategies to Mitigate the Impacts of Natural Hazards



The North Carolina Division of Emergency Management
Hazard Mitigation Section, Risk Assessment & Planning Branch

Tools & Techniques:

An Encyclopedia of Strategies to Mitigate the Impacts of Natural Hazards

September 2002

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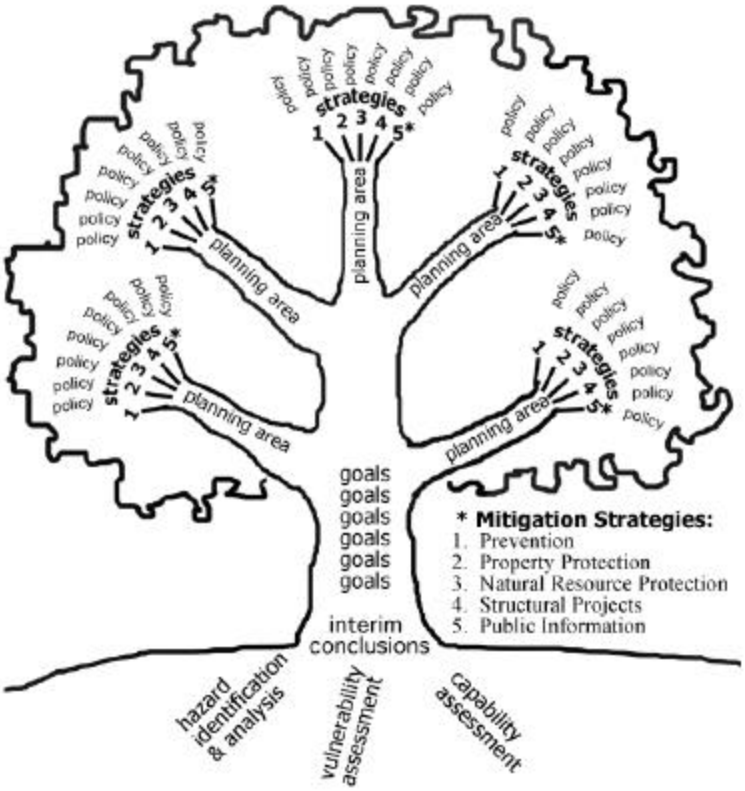
Introduction

Planning to Mitigate the Impacts of Natural Hazards

Natural hazards, such as hurricanes, tornadoes, and earthquakes, are a part of the natural environment. In the absence of built environment, a natural hazard causes damage only to a highly regenerative, adaptable, and resilient natural environment. When a natural hazard intersects with the built environment, the result is often a catalyst for *disaster*. Hazards are natural – disasters are not. Disasters are expensive, time-consuming, socially damaging, and are largely avoidable with appropriate community planning.

Hazard mitigation planning is the beginning of a process upon which a community embarks when it wishes to reduce the impact of natural hazards. As with any planning process, there are preliminary background information gathering steps, followed by an analysis of the alternatives, adoption of policy, and an establishment of monitoring, evaluating, and reporting procedures that lead to revisions and updates of the plan.

This *Encylopedia* is designed for use in conjuction with *Keeping Natural Hazards from Becoming Disasters: A Mitigation Planning Guidebook for Local Governments*. The *Guidebook* refers to the mitigation planning process in the context of a *tree metaphor* (see below). The background analyses (hazard identification and analysis, vulnerability assessment, and capability assessment) are the roots from which the mitigation planning tree grows. Goals are determined, and strategies for mitigation are developed for each planning area in the community. From the strategies, policies are developed. It is at this point where this *Encyclopedia* can help.



What follows is a list of the steps in the mitigation planning process, as described in the *Guidebook* and in the tree metaphor:

Step One: Identify Potential Natural Hazards
Step Two: Assess Hazard Vulnerability
Step Three: Assess Mitigation Capability
Step Four: Form Interim Conclusions (Acceptability Assessment)
Step Five: Establish Values and Goals
Step Six: Formulate Mitigation Policies
Step Seven: Establish Procedures for Monitoring, Evaluating, and Reporting Progress
Step Eight: Establish Procedures for Revisions and Updates of the Plan
Step Nine: Adoption

And, of course, the plan must be implemented.

This *Encyclopedia* is most useful during Step Six, when you are formulating the mitigation policies. The *Encyclopedia* includes descriptions of policies that serve as the leaves of the mitigation planning tree. The tools and techniques described in this book will help your community to be more resilient to natural hazards by making the community safer and better able to quickly recover following a disaster. While many policy options are listed in this *Encyclopedia*, it is not all-inclusive. The *Encyclopedia* is designed to serve as a starting point, to offer options for carrying out mitigation planning strategies.

How To Use This Document

When a community plans to mitigate the impacts of natural hazards, there is a natural tendency to spend more time and energy performing the background analyses than choosing the mitigation strategies. The purpose of the plan, however, is to develop a set of mitigation strategies, or tools and techniques, to help the community carry out the plan. This document, organized as an encyclopedia is intended to help in that process. An example entry follows:

Example Entry

Definition

The first portion of the entry is its Definition. This brief description most commonly gives a broad definition of the entry, and often includes information on its relevance to hazard mitigation.

Implementation

This section explains the important things to consider when deciding whether or not to implement the strategy.

Critique

Most hazard mitigation strategies have both pros and cons. The Critique section offers a perspective on the mitigation strategy.

This box contains a list of synonyms for this entry. Also included here are "See Also" references to entries that provide related information.

Index Listing

- So that you can see how each strategy is indexed, this list of relevant indices is included.
- All entries are indexed by Hazard, Activity, and North Carolina Region.
- Some are indexed by CRS Activity and Post-Disaster relevance.

Example

- Learning about how real communities have used certain mitigation strategies helps in the planning process. This section illustrates how communities have used the mitigation strategy, and how it worked (or didn't work). When possible, references are included so that you can easily get more information.

This *Encyclopedia* can be used in four ways: (1) you can look up the tools and techniques in the encyclopedia according to the common name; (2) you can use indexes to help you select which entries to look up; (3) you can consult the Frequently Asked Mitigation Planning Questions to guide your search; (4) you can read the whole document.

1. Look up the tools and techniques according to their common name.

The *Encyclopedia* is organized alphabetically according to the strategy's most common name. If you wish, for example, to learn more about acquisition, look it up under the "A" section. When applicable, cross references have been added to facilitate finding those entries with multiple names, and "see also" prompts you to look at related entries.

2. Use the indexes to narrow your search for mitigation strategies.

We developed the following indexes to help you narrow your search search for strategies that will mitigate the impacts of the natural hazards that your community may experience: Hazard, Activity, CRS, North Carolina Region, and Post-Disaster indexes. What follows is a description of each.

- **Hazard Index**
  The Hazard Index is meant to serve those who would like to look up the techniques that address the specific hazards to which the community is vulnerable. It is important to note that many strategies may be indexed under "All" as opposed to specific hazard events. The Hazards Index includes the primary natural hazards experienced in North Carolina:
  - **Drought**: Resulting from below-average precipitation, a drought is a cumulative hazard, occurring over time, that gives rise to other hazards such as wildfires or flash flooding (when an area that has received little rainfall suddenly experiences torrential downpours, the group's ability to absorb rainwater decreases, causing increased velocity of runoff and potential for flash flooding.).

  - **Earthquake**: An earthquake is a sudden motion or trembling that is caused by a release of strain accumulated within or along the edge of the Earth's tectonic plates. The severity of the effects depends on the amount of energy released from the fault or epicenter. North Carolina's vulnerability to earthquakes decreases from west to east in relation to the Eastern Tenessee Seismic Zone. Generally, there are three different zones of seismic risk in North Carolina. The eastern portion of the State faces minimal effects from seismic activity. Locations in the middle and southeastern areas of the State face a moderate hazard from seismic activity, while the area from Mecklenburg County west through the Blue Ridge faces the greatest risk. The steep topography of western North Carolina exacerbates the potential for damage, since ground movement on steep slopes can result in human injuries, damage to property, road closures, and more.

  - **Erosion**: Erosion is commonly used to describe the horizontal retreat of the shoreline along the ocean. It is considered a function of larger processes of shoreline change, which includes accretion. Erosion occurs when more sediment (for example, sand) is lost along a particular shoreline than is redeposited by the water body. Accretion results when more sediment is deposited along a particular shoreline than is lost.

    In assessing the erosion hazard in your community, it is important to realize that there is a temporal, or time aspect associated with the average rate at which a shoreline is either eroding or accreting. Over a long-term period (years), a shoreline is considered either eroding, accreting, or stable. When you evaluate coastal erosion in your community, you should focus on the long-term erosion situation. However, in the short-term, it is important to understand that storms can erode a shoreline that is, over the long-term, classified as accreting, and vice versa.

    Erosion is caused by coastal storms and flood events; changes in the geometry of tidal inlets, river outlets, and bay entrances; man-made structures and human activities such as shore protection structures and dredging; long-term erosion; and local scour around buildings and other structures.

- **Flood**: A flood is a natural event for rivers, streams and coastal areas. Excess water from snowmelt, rainfall, or storm surge accumulates and overflows onto the banks and adjacent floodplains. Floodplains are lowlands, adjacent to rivers, lakes and oceans that are subject to recurring floods. Flooding is the most common hazard in North Carolina, and thousands of households are located within floodplains. Floods can occur at any time of the year, and at any time of day or night. Floods generally fall into two categories: flash floods, the product of heavy localized precipitation in a short period over a given location, or caused by a dam break or levee failure; and general floods, which can occur in riverine, coastal, and urban settings.

- **Flash Flood**: Flash floods occur within a few minutes or hours of heavy amounts of rainfall, from a dam or levee failure, or from a sudden release of water held by an ice jam. In North Carolina, most flash flooding is caused by slow-moving thunderstorms, repeated thunderstorms in a local area, or heavy rains from hurricanes and tropical storms. Areas subject to rapid floodwater inundation pose special threats to life and property because there is insufficient time for warning, evacuation, emergency floodproofing, or other protective measures. Flash floods can destroy buildings and bridges, uproot trees, and scour out new drainage channels. Heavy rains that produce flash floods can also trigger mudslides. Flash flooding is a serious problem in the following areas: (1) steep rivers and streams in mountainous or hilly areas subject to sudden rainfall and rapid runoff; (2) Areas with steep slopes and little or no vegetative ground cover; (3) Areas behind dams or levees subject to failure or overtopping; (4) Barrier islands and other areas along the coast which may be subject to relatively rapid hurricane storm surge; (5) Urban areas where much of the ground is covered by impervious surfaces, or where fixed drainage channels may be unable to contain the runoff that is generated by intense rainfall events; and (6) Areas behind levees or dams where the protective structure suddenly fails or the design capacity is suddenly exceeded.

- **Hurricane**: A hurricane is a category of tropical cyclone characterized by thunderstorms and defined surface wind circulation. Hurricanes develop over warm waters and are caused by the atmospheric instability created by the collision of warm air with cooler air.

  Hurricane winds blow in a large spiral around a calm center called the eye, which can be 20-30 miles wide. When a hurricane nears land, it may bring torrential rains, high winds, storm surges, coastal flooding, inland flooding, and sometimes tornadoes. A single hurricane can last for more than two weeks over water and can extend outward 400 miles. The hurricane season for the Atlantic Coast is June 1 to November 30, with a peak around mid-September.

- **Landslide**: Common throughout the mountainous Appalachian region, landslides are described as downward movement of a slope and materials under the force of gravity. Landslides are influenced by human activity (mining and construction of buildings, railroads, and highways), and natural factors (geology, precipitation, and topography).

  Debris flows are flows of rock, earth, and other debris saturated with water. They develop when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt, changing the earth into a flowing river of mud or "slurry." Slurry can flow rapidly down slopes or through channels and can strike with little or no warning at avalanche speeds. Slurry can travel several miles from its source, growing in size as it picks up trees, cars, and other materials along the way. Other types of landslides include: rock slides, slumps, mudslides, and earthflows. All of these differ in terms of content and flow.

- **Nor'Easter**: Nor'Easters are extra-tropical events that produce gale-force winds and precipitation in the form of heavy rain or snow. They can cause increases in tidal elevations (storm surge), wind speed, and erosion. These cyclonic storms, called Nor'Easters because of the direction of the storm winds, can last for several days and can be very large – 1,000-mile wide storms are not uncommon. The coastal counties of North Carolina are most vulnerable to the impacts of Nor'Easters. Since the storms often occur at night, and typically make landfall with less warning than hurricanes (due to their rapid formation right along the coast), residents may be caught at

home unprepared. On the other hand, Nor'Easters typically occur during the off-season when fewer non-residents are visiting the coast.

- **Thunderstorm**: A typical thunderstorm may be three miles wide at its base, rise to between 40,000 to 60,000 feet in the troposphere, and contain half a million tons of condensed water. Conglomerations of thunderstorms along cold fronts (with squall lines) can extend for hundreds of miles. Thunderstorms contain tremendous amounts of energy derived from condensation of water. The half million tons of condensed water release 300 trillion calories of energy, equivalent to about 100 million kilowatt-hours of electricity, or several Hiroshima-sized atomic bombs.

  According to the National Weather service, a severe thunderstorm is one that produces tornadoes, hail 0.75 inches or more in diameter, or winds of 50 knots (58 mph) or more. Structural wind damage may imply the occurrence of a severe thunderstorm. Hail, formed by the accretion of supercooled liquid water on ice particles in a thunderstorm updraft, can pose a serious threat to agriculture and exposed objects. Likewise, strong winds can potentially wreak havoc on fragile or flimsy structures, or yield secondary damage through the downing of trees. Lightning associated with thunderstorms poses a threat to people and animals in unsheltered areas. The tornado, however, is by far the greatest natural hazard threat from a severe thunderstorm.

- **Tornado**: A tornado is a violently rotating column of air extending to the ground. Over water, a tornado is called a waterspout. The most violent tornadoes are capable of tremendous destruction with wind speeds of 250 mph or more. Damage paths can be in excess of 1 mile wide and 50 miles long. Among the most unpredictable of weather phenomena, the tornado season runs ordinarily from March through August, but tornadoes can strike at any time of the year if the essential conditions are present. Thunderstorms and hurricanes spawn tornadoes when cold air overrides a layer of warm air, causing the warm air to rise rapidly. The winds produced from hurricanes, earthquake-induced fires, and wildfires have also been known to produce tornadoes.

- **Wildfire**: A wildfire is an uncontrolled fire spreading through vegetative fuels, exposing and possibly consuming structures. They often begin unnoticed and spread quickly and are usually signaled by dense smoke that fills the air for miles around. Both naturally occurring and non-native species of grasses, brush, and trees fuel wildfires. A wildland fire is a wildfire in an area in which development is essentially nonexistent, except for roads, railroads, power lines and similar facilities. An Urban-Wildland Interface fire is a wildfire in a geographical area where structures and other human development meet or intermingle with wildland or vegetative fuels. People start more than four out of every five wildfires, usually as debris burns, arson, or carelessness. Lightning strikes are the next leading cause of wildfires.

  North Carolina, with its large amount of wooded areas, is included among the states with a high risk of wildfire. As development has spread into areas of North Carolina which were previously rural, new residents have been relatively unaware of the hazards posed by wildfires and have used highly flammable material for constructing buildings. This has increased the threat of loss of life and property, and has also resulted in a greater population of people less prepared to cope with wildfire hazards. The southern coastal plain and mountain region areparticularly vulnerable to the wildfire hazard.

- **Severe Winter Storm**: Severe winter storms can produce an array of hazardous weather conditions, including heavy snow, blizzards, freezing rain and ice pellets and extreme cold. Extreme snow events are the most potentially disruptive to society, for they can bring down power lines, trees and lead to roof collapses. All forms of severe winter weather can make traveling treacherous. Severe winter storms are extra-tropical cyclones fueled by strong temperature gradients and an active upper-level jet stream. The winter storms that impact North Carolina generally form in the Gulf of Mexico or off the southeast Atlantic Coast. Few of these storms result in blizzard conditions, defined by the presence of winds in excess of 35 mph, falling and blowing snow, and a maximum temperature of 20° Fahrenheit. While the frequency and magnitude of snow events are highest in the mountains due to elevation, the geographical

orientation of the mountains and Piedmont contribute to a regular occurrence of freezing precipitation events (e.g., ice pellets and freezing rain) in the Piedmont.

The above descriptions of North Carolina's natural hazards were extracted from Appendix A in *Keeping Natural Hazards from Becoming Disasters: A Mitigation Planning Guidebook for Local Governments*, available from the North Carolina Division of Emergency Management. You may find it useful to refer to the complete appendix in the *Guidebook* for more information on assessing the natural hazards to which your community is vulnerable.

- **Activity Index**
  The Activity Index is especially useful in illustrating that mitigation practices are the job of the entire local government, not just the planning or emergency management departments. If you are the head of a specific department, this index will help you determine what your department can do to further mitigation efforts. If you are a town or city manager, this index will help you delegate hazard mitigation tasks. If you are part of the planning department, this index will help you determine who should serve on committees, and may spur involvement in the planning process from individuals across disciplines.

- **CRS Index**
  The CRS Index relates to the Community Rating System, which is a component of the National Flood Insurance Program (NFIP). Those communities who regulate development in the floodplain are eligible to participate in NFIP, and those communities who take measures beyond NFIP minimum standards earn CRS points. These points are used to reduce the insurance rate premiums that residents in the community pay. Therefore, since CRS can be a cost saver for residents, those communities that participate in NFIP may be interested to know which mitigation strategies may serve the objective of NFIP rate reduction through the accumulation of CRS points. While this encyclopedia cannot be used in lieu of the CRS Manual, it can provide ideas for accomplishing a community goal of lowering flood insurance premiums. Encyclopedia entries are indexed according to its relevant CRS activity. The following list of CRS activities were used in developing the index (the numbers correspond with the section of the 1999 CRS Application document, found online at http://www.fema.gov/nfip/crsapp1.pdf).

NFIP/CRS

- 310 Elevation Certificates
- 320 Map Information
- 330 Outreach Projects
- 340 Hazard Disclosure
- 350 Flood Protection Library
- 360 Flood Protection Assistance
- 400SH Special Hazard Areas
- 410 Additional Flood Data
- 420 Open Space Preservation
- 430 Higher Regulatory Standards
- 430LZ Low Density Zoning
- 440 Flood Data Maintenance
- 450 Stormwater Management
- 500 Repetitive Loss Areas
- 510 Floodplain Management Planning
- 520 Acquisition and Relocation
- 530 Retrofitting
- 540 Drainage System Maintenance
- 540 Drainage System Maintenance
- 610 Flood Warning Program
- 620 Levee Safety
- 630 Dam Safety
- 710 Community Growth Adjustment
- 720 Community Total Points

- **North Carolina Region**
  North Carolina's landscape is diverse, and consequently the hazards resulting from storm events can vary greatly. For example, torrential rainfall and flooding associated with large storm events may cause erosion on the coast and landslides in the mountains. Therefore, the mitigation strategies employed may be quite different from region to region. This index is useful for identifying only those strategies pertinent to your community's region. Note that many tools and techniques are relevant throughout the state, thus indexed as "Statewide."

- **Post-Disaster**
  A small number of entries are indexed as "Post-Disaster." This means that these are the tools to turn to if you are approaching mitigation immediately following a disaster in your community.

3. Consult the Frequently Asked Questions

During the mitigation planning process, it is necessary to conduct background analyses that provide information on a community's vulnerability. After conducting these analyses, certain questions arise. For example, a community has discovered, through the background analyses, that a bulk of the tax base is in the floodplain. The community is unsure which mitigation strategies might help to solve this problem. The community can look at the Frequently Asked Questions index for the question, "What if a large portion of my tax base is currently in a hazardous area?" This question has a bulleted list of answers that correspond to encyclopedia entries. To learn more about each suggested remedy, simply look it up in the encyclopedia.

4. Read the whole document.

This document, for all of its indexing and cross referencing, may actually be best read cover-to-cover. After all, as a creative public servant, you may have ideas for how you can apply a certain strategy to your specific situation – you can make connections and come up with creative implementation ideas. For example, some policies, in content, may not apply to your community or the hazards to which you are vulnerable, but these seemingly irrelevant strategies might be of interest to you for the implementation concerns that might be similar to those your community could experience. Or, you may find examples that are relevant to your community because of the size and politics of the area. Therefore, you may find it beneficial to read each of the entries.

Frequently Asked Mitigation Planning Questions

What follows are seven questions that often arise after the background analyses are completed and the process begins to determine the tools and techniques that will be used to mitigate the impacts of natural hazards. The questions below include a listing of answers that correspond with entries in this Encyclopedia. The lists are certainly not exhaustive. We recommend that you use consider the answers as a starting point. Keep in mind that additional tools and techniques may work in your community.

What if community features (existing infrastructure, critical facilities, existing development) are in a hazardous areas?

- Access to Neighborhoods
- Acquisition
- Capability Analysis
- Capital Facilities Plans
- Community Awareness Programs
- Comprehensive Plans
- Critical Facilities
- Drainage Culverts
- Drainage System Maintenance
- Earthquakes
- Elevation
- Emergency Thoroughfares
- Firebreaks
- Floodplain Management Plans
- Fuel Loads
- Grassy Swales
- Hazard Identification
- Hazard Mitigation and Post-Disaster Reconstruction Plans
- Home Inspection Programs
- Impervious Surface Limits
- Mapping Hazards
- Moratoria
- Porous Pavement
- Real EstateDisclosure Requirements
- Retention Ponds
- Scenario Analysis
- Setbacks
- Slowing Development
- Smart Growth
- Stormwater Drain Maintenance

What if a large portion of your tax base is currently in a hazardous area?

- Audits of Small Businesses
- Building Codes
- Commercial Park
- Development Caps

- Firebreaks
- Floating Zones
- Floodplain Management Plans
- Grassy Swales
- Hazard Identification
- Hazard Mitigation and Post-Disaster Reconstruction Plan
- Impervious Surface Limits
- Industrial Park
- Moratoria
- Overlay Zones
- Porous Pavement
- Relocation
- Retention Ponds
- Scenario Analysis
- Smart Growth
- Stormwater Drain Management
- Mapping Hazards

What can you do about repetitive loss structures?

- Acquisition
- Building Codes
- Detention Basin
- Drainage Culverts
- Drainage System Maintenance
- Dune Protection and Shoreline Setbacks
- Elevation
- Firebreaks
- Floating Zones
- Floodplain Management Plans
- Floodproofing
- Moratoria
- Real Estate Disclosure Requirements
- Relocation
- Sewage Lift Station
- Stormwater Drain Maintenance

What if there are indications that development patters may occur in hazardous areas?

- Acquisition
- Bonus and Incentive Zoning
- Capital Improvements Plans (CIP)
- Comprehensive Plans
- Concurrency
- Developer Exactions
- Development Density
- Differential Assessment
- Dune Protection and Shoreline Setbacks
- Environmental Impact Ordinances
- Government Expenditure Limitation in High-Hazard Areas
- Impact Fees
- Infill Development
- Mapping Hazards
- Marginal Cost Pricing
- Performance or Impact Zoning
- Planned Unit Development
- Purchase of Development Rights
- Smart Growth

- Transfer of Development Rights

My vulnerability analysis revealed that some of the undeveloped areas in the hazard area of my community are zoned for residential development. What can I do?

- Acquisition
- Agricultural Use Zoning
- Bonus and Incentive Zoning
- Concurrency
- Contract Zoning, Conditional Zoning and Special Exceptions
- Developer Exactions
- Environmental Impact Ordinances
- Impact Fees
- Infill Development
- Purchase of Development Rights
- Setbacks
- Slowing Development
- Subdivision Regulations
- Transfer of Development Rights

What tools can I use to implement green infrastructure in my community?

- Easements
- Grassy Swales
- Green Infrastructure
- Impervious Surface Limits
- Land Treatment
- Mapping Hazards
- Natural Environmental Features
- Onsite Sediment Retention
- Parks
- Purchase of Development Rights
- Slope Stabilization
- Soil Conservation and Steep Slope Stabiliziation
- Vegetation
- Wetlands Preservation

My community is on a barrier island. The problem is that barrier islands naturally move. What can I do?

- Acquisition
- Beach Management Plans
- Beach Nourishment
- Carrying Capacity
- Dredging
- Dune Protection and Shoreline Setbacks
- Floating Zones
- Groins
- Jetties
- Offshore Breakwaters
- Revetments
- Roadway Realignment
- Sand Dunes
- Sand Scraping
- Seawalls and Bulkheads
- Sediment-Trapping Vegetation, Coastal

Strategies by Index

Description of the Indexes

Activity Index: Mitigating the impacts of natural hazards is a job for more than just the planning department. All local government departments can be involved, as well as federal and state agencies and organizations. The Activity Index highlights the mitigation strategies under the interest and purview of the various local, state, and federal organizations.

CRS Index: The CRS Index relates to the Community Rating System, which is a component of the National Flood Insurance Program. If your community participates in the NFIP, you might be interested in which mitigation strategies may contribute to NFIP rate reduction through the accumulation of CRS points. While this encyclopedia cannot be used in lieu of the CRS Manual, it can provide ideas for accomplishing a community goal of lowering flood insurance premiums.

Hazard Index: Fortunately, every community is not vulnerable to all natural hazards. Once you have established to which hazards your community is vulnerable, you can look to this index to point you to the mitigation tools and techniques that address specific hazards. "All" indicates that the strategy can be useful in mitigating the impacts of all natural hazards.

North Carolina Region Index: What works in the mountains might be irrelevant on the coast. This index is meant to guide your selection of mitigation strategies by the region in which your community falls. Note that many tools and techniques fall under the “Statewide” category.

Post-Disaster Index: The Post Disaster index is meant to guide you to those strategies that are specific to a post-disaster situation. For example, your community has just experienced extensive flooding from a storm. Which tools should you reach for first? This list provides you with a starting place.

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The Encyclopedia

A

Access to Neighborhoods

Definition

Provide additional means of access into single-entry neighborhoods, in order to prevent residents from becoming trapped in a hazardous area during a wildfire or flood.

Neighborhood Access

Index Listing

Hazard
- All
- Engineering
- Planning
- Public Works

North Carolina Region
- Statewide

Implementation

"Gated" communities and other single-entry subdivisions have been a popular style of neighborhood development over the past couple of decades. Within these types of subdivisions, there is only one, sometimes-guarded, means of entry; residents have only one means of exit. The danger of an unexpected hazard is particularly great if the path of exit is subject to blockage by wildfires or floodwaters. Consequently, single-entry neighborhoods that are partially surrounded by woods are at exceptional risk. Providing additional means of access or breakaway gates lessens such a risk. Points to consider in determining whether to provide additional means of access for at-risk neighborhoods include:

- Fast-onset fire can trap citizens or permit escape paths accessible only by foot, which is problematic for those with mobility challenges, such as infants and elderly and disabled persons.
- Personal property is less likely to be salvaged if emergency vehicles cannot access the scene.
- Multiple paths into a neighborhood promote interconnections with the larger community.

Critique

Some citizens may feel that multiple entries will produce a throughway, resultant traffic, and a loss in their sense of security. However, concerns over through-traffic may be alleviated by designating the new street as one-way, or by using one-way (exit only) breakaway gates.

Acquisition

Fee Simple Acquisition of Land and Damaged Structures
See Also: Green Infrastructure
See Also: Parks
See Also: Relocation
See Also: Beach Nourishment

Hazard:
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Engineering
- Parks and Recreation
- Planning
- Emergency Management
- Town/City Manager

CRS-Compatible Activity:
- 420: Open Space Preservation
- 520: Acquisition and Relocation

North Carolina Region:
- Statewide

Post Disaster

Definition

Land ownership is often defined as a bundle of rights, of which the right to develop is only one. When one person owns all the rights associated with a parcel of land they are said to own the land "in fee simple." Acquiring a property in fee simple means buying the land outright. It provides a local government with the greatest level of control over the use and disposition of a parcel.

Implementation

The power of acquisition can be a useful tool for pursuing mitigation goals. Local governments may find the most effective method for completely hazard-proofing a particular piece of property is to remove it from the private market, thereby eliminating or reducing the possibility of inappropriate development. Given its cost, this technique should be used only for property in the most hazardous areas, where property and life is subject to repeated damage or extreme risk.[1] Properties that match this description must not return to the marketplace. Communities may not have to pay full price for damaged structures acquired in the wake of a disaster. Often they can purchase a property for the difference in value between its full price and payments already made to the landowner, such as insurance settlements and FEMA loans. Downzoning can help reduce development pressure on privately-held land, making it easier and less expensive to acquire for mitigation purposes.[2] Checkerboard purchases should be avoided whenever possible since dispersed properties are more costly and difficult to maintain.

Fee simple acquisition can be used to meet several community objectives at once. One example would be the purchase of beachfront properties to ensure recreational access and reduce hazard risk. Acquisition can also be used where general land-use regulations are not sufficient or where environmental objectives are sought. Acquiring properties in the floodplain and reverting them to open space can restore the natural function of the floodplain or wetlands. Similar gains can be made if parks and recreation areas replace flood-prone buildings. Acquisition policies could also target beachfront properties where redevelopment would be permitted under current regulations but would impact the beach and dune system.[3]

There are four types of buyouts where built property is involved. *Basic buyouts* are community-run programs without a relocation element. *Buyout and infill* programs are designed to encourage the relocation of families and structures from the floodplain to vacant lots in less hazard-prone neighborhoods. Communities operating *Buyout and reorganization* plans often create new subdivisions into which they actively relocate houses and businesses. The community will usually sponsor the planning and installation of infrastructure. *Buyout and complete relocation* is the construction of a new town using new or relocated old buildings.[4]

Examples

- In the aftermath of Hurricane Floyd in 1999, FEMA and the State of North Carolina engaged in a buyout program of homes, hog farms and waste treatment plants in the floodplain that totaled $254 million as of September 2000, making the acquisition effort FEMA's largest ever. More than 4,200 homes were purchased and demolished, and are planned as open space for the future[5]. The buyout of hog farms in the floodplain was inspired by the concern for public health and potential for fish kills after Hurricane Floyd flooded hog waste lagoons on 40 farms. The buyout was concentrated on purchasing those farms with the highest risk for future pollution in a flood[6].

FEMA Director James Lee Witt stated that the acquisition would ultimately save federal taxpayers money because "every dollar we spend saves $2 or $3 in future losses[7]."

- An example of a highly successful local hazard mitigation acquisition program can be found in Tulsa, OK. After the 1984 Memorial Day Flood the city undertook an extensive buy-out program in areas that were historically repeatedly flooded. The city used FEMA funds and bonds financed with sales tax revenues to acquire more than 500 flood-damaged homes. This program, in conjunction with the installation of retention basins, has substantially reduced the costs of property damage and emergency relief in subsequent floods.[8] Tulsa's acquisition program achieved several non-mitigation community objectives, including neighborhood redevelopment and the provision of recreation space.[9]
- Between 1990-94, Dade County, FL, acquired 104 acres of hazard-prone land through its Environmentally-Endangered Lands program. The program is funded by a voter-approved bond measure.
- The Town of Wrightsville Beach, NC acquired four undeveloped beachfront lots for roughly $240,000 in August 2000. The land had been purchased by three brothers in 1914, who platted it and planned a subdivision of 60 lots, but erosion and an inlet created by a nearby jetty submerged almost all of the lots. In 1980 the construction of another local jetty resulted in the reclamation of the land from the water, and heirs of the three brothers lobbied for the rezoning of the land from conservation to residential uses. However, the rezoning effort was obviated by the passage of Hurricane Fran in 1996; the storm once again submerged the land. The Town of Wrightsville Beach chose to purchase those lots least susceptible to erosion and submersion, and thereby most vulnerable to development. In making the purchase, the town applied for and received grants of more than $270,000 from the Federal Emergency Management Agency and of more than $300,000 from the U.S. Department of Housing and Urban Development[10].
- The Wapello Levee District, Louisa County, IA, chose to buy out farmers after the 1993 Midwest Floods damaged the local levee system. The land has been annexed by the neighboring Mark Twain National Wildlife Refuge and is being returned to natural uses. In addition to providing permanent flood mitigation, the program is restoring natural habitats and allowing the river to return to its original course, which includes a curve over much of the district. Approximately 2,600 acres were purchased using a combination of federal and state funds.
- Cherokee, IA, developed a flexible acquisition program following the 1993 floods. Homeowners could sell their property to the city and buy outside the floodplain or they could sell the land and relocate the structure (if it was repairable). In addition, the city bought 36 homes that it re-sold to the general public to relocate outside the floodplain. These resales allowed Cherokee to recoup some of the cost of acquiring the structures. The city designed a new subdivision to accommodate relocated homes, but it also encouraged relocaters to choose infill sites. The city used state grants to provide down payment assistance to low-income families.[11]
- Lincoln County, MO, officials used pre-disaster tax databases to assess the pre-1993 Flood value for local homes. This was the basis for determining the amount of damage to each home. Establishing a consistent process for damage assessments reduced the chances of unfairness. The criteria for purchase were: 1) primary residence, greater than 50% damaged; 2) primary residence, less than 50% damaged; 3) secondary residence (vacation and investor-owned homes); and 4) all other homes, including those bought after the buyout program began.[12]

- St. Charles, MO, elected to acquire owner-occupied homes in the floodplain first, followed by investor-owned homes in the floodplain. The remaining purchases extended geographically outward from higher to lesser risk areas.[13]

Critique

Fee-simple purchase is usually the most expensive method of land acquisition. In addition to the cost of buying the property, a local government must delete the property from its property tax rolls and assume its maintenance costs.

Adequate Public Facilities Requirements

See: Concurrency

Advance Acquisition and Land Banking

Definition

Advance site acquisition, also known as land banking, involves the purchase of land by the government for future public facilities or for resale to the private sector. The goal is to influence the character and/or timing of growth. Municipalities may acquire sites in advance through the power of eminent domain, in conjunction with official maps or master plans[14]. Acquisition through purchase is also possible.

Land Banking

Index Listing

Hazard:
- All

Activity:
- Town/City Manager
- Planning

North Carolina Region:
- Statewide

Implementation

By exercising control over the release of land for development, a local government can avoid the private development of hazardous parcels[15]. It can also ensure that less hazard-prone property is available for siting public facilities, such as schools or emergency services departments. County or regional governments may be the most appropriate users of this technique, since land markets are often regional and therefore beyond the power of local jurisdictions.

Examples:

- The city of Richmond, VA, has had a policy of advance land acquisition since 1946. The city's first master plan was based on a 20-year growth projection that identified the location of future capital improvement projects. In 1949, a city ordinance was enacted enabling the municipality to acquire any real property on which private construction was contemplated if the property in question was designated on the master plan for some future public use. The city has realized significant savings by acquiring sites early for expressways, street widening and school additions.
- Montgomery County, MD, is authorized to acquire land adjacent to proposed public facilities at the time the land for the facility itself is acquired. The county can then make any necessary improvements and dispose of the land for private development in a manner consistent with the nature of the public facility.

Critique

Private landowners may have several objections: first, the public sector, rather than private landowners, receives the benefits of increases in the property value between purchase and development. Second, the value of land outside the land bank may be reduced because there is less possibility of developer-contrived scarcities, and because the government may sell land at below market prices. This technique requires a high level of expertise on the part of

planning staff. Financing may be tricky: for example, bridging the gap between the purchase of the land and revenues from its sale may require debt financing, which will create pressure to increase sale prices.

Aerial Lines

Definition

Avoid use of "aerial" or non-underground extensions of water, sewer and gas lines, and/or regularly clear sediment build-up on riverbanks near aerial lines, in order to decrease the likelihood of damming due to the placement of utilities. Aerial lines tend to span watercourses at a height reasonably close to the water's surface, and pipes may extend from one sloped bank to another, creating a damming hazard similar to low-lying bridges.

If debris and sediment accumulate at the points where an aerial line meets the bank, a dam may form that will be added to by future floodwaters.

Index Listing

Hazard:
- Flooding
- Flash Flooding

Hurricane
- Thunderstorm

Activity:
- Planning
- Public Works

North Carolina Region:
- Statewide

Critique

Aerial lines may be unavoidable if their burial underneath the riverbed proves cost prohibitive or environmentally detrimental.

Agricultural Use Zoning

Definition

Agricultural use zoning restricts the density of structures allowed on land used for agricultural purposes, usually by setting a minimum lot size that corresponds to the size of a viable farm. The intent is to reduce the development pressure on traditionally agricultural properties.

Implementation

This regulation can be used to restrict the amount of residential and commercial property in hazard areas (see also Differential Assessment/Taxation).

Zoning, Agricultural Use

Index Listing

Hazard:
- All

Activity:
- Town/City Manager
- Planning

North Carolina Region:
- Statewide

Examples:

- Northampton, MA, reserved 1,500 acres within the Connecticut River floodplain as an agricultural use district.
- Glastonbury, CT, created an agricultural use district for 800 acres along the Connecticut River[16].

Critique

While these regulations are designed to ensure that agricultural production is the only economically-productive use of the land, they do not ensure that land remains as working farms. Some farmers use the value of their as residential parcels as leverage when borrowing money. They may oppose these regulations since they reduce the value of land for that purpose.

Analysis

See: Scenario Analysis

Animal Shelter Location

Definition

Disallow animal shelters in hazardous areas to avert the need for evacuation and temporary housing of a large numbers of animals during a hazard. Caged animals in particular do not have a good chance of surviving a natural hazard.

Critique

This practice may not be essential if an emergency housing agreement can be arranged with another local shelter in a less hazardous area.

See Also: Disaster Warning
See Also: Education and Training

Index Listing

Hazard:
- All

Activity:
- Planning

North Carolina Region:
- Statewide

Audits of Small Businesses

Definition

Offer hazard-susceptibility audits to local small businesses to lessen the percent of small businesses that are vulnerable and unprepared for hazards. Considering the contribution of small business to the tax base and job market, these audits are a worthwhile investment of inspection resources. In addition, the voluntary hazard-susceptibility audit presents a chance to distribute materials concerning mitigation to an engaged audience. If budgets are tight, the program could include the request of a small donation to make this service available to other local businesses.

Business Audits
Small Business Audits

Index Listing

Hazard:
- All

Activity:
- Town/City Manager
- Emergency Management
- Planning

CRS-Compatible Activity:
- 330: Outreach Projects

North Carolina Region:
- Statewide

Implementation

For home and business retrofit measures that are appropriate for the type and level of hazard facing your community, see publications and online manuals of the Institute for Business and Home Safety (http://www.ibhs.org) and FEMA's "Mitigation How To Series" (http://www.fema.gov/mit/).

Average Density

See: Planned Unit Development

B

Basin

See: Stormwater Basin

Beach Management Plans

Definition

Beach management plans can be used to collect a number of erosion protection and hazard mitigation techniques into a single directive for action. They may be one component of a comprehensive plan. More likely, however, they act as stand-alone plans for the coastal ecosystem as a whole and its component habitats.

Implementation

Beach management plans could address the following, among other issues: sand-trapping structures; beach management; shoreline protection works; elevation; relocation; zoning; and acquisition.

Plans, Beach Management

Index Listing

Hazard:
- Erosion
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Beach Management
- Shore Protection
- Planning
- Town/City Manager

CRS-Compatible Activity:
- 400SH Special Hazard Area

North Carolina Region:
- Eastern/Coastal

Beach Nourishment

Definition

A beach that is relatively stable or growing provides natural protection to structures behind it. Beaches that are losing sand though erosion or starvation may, however, endanger property. As the water line advances inland, the danger of damage increases. Beach nourishment is the artificial replacement or addition of sand to beaches to widen the backshore and move the high-water line offshore. This technique is expensive, temporary, and requires maintenance at great cost; sometimes, although not always, the federal government will assume a percentage of beach nourishment's cost. Acquisition of at-risk properties and shoreline is an alternative to beach nourishment that should be explored. If shoreline properties can be purchased prior to development, exemplified by the Town of Wrightsville Beach's acquisition of four undeveloped, erosion-prone lots, this technique may be

Nourishment
Renourishment
See Also: Acquisition

Index Listing

Hazard:
- Erosion
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Coastal Engineering
- Beach Management
- Shore Protection
- Town/City Manager
- Planning
- Coastal Management

North Carolina Region:
- Eastern/Coastal

Post Disaster

less expensive than beach nourishment in the long run; however, after development has occurred, acquisition may be prohibitively expensive.

Implementation

The effectiveness and longevity of a beach nourishment project depends on the type of imported sand, the slope of the beach, the strength of cross-shore currents, and the frequency of storms. The slope of the nourished beach should match as closely as possible the beach's original slope, and fill should resemble the original beach material, since finer fill will erode more quickly than the native beach. Conversely, fill that is too coarse or has too high a shell content can disrupt the burrowing habits of coquina clams and mole crabs: if it is too difficult for these organisms to dig into the sand, they may be washed out to sea in higher proportions, and shore birds will have less prey. Turtle nesting habits may also be adversely affected by coarse or shell-filled nourishment sand. Any beach construction project should be timed to interfere as little as possible with natural ecological processes, such as the breeding or nesting seasons of shoreline birds and animals.

Planners should consider the beaches' natural erosion process when evaluating the long-term cost-effectiveness of any beach nourishment program, as well as the potential for one or more high sand loss events, such as hurricanes or winter storms, to strike the beach in the post-nourishment period. The true price of nourishment depends on the rate of loss from the beach and the frequency of subsequent renourishment projects, which is influenced by the frequency of hurricane and storm events.

CAMA regulations govern the nourishment of coastal beaches. A CAMA permit is required for each nourishment, and the effects of prior nourishment efforts are evaluated as part of the permitting process. In general, permits will not be issued where high erosion rates will require frequent maintenance or renourishment of the beach. Many experts believe that dredge material should be used for nourishment only if the material matches the existing beach in grain size, if it is handled properly, and if it is allowed to dry before being applied[17].

Examples:

- Replenishment of the severely eroded Miami Beach cost $64 million dollars for 15 miles of new sand.
- Carolina Beach, NC, saw increased development along the beachfront following its beach renourishment program[18].
- In 1992, dredged sandy material from a navigation project in Port Canaveral, FL, was dispersed downdrift of the harbor, but into the sand cycle of neighboring Cocoa Beach. A study performed shortly afterward found that the material was moving toward Cocoa Beach. In the meantime, it was acting as an offshore buffer dampening the waves that were causing Cocoa Beach to experience high erosion rates[19].
- Carteret County, NC placed a $30 million bond issue on the March 2000 ballot for voter approval of a 17 mile beach nourishment project on Bogue Banks, marking the first time in the state's history that a local community financed its own nourishment project without the state or federal government contributing funds[20]. The nourishment project prompted an informal but well-publicized public debate over whether beach nourishment represented a subsidy to beachfront homeowners or a benefit to the county economy as a whole since the nourished beach would continue to support local tourism. The bond was not approved, providing the incentive for the beach town of Pine Knoll Shores to place its own successful $8 million bond referendum on the March 2001 ballot. The referendum provided for the nourishment's financing at a two-tiered rate for beachfront property owners and property owners not on the beach, who paid 41 cents per $100 property tax valuation and 4 cents per $100 valuation, respectively[21]. The subsequent nourishment project has also been marred by unfavorable reviews of the fill compatibility, which is much darker, coarser, and has a much higher shell content than the original beach sand, and by the death of a number of sea turtles protected by the Endangered Species Act that were sucked into the hopper dredge.

Critique:

Large scale nourishment programs can be very expensive, on the order of $1-$5 million per mile per application. The frequency of nourishment required to maintain a beach is difficult to predict. Most Atlantic-seaboard replenishment projects have a life-span of 2-10 years, depending on the frequency and intensity of storms[22]. Replenished beaches tend to erode more quickly than natural beaches[23]. Beaches in areas of high erosion may require near-constant replenishment to maintain historic shoreline levels.

While nourishment programs may offer wider beaches for recreational use, they may also unintentionally worsen the hazard risk. Renourishment sand is often taken from neighboring offshore banks because they offer an inexpensive source of matching sand. Shearing these banks is shortsighted, since they provide the beach with an offshore "speed bump." The result is that larger waves reach the shore, causing more severe shoreline erosion. Nourishment programs may also spur shorefront development, putting even more structures at risk[24].

Berms

See: Cemeteries
See: Dikes

Bonus and Incentive Zoning

Definition

Bonus and Incentive Zoning refers to the practice of allowing developers to exceed limitations imposed by current regulations, such as building height, floor area or density, in return for specific concessions.

Zoning, Bonus
Zoning, Incentive

Index Listing

Hazard:
- All

Activity:
- Planning

North Carolina Region:
- Statewide

Implementation

Communities can offer bonuses, in the form of increased densities or floor space, to developers who avoid building in hazard-prone areas or integrate mitigation into their designs. This method could be used to exact dune walkovers, open space for mitigation purposes, or on-site mitigation facilities such as retention ponds. Communities could also offer incentives for the donation of hazard-prone portions of a property or for clustering development away from hazard-prone portions of a property. This technique should be used in conjunction with traditional (use-based) zoning in order to remain within the limits of the North Carolina enabling legislation[25].

Examples:

- The plan for Fernandina Beach, Florida calls for density bonuses for developers who: make dedications of land for public beach access; dedicate unprotected dune areas; cluster structures landward of and away from dunes; elevate structures to protect existing dune vegetation; or build dune walkovers. The plan goes on to require that the bonus system not increase hurricane evacuation time or overtax infrastructure[26].

Critique

This technique has generally been limited to metropolitan areas, where land is scarcer and the market benefit to the developer is more tangible. While similar to the accepted practice of dedication, bonuses and incentives may be legally vulnerable as contract or conditional zoning. The extent of the connection that must be established between the concession and the government purpose is not clear. At the very least, the public benefit must be clearly defined. The technique can be counterproductive in some locations, such as coastal areas, if it encourages higher densities at the fringe of the hazard zone[27].

Breakwaters

See: Offshore Breakwaters

Bridges

Definition

Raise low-lying bridges, and/or routinely clean debris from the support bracing underneath low-lying bridge, in order to decrease the likelihood that large objects carried by floodwaters will lodge against a bridge and subsequently dam the rivercourse.

Of particular concern are fallen trees, which, when swept into a river and snagged by a bridge, can quickly capture floating debris, potentially forming a solid dam. As a result, areas upstream and adjacent to the unintended dam can receive flood levels unanticipated by hazard mapping and risk assessments. Finally, under the weight of a newly formed reservoir, the bridge may tear from its foundation, allowing a destructive wall of water to rush downstream.

See Also: Drainage Culverts

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricanes
- Nor'easter
- Thunderstorm

Activity:
- Planning
- Public Works

North Carolina Region:
- Statewide

Implementation

When a bridge is scheduled for repair or replacement, local government might evaluate whether it lies low, relative to base flood elevation, presenting a damming hazard. Other opportunities inherent in bridge repair/replacement include the addition of a safe pedestrian walkway or bikelane, the coordination with historic preservation of covered, or other significant, bridges, and the creation of a signature landmark for the town.

Critique

Elevation may be financially feasible only with relatively light, post-and-lentil type bridges, spanning tributaries or narrow sections of a main river. In addition, a state or regional authority may be responsible for many local bridges. However, regardless of jurisdiction, local crews can occasionally remove large debris trapped in the underbracing: the best time to schedule cleaning sessions is just after heavy storm events.

Building Codes

Definition

Building codes are laws, ordinances, or governmental regulations that set forth standards and requirements for the construction, maintenance, operation, occupancy, use or appearance of buildings, premises, and dwelling units. North Carolina has a mandatory state-wide building code, which is administered and enforced at the local level by county or municipal inspectors who are certified by the state. The NC Building Codes regulate for fire resistance, in addition to seismic, flooding and high wind resilience. These codes are reviewed annually and amended as new requirements and materials are introduced.

See Also: Education and Training

Index Listing

Hazard:
- All

Activity:
- Engineering
- Inspection
- Town/City Manager
- Planning

CRS-Compatible Activity:
- 430 Higher Regulatory Standards

North Carolina Region:
- Statewide

Implementation

Local governments are not allowed to alter the state building code. However, they may adopt codes that the state deems to meet "adequate minimum standards"—usually those that exceed state standards for a specific purpose, affording local governments the opportunity to write a superior

code that meets local standards of hazard resistance and provide an official certificate to ride with the estate. Not every building needs to be built to the same standard. For example, North Carolina has a specific building standard for coastal counties that is designed to ensure a structure's survival in 120 mph winds. Differences in the code could be delineated within a jurisdiction. The code must require that the building be able to withstand the hazard risk for its particular site, whatever those risks are. This may mean generating codes for various risk zones or to address specific hazards. Some additional level of risk may be acceptable for uninhabited buildings.

Enforcement at the local level extends beyond construction inspections to the advance review of plans. An applicant for a building permit must submit plans for approval. The local building department reviews the plans and elects to approve or reject them or to require revisions. Construction cannot begin until local officials confirm that the plans are in accordance with the code.

A building inspector must then visually monitor the construction of the building. The inspector's duty is make sure that the project follows the plans as approved. Inspectors are empowered to stop work on projects that fail to conform to the plans. Any observed errors must be fixed before work can continue. The inspector must perform a final review before an occupancy permit is issued.

One way to require non-conforming structures to come up to code is to establish passive or active code triggers, such as a change in use. In order to qualify for a change in use, the building would have to meet or approach current code. A different kind of code trigger would require that buildings that have suffered a certain degree of damage be renovated to a higher level of natural hazards resilience. Another approach to code enforcement is to establish financial incentive or voluntary compliance programs.

Disseminating public information is a good way to help the general public develop an appreciation for the purposes that these codes and standards serve. Local communities can help build public support for strict enforcement of building codes by initiating publicity campaigns with this objective in mind. Demonstration projects that display the use of hazard-resilient building techniques can increase consumer awareness of and preference for hazard-resilient construction.

Examples:

- The city of Los Angeles established a code trigger to address the rehabilitation of its unreinforced masonry (URM) buildings. The city classified these buildings according to their emergency usefulness (as police or fire stations or hospitals), their structural integrity, occupant load, and historical importance. With this classification system, the city then established a schedule for siting structures that ranged from "immediately", for those buildings deemed "essential" to within 4 years for the "low risk" buildings. The ordinance called for all buildings to be brought into compliance within 15 years. When a structure was cited, an owner had several options to extend or alter this time limit. A partial compliance provision allowed owners the option of extending the time to comply for up to 10 years, depending on the building's classification. Owners also had the option of appealing their property's classification, changing the use of the building, or demolishing the property entirely. Results of subsequent studies indicated that over time, owners of the URMs recouped the costs imposed on them by the ordinance. The ordinance did not hurt resale value, and retrofitting enhanced values. Compliance with the ordinance tended to raise the sale price by 37 percent.
- The barrier island community of Seabrook Island, SC developed a voluntary program called "Value Added Quality." VAQ is a set of building specifications that are designed to make new and renovated homes more resistant to high winds and wind-driven rain. Builders that follow the procedures for VAQ certification are given a certificate that can be used to promote the property during its subsequent sales. Studies have found that regulations can be effective when supplemented with economic

incentives[28].

- In Charleston, South Carolina, the 113 Calhoun Street Sustainability Center (a public-private partnership involving the city, academic institutions and the building community) is renovating a hazard-damaged old house to demonstrate how hazard-resilient features can be incorporated into restoration as well as new construction.

Critique

Building codes can be an effective way to ensure that development is built to withstand natural hazards. In particular, seismic and floodproofing codes effectively save lives and reduce building collapse[29]. Changes in the codes are often difficult to enact and can be expensive for homebuilders to implement. The latter issue is of specific concern to the owners of manufactured housing, which comprises a significant percentage of the affordable housing stock in North Carolina.

Building codes apply primarily to new construction or buildings undergoing substantial alteration. Requiring old buildings to be retrofitted to new standards can be politically contentious[30]. Building inspectors are often under pressure to relax codes during post-storm reconstruction, even as the need for strict enforcement is most apparent. Such conditions emphasize the need for prior planning to set government policies regarding reconstruction in advance of a disaster.

At the same time, much of the responsibility for quality workmanship still resides with the builder. New buildings can fail in a disaster if builders or inspectors do not adequately observe the code. Studies of the damage caused by Hurricane Andrew in 1992 attributed one-quarter of the storm's total damages to "shoddy workmanship and poor enforcement of the building codes[31]." Adherence to existing codes and standards is essential to maintaining public safety and promoting an effective local mitigation program—so much so that the insurance industry has moved to rate communities according to their ability to enforce the building code and by the qualifications and training of their staff[32].

Building Inspectors

Definition

Promote advanced training for local building inspectors to gain experienced, meticulous, and multi-talented staff on the local inspections team. Well-trained inspectors are more likely to recognize building practices that are suspect with regard to hazard resilience, and can pass on their expertise to junior staff, thereby fostering a tradition of sustainable education within the inspections department.

Inspection, Building

Index Listing

Hazard:
- All

Activity:
- Building Inspection
- Town/City Manager
- Planning

North Carolina Region:
- Statewide

Implementation

Brief training sessions could be provided to county or privately contracted inspectors who are working on local projects, to ensure that these supplemental staff are aware of local codes that are more stringent than county or state codes (such as free-board requirements).

Bulkheads

See: Seawalls and Bulkheads

Burial of Utility Lines

See: Utility Lines

Business Audits

See: Audits of Small Businesses

Business Exchange Program

Definition

Set up a business exchange program that offers expanded development rights for mitigation retrofits Examples include greater density or reduced parking requirements in exchange for hazard-wise rehabilitation of a structure. However, ensure that granting the expanded development rights does not nullify the mitigation action by exposing an inordinate number of people to the hazard.

Index Listing

Hazard:
- All

Activity:
- Town/City Manager
- Planning

North Carolina Region:
- Statewide

Implementation

The program must be advertised, although certainly not guaranteed, to all local businesses to avoid the appearance of collusion. Businesses outside the areas of hazard could also participate in the exchange program by directly contributing funds to public mitigation activities. The conditions and limitations of the program should be clearly stated, and local government should retain the right of final discretion, to be used on a case-by-case basis.

C

Capability Analysis

Index Listing
Hazard:
- All

Activity:
- Town/City Manager
- Planning
- Emergency Management

CRS-Compatible Activity:
- 610: Flood Warning Program

North Carolina Region:
- Statewide

Definition

Capability analysis refers to the process of evaluating the ability of a community to mitigate against, prepare for, respond to, and recover from a natural hazard.

Implementation

This kind of analysis should look at four areas of capability:

- administrative/institutional capability, including local emergency management capacity and inter-local government coordination.
- legal capability, including ordinances that aid or hinder mitigation efforts
- fiscal capability, including the funds and funding sources are available to the community to pay for mitigation efforts
- technical capability, including an assessment of the level of technical ability within the community to design and implement mitigation measures

Capital Facilities Plans

Capital Improvements Program
Focused Public Investment Plan
Plans, Capital Facilities
Plans, Capital Improvements
Program, Capital Improvements
Public Facilities

Index Listing
Hazard:
- All

Activity:
- Engineering
- Planning
- Public Works
- Town/City Manager

CRS-Compatible Activity:
- 520: Acquisition and Relocation

North Carolina Region:
- Statewide

Definition

The term 'capital facilities' refers to infrastructure and services such as sewer, water and transportation systems, as well as police stations, fire stations, health clinics and schools[33]. Capital facilities form an important aspect of hazard mitigation in that current facilities can be relocated to less hazard-prone areas or retrofitted, and the planning of future facilities such as sewer and water extensions can be used to avoid extending infrastructure into hazardous areas. The latter tool is referred to as a capital improvements program (CIP), which sets public spending on improvements for the ensuing five to ten years. CIPs define when, where, and what level of municipal services a government will supply and what level of expenditure should be expected.

Implementation

A number of measures may be taken to ensure the resilience of current or existing capital facilities to natural hazard events. Public utilities should be relocated, upgraded or floodproofed. Power and telephone lines may be buried underground (see **Utility Lines**). Wastewater treatment plants tend to be located at the lowest geographic point in the community in order to maximize their gravity flow area. Since these points are typically in floodplains, treatment plants are frequently flooded and shut down for temporary or extended periods of time. They should be relocated or

floodproofed. Finally, public buildings that function as shelters following a disaster should be designed or upgraded to operate safely in hazard conditions. Schools should be made earthquake-resistant throughout.

Examples:

- Memphis (TN) Light, Gas and Water won a FEMA Hazard Mitigation Grant Program grant to pay 75% of the cost of retrofitting its pump station to withstand earthquakes. While the grant is valued at $480,000, estimated cost of replacing the facility is $12M and each day of lost service is valued at $1.4M.[34]
- Instead of requiring new schools to be entirely hazard-proofed, Dade County, FL, requires new buildings to have a "wind and debris resistant storm pod." The pod provides a shelter for the community while adding only an estimated two percent to the cost of construction.[35]

In contrast, the capital improvements program or CIP addresses the long-term growth of a community by providing a framework for the location and expansion of capital facilities in the future. Typically a part of the comprehensive plan, the CIP can be effective at managing growth because it is rarely feasible for a developer to provide water, sewer and other services without a public subsidy, and should be used to limit development in underserved, hazard-prone areas. In addition to saving the cost of infrastructure, communities save the cost of mitigation and disaster recovery. The CIP budgeting structure can be used for tracking and using **impact fees** and **exactions**, which may be dedicated for mitigation purposes.[36]

Capital improvements can be addressed more narrowly than at the community-wide scale. A focused public investment plan (FPIP) is a capital improvement plan for a specific small area. Like a community capital improvements program, a FPIP coordinates public investments in water, sewer, streets, schools and parks.

Critique

In providing additional capacity, the retrofit or improvement of existing capital facilities to withstand natural hazards may inadvertently encourage additional development in hazard-prone areas. For example, widening a road to reduce evacuation times may stimulate additional development. As a result, capital facilities planning that makes improvements to existing infrastructure should be done in conjunction with other land use planning measures to ensure that development in hazard-prone areas is not stimulated. (For more information, see **Concurrency**). On the other hand, explicitly prohibiting post-disaster reconstruction of public facilities in hazard-prone areas may encourage residents in these areas to relocate, since they cannot be sure that services will be restored after a disaster.

With regard to CIP, this technique is less expensive and less likely to face legal challenges than many other growth management techniques because budgeting is a recognized function of local government. The drawback is that municipalities often ignore their own capital improvements programs. Developers are sometimes willing and able to provide their own infrastructure. CIP should not be a community's sole land-use policy because although it directs the location and timing of development, it does not address its type or quality.[37]

Capital Improvements Program (CIP)

See: Capital Facilities Plans

Carrying Capacity

Index Listing

Hazard:
- All

Activity:
- Town/City Manager
- Planning

North Carolina Region:
- Statewide

Definition

Carrying capacity is a way of thinking about how much human impact an ecosystem can withstand. The concept of carrying capacity is borrowed from biology, where it refers to the amount of growth an area can sustain before it reaches a certain threshold, usually a point of irreversible change. Carrying capacity can be used in planning to refer to the amount of use or change that can be accommodated within the limits of the natural or man-made environment, or the limits of institutional change.

Implementation

Carrying capacity can be used to evaluate the impact of development on the natural system, on man-made structures, and on institutions. In the case of hazard mitigation, these limits could be designed to curtail development that exceeds evacuation capacity; to direct development away from natural mitigation features whose effectiveness would be diminished by building; or to restrict development in fragile and hazard-prone areas. It is important that the linkage between the impact and the limit be quantified. Limits can be applied in terms of the realistic evacuation capabilities, water supply, sewer and road capacities, and land area.

More abstractly, the carrying capacity concept could be applied to the institutional willingness of a community to engage in hazard mitigation planning. It is possible that at some population size, at some socio-economic composition, or at some distance from a hazard event, communities become less inclined to spend their resources on hazard mitigation. For example, one study found that the greater the percentage of the floodplain that was already developed, the less likely the community was to mitigate these properties. On the other hand, community wealth has been found to positively influence mitigation because the cost of action is seen as relatively lower, the tax base will support innovative programs, and the community may be willing to regulate high-hazard, high-wealth areas.

Examples:

- Sanibel, FL, estimated its population threshold based on this barrier island's carrying capacity. The community used two measures: environmental carrying capacity, which is defined as the limits of the wetlands' ability to process pollutants, and structural carrying capacity, which is the limit of the evacuation capacity of its roads. Estimates of the maximum capacity of these systems provide the basis for Sanibel's comprehensive plan and the justification for the island's development management program. Sanibel's development regulations are designed to match development to the specific capacities of the various ecological zones on the island.

Critique

The links between development and its impacts can be difficult to quantify precisely. Carrying capacity should be a method for evaluating public policy decisions, not a way to make decisions.

Cemeteries

Definition

When cemeteries are located in or near a floodplain, protect public and private cemeteries with grassy berms to protect burial sites from floodwaters.

Implementation

Ideally, the government-owned, roadside easement is wide enough to build an adequate berm. Berms can also be used strategically as part of the stormwater system, channeling water into appropriate receptor areas such as natural lands, culverts, or detention ponds.

Critique

There may be concerns with crime surveillance if berms are over a certain height.

Berms

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Planning
- Public Works

North Carolina Region:
- Statewide

Channelization

Definition

Channelization is a general term used to describe a range of modifications to stream beds. These modifications can include widening or dredging the channel or lining it with impervious materials. All of these actions share a common purpose: to increase the volume and/or velocity of water flow in the channel.

Implementation

Streams and channels that are intended to drain stormwater or function as part of a **diversion** must be large enough for the flood hazard. Increases in **impervious surface** resulting from development can significantly increase the storm runoff levels. Channelization can improve a stream's ability to mitigate floods by increasing the rate at which surplus water is carried away. Where soil erosion and sediment deposition have partially filled in a channel, widening or dredging can restore its former drainage capacity. Care must be taken that channelization does not significantly alter the stream dynamics downstream.

Index Listing

Hazard:
- Erosion
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Engineering
- Planning
- Public Works

North Carolina Region:
- Statewide

Channelization is designed to move water quickly away from built areas. One alternative is to absorb the water onsite or nearby. This can be done by using wetlands and stream bank vegetation to slow, absorb and filter pollutants out of stream water (see **Floodplain Management Plans**, **Vegetation**, **Wetlands Preservation**, and **Acquisition**).

Examples:

- The city of Los Angeles cleared, straightened, deepened and lined its flood channels with concrete to reduce friction and increase velocities. The channels have prevented flooding where they have not been overtopped by floods that exceeded capacity. However, the channels are a drowning hazard because the rapidly flowing water and concrete sides make the channels difficult to escape.[38]

Critique

Channelization can lead to erosion problems on unimproved stream banks by increasing the velocity at which water moves along the bank. An increased stream flow rate can also diminish the ability of the natural streambed to support many forms of aquatic life. This effect is most pernicious when the channel is lined with an impervious material like concrete.

An associated hazard can result from the channelization of storm-related runoff. Many flood channels or storm sewers are designed to prevent water from flooding streets by directing it into a nearby stream. If these stormwater facilities are lined with cement or other impervious surfaces they may drain too quickly, overwhelming the target stream's capacity and causing flooding. If the runoff that flows into streams has not been filtered, it can contaminate downstream water bodies.

Finally, by removing the river's vegetated banks and riparian corridor, as well as by straightening the natural meander of the river's path, this measure irreparably alters the aesthetic value of the river.

Cluster Development

See: Planned Unit Development

Commercial Park

Definition

Assemble parcels for a low-hazard commercial or light industrial park, viable for both large and small local businesses that are currently vulnerable to natural hazards. The security (and newness) of the commercial park may entice entry of new business or industry, thereby encouraging spatial economic diversification. The resulting decentralization of the local commercial vitality and tax base can decrease the probability of economy-crippling destruction by hazards.

Industrial Park
Park, Industrial

Index Listing

Hazard:
- All

Activity:
- Planning

CRS-Compatible Activity:
- 520: Acquisition and Relocation

North Carolina Region:
- Statewide

Implementation

If possible, place business parks in areas designated in the master plan to receive commercial development, in order to avoid traffic scenarios incompatible with residential development. In choosing a location, consider the feasibility of connecting the site with the public transit system.

Community Awareness Programs

See Also: Real Estate Disclosure Requirements
See Also: Disaster Warning
See Also: Education and Training
See Also: Home Inspection Programs

Index Listing

Hazard:
- All

Activity:
- Emergency Management
- Town/City Manager
- Planning

CRS-Compatible Activity:
- 330: Outreach Projects

North Carolina Region:
- Statewide

Definition

Community awareness programs may be used in conjunction with or in place of real estate disclosure requirements to directly educate homebuyers and the general public of hazard risks and mitigation strategies.

Implementation

Information can be presented in a number of ways, including pamphlets, brochures, literature, workshops, radio and TV ads or billboards. Marking historical disasters, such as flood levels, in prominent places can be an effective way of increasing community awareness of natural hazards. Important topics to cover with a general awareness program include: things to consider when purchasing a home or business; means of identifying hazards; and ways to limit exposure and reduce future property damages. Awareness programs that are specifically targeted at new home buyers should educate them on mitigation techniques and features to look for when considering the purchase of a home in a hazard area.

Both education and regulation are more effective when they are paired than when they stand alone. Planning could be considered a community awareness program, since participation in the planning process can help communities establish a feeling of "ownership" over mitigation measures. This, in turn, may help generate public support for mitigation. Awareness and outreach programs should be targeted at people who are directly affected by mitigation activities, such as acquisition programs, to address their concerns and to explain the importance and consequences of these actions.

Examples:

- Fernandina Beach, FL, officials planned to establish a citizens' advisory committee to participate in developing mitigation measures. They also planned to make regular appearances at business group meetings, such as the local Chamber of Commerce, to make businesses aware of mitigation techniques.
- Avalon Borough, NJ, developed and mass-mailed flood-level maps with a letter of explanation to residents. Officials prepare and distribute a quarterly newsletter outlining proposed evacuation routes, dredging and beach-fill projects and shelter locations (1992).
- Following severe flooding in 1990, South Holland, IL formed a Flood Liaison Committee to bring residents and officials together to create a flood hazard plan. The committee also studied flood control alternatives, hosted a floodproofing open house, and enrolled the community in the Community Rating System. The village established a Flood Assistance Program that provides public information and technical assistance to homeowners.

Critique

General awareness programs have a "mixed" record of building public support for mitigation. More successful are self-help programs with a narrow scope, such as residential floodproofing or earthquake mitigation drives.

Comprehensive Plans

Definition

Plans, Comprehensive

Index Listing

Hazard:
- All

Activity:
- Town/City Manager
- Planning

CRS-Compatible Activity
- 420 Open Space Preservation

North Carolina Region:
- Statewide

Comprehensive plans identify how a community should be developed and where development should not occur. They govern the rate, intensity, form and quality of physical development. A thorough comprehensive plan will also address economic development, environmental, social and hazard mitigation concerns. Their main advantage as a hazard planning tool is that they guide other local measures, such as capital improvement programs, zoning ordinances, and subdivision ordinances. Comprehensive plans are useful for creating a body of information about local hazard risks. On the one hand, they help identify hazard areas. The appropriate land uses and building (or retrofitting) standards can then be applied to those areas. On the other hand, they identify areas that are less vulnerable to hazards, where development should be directed[39]. Their main advantage as a hazard planning tool is that they guide other local measures, such as capital improvement programs, zoning ordinances and subdivision ordinances.

Implementation

Hazard mitigation is often addressed through separate, stand-alone plans created in the wake of a disaster. Some hazard experts believe integrating mitigation into comprehensive plans is preferable to developing independent hazard plans[40]. In the former case, mitigation may be one element of a comprehensive plan or it may be integrated with other elements. The typical elements of a comprehensive plan include land use, transportation, economic development, environmental protection, dedication of open space, provision of infrastructure and other municipal functions. The drawback to making mitigation one of these is that it can be overshadowed by a community's other concerns[41].

On the other hand, integrating mitigation into comprehensive planning can improve its effectiveness in four important ways. First, it institutionalizes the process of addressing hazards. This may help make mitigation a habit for community officials. Second, it can create a constituency for mitigation by making it a part of the public discussion of community goals that should be a part of any comprehensive planning process. Third, it allows communities to integrate mitigation with other community objectives. An example of this would be acquiring flood prone properties to achieve both mitigation and open space goals[42]. Fourth, integrating mitigation planning makes it easier for communities to address multiple hazards at once, a process known as cross-mitigation.

Comprehensive planning requires local governments to collect and analyze information about land's suitability for development. This process helps policy makers and local residents understand the limitations to development in hazard-prone areas[43]. In turn, land uses can be tailored to the hazard risk, typically by reserving dangerous areas for less intensive, hazard-compatible uses such as parks, golf courses, backyards, wildlife refuges or natural areas. Other elements of a plan can directly address hazard risk. For example, the capital improvements element should address the elevation or relocation of critical public facilities that could be incapacitated by natural hazards.

Plans can take four forms. Land classification plans are maps of districts that are subject to different growth management policies. These districts may include areas with high hazard risk (and, preferably, strict restrictions on growth). A land-use design plan presents a future image for the community. This image may include open space reservations that are purposely located in hazard-prone areas. A verbal policy plan is oriented toward policy statements rather than spatial distributions. One segment of this type of plan may be dedicated to hazard mitigation policies. A development management plan identifies a specific program for development, which may be in part aimed at restricting development in hazard areas[44]. Plans may borrow components from more than one of these varieties.

Specific development plans describe land uses and subdivisions in greater detail and cover a smaller area than do comprehensive plans, zoning maps, or public facilities plans. They may designate specific uses or design standards

that vary from the zoning ordinance and may even contain enough detail to allow approval of developments that comply without a public hearing.
The objective of these plans is to preclude inefficient or hazardous land use by coordinating the development of adjacent properties. Developers have an incentive to comply since appropriate designs ensure a fast track for approval.

Examples:

- North Carolina's Coastal Area Management Act requires that each coastal county produce a comprehensive land use plan, of which hazard mitigation must be one element.
- The objectives for Dade County, Florida's comprehensive plan include maintaining or lowering evacuation times, increasing shelter capacity by 25 percent by the year 2000, and using pre- and post-disaster development management techniques to reduce building in coastal high-hazard areas[45].

Critique

Comprehensive plans have limited authority, even where they are required by the state. In North Carolina they are required in two cases: if the community is subject to the Coastal Area Management Act; or if the community wants to establish a zoning code. Zoning codes must be in accordance with a comprehensive plan.

Concurrency

Definition

Concurrency measures are designed to match the pace of new growth (which requires public spending on roads, water and sewer service, etc.) to the community's ability to pay for infrastructure. Public services must be concurrent with the demand. "Adequate public facilities" is a measure of the level of municipal services that must exist when a development is completed or within a certain period afterward.

Adequate Public Facilities Requirements
Public Facilities, Adequate Requirements
Requirements, Adequate Public Facilities

Index Listing

Hazard:
- All

Activity:
- Engineering
- Town/City Manager
- Planning
- Public Works

North Carolina Region:
- Statewide

Implementation

Communities should be aware that these programs can redirect development into unexpected places. Cities should be especially careful when promising or extending services outside the city limits that they do not provide services to hazard-prone areas. Creating an urban services district may help define where these services will and will not be provided. Clarifying the long-term development expectations this way may help shift the direction of development toward more acceptable locations.

Adequate Public Facilities (APF) programs can also require that an adequate degree of mitigation is provided for new development. For example, a municipality could require that the water supply for fire-fighting purposes meet some APF level for all new development. APF or concurrency requirements are often written into comprehensive plans as a means of timing development.

Critique

These requirements can have the effect of encouraging development in areas already well served by public facilities. This might lead to higher densities in developed, hazard-prone areas. On the other hand, it might shift development to hazard-prone areas with lower service requirements.

Development timing measures such as these must have the support of the community or they are likely to be ignored. Development timing has been challenged in court in states like North Carolina, where local government is limited to powers specifically granted by the state. Within city limits, a municipality may be required to provide the same service to everyone. Foreclosing on private provision of facilities by, for example, limiting septic permits may be legally problematic.

Consultant

See: Review of Site Plan by Specialist

Contract Zoning, Conditional Zoning and Special Exceptions

Zoning, Conditional
Zoning, Contract
Special Exceptions

Index Listing

Hazard:
- All

Activity:
- Town/City Manager
- Planning

North Carolina Region:
- Statewide

Definition

Under contractual or conditional approaches, the property owner agrees to certain conditions in exchange for rezoning or an exemption from other aspects of the zoning code. The conditions are negotiated on a case-by-case basis. The difference between contract and conditional zoning is that the government is contractually obligated to allow the use negotiated under contract conditions.

The term special exception, which is often used interchangeably with conditional or special use permit, is used for activities that are permissible within a zone but require an additional layer of approval (unlike a variance, which is a departure from the permissible uses in a zone). This extra layer is required if the conditional use needs additional scrutiny or must meet specific criteria. Special use permits are often required where a project would be approved if the developer is able to show that he or she could mitigate for the adverse environmental impacts of their development. The community is not obligated to provide anything to the recipient of a special exception.

Implementation

Special use could be used to give communities a process for reviewing projects in hazard-prone areas. For example, it might allow certain uses in higher-risk areas if the developer can demonstrate that mitigation techniques would be incorporated.

Critique

Both contract and conditional zoning can be challenged on the grounds that all land in a zoning district must be subject to the same restrictions, as illegal spot zoning, or for contradicting the comprehensive plan. Both contract and conditional zoning have been ruled invalid in North Carolina. The purpose of these techniques is to provide flexibility in dealing with a small number of land parcels, but they can nonetheless be unpopular with developers since the actual requirements for development may not be explicit until the project review stages.

Controlled Burning

See: Prescribed Burning

Critical Facilities

Definition

Critical facilities are essential to the health, safety and viability of a community. These are the buildings, services, and utilities without which residents and businesses cannot survive for long, such as hospitals, police stations, fire stations and sewage treatment plants. Therefore, the security of these facilities is imperative to ensure the public's health and safety in the aftermath of a hazard event. Steps that communities can take to better protect their critical facilities include such measures as retrofitting, relocation and acquisition. See the cross-referenced entries above for more ideas on how to increase the resiliency of your critical facilities to hazard events.

See Also: Freshwater Well
See Also: Safe Site
See Also: School Facility
See Also: Seismic Retrofits of Critical Facilities
See Also: Vulnerability Assessment
See Also: Capital Improvements Program
See Also: Acquisition

Index Listing

Hazard:
- All

Activity:
- Planning

CRS-Compatible Activity:
- 520: Acquisition and Relocation

North Carolina Region:
- Statewide

Culverts

See: Drainage Culverts

D

Damaged Structures

See: Acquisition

Dams and Reservoirs

Reservoirs

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricanes
- Nor'easter
- Thunderstorm

Activity:
- Coastal Engineering
- Engineering
- Town/City Manager
- Planning
- Public Works

CRS-Compatible Activity:
- 630: Dam Safety

North Carolina Region:
- Statewide

Definition

A dam is a structure built across a waterway to impound water. Dams act as flood control devices and also to maintain water depths for navigation, irrigation, water supply, hydropower and other purposes. Reservoirs are water storage facilities. Like retention ponds, reservoirs can be used to hold water during peak runoff periods in order to promote groundwater infiltration or to allow for controlled release during non-peak periods.

Implementation

Dams and reservoirs can serve as effective flood control measures by retaining water and releasing it at a controlled rate that does not overwhelm the capacity of downstream channels. The storage capacity of a dam or reservoir should be a primary consideration in its design and construction. The capacity should be large enough to accommodate historic-scale flood events. Any dam or reservoir should include a spillway—a feature of a dam allowing excess water to pass without over-topping the dam. Usually a spillway functions only during a large flood.

A community should do a thorough watershed analysis that identifies all of the effects of building a dam, including the expected monetary, environmental and social costs. The study should identify the most effective and efficient location for each potential dam. This study should also ensure that a dam that reduces flooding in one location will not increase the flooding problem elsewhere.

Dam failure is difficult to mitigate. Local officials should monitor dam maintenance and pressure state officials and private dam owners to follow prudent safety procedures. Local governments should use land-use controls, including zoning and acquisitions, to keep the floodway clear of development downstream of the dam. Building codes in these areas should require that homes be elevated to a base flood elevation that assumes dam failure.

Critique

As with other structural projects, dams and reservoirs are expensive, occupy a lot of land, require periodic maintenance, and only prevent damage from floods for the capacity they are designed to handle. Dams have many environmental costs and eliminate the natural and beneficial functions of the floodplain, including its ability to absorb stormwater. The potential for dam failure is an additional hazard. The long-term viability of any dam depends on the normal sediment load in the waterway to be dammed. Sedimentation can reduce the capacity of a reservoir or increase its volume, decreasing its flood storage capacity.

Ownership and control of dams may not reside solely with local governments making it harder for local officials to direct their use and safety. Dam and reservoir projects are frequently managed with the help of state or federal agencies, such as the U.S. Army Corps of Engineers and the Natural Resources Conservation Service. Sometimes dams are operated cooperatively by several local jurisdictions. Others are owned and operated privately.

Debris

See: Stormwater Drain Maintenance

Density, Development

See: Development Density

Detention Basin

See: Stormwater Basin

Developer Exactions

Exactions
See Also: Impact Fees

Index Listing

Hazard:
- All

Activity:
- Town/City Manager
- Planning

North Carolina Region:
- Statewide

Definition

Unlike impact fees, which are a use-based charge, exactions are direct private investments in the public infrastructure needs created by new development. Exactions can take the form of on- or off-site improvements, land dedication or grants to the community. Unlike impact fees, exactions are negotiated on a case-by-case basis. They are often a condition for development approval.

Implementation

Communities should be explicit about the importance of mitigation efforts when negotiating exactions. Land dedications are generally a preferable form of exaction because they have a close proportional relationship to the development. Fortunately, dedications of open space in the floodplain or other hazard-prone areas can be a significant aid to mitigation efforts. However, local governments should be prepared to cover the costs of maintaining land acquired through an exaction. Cash exactions could be dedicated to a land acquisition or post-storm reconstruction fund[46]. Communities should require that public facilities that are to be dedicated to the community be built to hazard-resilient standards[47].

Critique

There must be a rough proportionality between the impact of development and the negotiated exaction. Negotiated exactions can be very specific, but they also create problems: they usually reflect the needs of individual developments and not the community as a whole; they are not predictable far in advance; particular conditions of a project or the bargaining ability of the negotiators may make some exactions appear inequitable; small developments may not be subject to the same kind or degree of exactions as large ones, even though they can have the same or greater cumulative effect; and exactions do not cover maintenance costs. Land dedications, a common form of exaction, do not pay for improvements.

Development Caps

See: Slowing Development

Development Density

Definition

Lower the allowable intensity of development in hazardous areas to prevent intense private development within areas delineated as high-hazard. Density ordinances can be applied within floodplains, on hillsides, along fault lines, in the surcharge area along the coast, or any other area that can be demonstrated as a high-risk zone.

Density, Development

Index Listing

Hazard:
- All

Activity:
- Planning

CRS-Compatible Activity:
- 430 LZ: Low Density Zoning

North Carolina Region:
- Statewide

Implementation

There are two primary ways to regulate residential development density: set maximum housing density or set minimum lot size. In terms of floodplain development, both approaches are complemented by limits on the percentage of impervious surface within parcels. 11 Intensity can also refer to the type of development: new commercial development can reasonably be precluded or dissuaded from hazardous areas in the interest of protecting these major contributors to the tax base.

Critique

Be aware of the possible inefficiencies in servicing dispersed development.

Development Impact Fee

See: Impact Fees/System Development Charges

Development Impact Tax/Improvement Tax

Definition

These are taxes on new construction, including alterations to existing structures, usually paid while applying for a building permit. Unlike an impact fee, this charge does not need to be in proportion to the cost of improvements, and there are fewer restrictions on how the revenues can be spent.

Impact Tax
Improvement Tax
Taxes, Impact
Taxes, Improvement

Index Listing

Hazard:
- All

Activity:
- Building Inspection
- Town/City Manager
- Planning

North Carolina Region:
- Statewide

Implementation

Because these funds are collected on new development, they should be used to mitigate the impacts of that development. Potential projects for hazard mitigation are discussed throughout this document.

Development, Infill

See: Infill Development

Development Rights

See: Purchase of Development Rights (PDR)
See: Transfer of Development Rights (TDR)

Development Taxes

See: Land Gains Taxation

Differential Assessment/Taxation

Definition

Differential assessment is a technique for reducing the tax burden on land facing development pressure by recognizing that undeveloped properties require fewer public services. This technique can moderate the pressure to develop land at its "highest and best" use in one of several ways: by reducing the tax rate applied to land so that payments are equal to its essential services; by reducing the assessed value of land to a percentage of urban land; or by assessing the value of land based on its income-producing capacity, as opposed to its market value.

See Also: Easements

Index Listing

Hazard:
- All

Activity:
- Town/City Manager
- Planning

North Carolina Region:
- Statewide

Implementation

Differential assessment is typically allowed for farm and forestland, open space and recreational uses[48]. It could be used for mitigation purposes to reduce the development pressure on hazard-prone or hazard-mitigating open space. Alternatively, it could be used as an incentive to reduce the density of proposed projects in hazard-prone areas. Easement and development rights donations or sales could also be encouraged through differential assessment[49].

There are three major types of differential taxation. The first, pure preferential assessment, allows property to be assessed at its current (rather than highest and best) use. The owner does not have to repay past taxes if he or she changes its use. Deferred taxation requires the landowner to make up some of the tax benefit if the land use changes. Restrictive agreements require that a landowner enter into a written agreement to maintain the land in a certain use for a specified length of time. Penalties would apply if the landowner broke the agreement. The agreement could be written to automatically renew each year after the minimum period unless the landowner explicitly chooses to end the agreement[50]. Speculation can be combated with either a change in use/conveyance penalty, or a deferred taxation system, where the difference between market and preferential tax rates are paid when the property is converted to a higher use. Laws vary, but most penalties range between five to ten years of past taxes due. In rapidly growing areas, the amount of accumulated past taxes may not be enough to offset profits.

Examples:

- North Carolina allows the preferential taxation of farm and forestland under a deferred taxation approach. Historic properties are also eligible for a preferred tax rate[51].

Critique

The loss of tax revenue from this program can be substantial. It can also have the unintended consequence of encouraging speculators, who could purchase property with a low tax burden and sell it when the difference between its assessed and market values grows. For this reason, differential assessment probably works best in a stagnant to moderately-active real estate market, when the opportunity costs for holding land are low. It may be more effective if used in conjunction with zoning that reduces the allowable density—thereby reducing the development pressure on each parcel[52]. Legal challenges to this technique have been based on uniform taxation provisions in state constitutions[53].

Dikes, Levees, Floodwalls and Berms

Levees
Floodwalls
Berms
See Also: Sewage Treatment Plant Retrofit

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Coastal Engineering
- Engineering
- Town/City Manager
- Planning
- Public Works

CRS-Compatible Activity:
- 620: Levee Safety
- 530: Retrofitting

North Carolina Region:
- Statewide

Definition

Dikes and levees are often used synonymously. Dikes are usually an earthen or rock structure built partially across a river for the purpose of maintaining the depth and location of a navigation channel. Levees are earthen embankments used to protect low-lying lands from flooding. Levees are built between the floodway and the structures that they are intended to protect. A floodwall is a reinforced concrete wall that acts as a barrier against floodwaters. Floodwalls are usually built in lieu of levees where the space between the floodway and neighboring structures is limited. Berms are barriers created by grading or filling areas with soil and are meant to keep flood waters from reaching buildings.

Implementation

To be effective, levees (or any similar flood control structure) must be located outside of the floodway and must compensate for the flood storage they displace. Levees, dikes and floodwalls should not be used to reclaim land in the floodplain for development. Floodplain managers should consider alternative, ecosystem-friendly mitigation techniques. These include protecting or restoring wetlands (see Vegetation and Wetlands Preservation) and acquiring flood-prone structures and properties for non-constructed uses, such as recreational or open space (see Acquisition and Relocation).

Examples:

- The city of Batavia, NY, constructed a dike and berm system as a response to the repeated flooding of Tonawanda Creek. These flood control structures were designed to channel high waters into Kibbe Park, a recreational area that is located on the banks of the creek on the south side of the city. By directing the waters into the park, the city was able to contain much of the flooding in this uninhabited area rather allowing it to continue to drain into the surrounding residential neighborhoods.
- The Des Moines, IA Floodwall, the only structural flood mitigation project funded by FEMA after the 1993 Midwest Floods, includes a moveable floodgate that completes a levee that was built to protect the city in 1961. The gap in the levee that existed prior to the construction of the floodwall was responsible for more than $117 million in flood-related damage to property in Des Moines. The floodgate cost $484,000.

Critique

The Midwest Floods of 1993 clearly demonstrated that each of these structures is subject to being overtopped or breached by floods that exceed their design. Despite this risk, their existence may encourage development in areas they appear to protect.

These structures interfere with the environment's ability to naturally mitigate floods, which it can do by absorbing high water into wetlands and low-lying areas. These walls prevent flood waters from flowing into the natural floodplain. As a result, they frequently concentrate flooding in locations up- and downstream from their location.

These flood control structures can also deprive natural habitats, such as wetlands, of the water they need to function[54].

Disaster Warning

Definition

The first step in responding to a potential disaster is to know that one is coming. Disaster warning refers to both the monitoring of local conditions and the broadcasting of pre-event alerts.

Implementation

Disaster warnings are issued through the National Weather Service and can be administered in a number of ways, including via sirens, radio, television, cable TV, mobile public-address systems, telephone trees, and even door-to-door contact. Posted signs can be used to identify risks at a particular site. Multiple or redundant warning systems are most effective, as they ensure that a message will be received even if one part of the warning system is not heard.

Warning
See Also: Animal Shelter Location
See Also: Community Awareness Programs
See Also: Education and Training

Index Listing

Hazard:
- All

Activity:
- Town/City Manager
- Emergency Management

CRS-Compatible Activity:
- 610: Flood Warning Program

North Carolina Region:
- Statewide

Examples:

- Avalon, NJ, installed a borough wide public address warning system that includes television access through the local cable television company (1992)[55].

Critique

People ignore warnings for a variety of reasons: they misperceive the probability of a disaster; they underestimate the effectiveness of mitigation measures; they have a fatalistic belief that it is impossible to control their fate. On the other hand, people may rely too heavily on warnings, leading them to unnecessarily expose themselves to risk[56].

Disclosure Requirements

See: Real Estate Disclosure Requirements

Diversions

Definition

A diversion is a new stream channel that sends floodwater to an alternative location, reducing flooding or erosion along the primary route. Diversions can be surface channels, overflow weirs, or tunnels. During normal flows, the water stays in the primary channel. Under flood conditions the stream spills over to the diversion channel or tunnel, which carries the excess water to a receiving river, lake, reservoir or retention pond.

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Erosion
- Thunderstorm

Activity:
- Engineering
- Planning
- Public Works

North Carolina Region:
- Statewide

Implementation

In addition to flood prevention, diversions can be used for slope stabilization and erosion prevention. In the latter cases, the diversion is used to channel water away from loose soils. Care must be taken to ensure that the diversion does not cause a flood problem in a new location. Even the appearance of transferring flood waters to someone else's neighborhood greatly complicates—and may halt—a diversion project.

Critique

Since diversions are limited by their need for a receiving site, they are not a solution for every case. Unless the target water body is relatively close to the flood-prone stream and the land in between is low and vacant, the cost of creating a diversion can be prohibitive. Tunnels are no less expensive, but they can make a diversion possible where the topography and land use are otherwise not favorable.

Drainage Culverts

Definition

Increase dimensions of drainage culverts in the most troublesome areas to improve stormwater removal in repetitively flooded areas. Wider culverts enhance the ability of the neighborhood stormwater system to convey accumulated surface waters.

Implementation

Prioritize culverts for upgrade according to their level of susceptibility or the number of property owners affected, and err on the side of overestimation when building culverts under new streets. Downstream culverts, particularly culverts downstream of large urban areas, might be enlarged to compensate for decreases in pervious surfaces.

Culverts
See Also: Bridges
See Also: Drainage System Maintenance

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Engineering
- Planning
- Public Works

CRS-Compatible Activity:
- 540: Drainage System Maintenance

North Carolina Region:
- Statewide

Drainage System Maintenance

Definition

Clogged or broken drainage systems can seriously impair stormwater management efforts. Flood channels, storm sewers, retaining ponds and erosion basins can become blocked by overgrowth, debris, sedimentation, or components that fail with age.

Implementation

Drainage systems require perpetual maintenance. Replacement or improvement of culverts, mains, stormwater lines, sewer pipes and backup valves should be part of a general program of maintenance and improvement to reduce flooding hazards.

Regulations should ensure that the system is allowed to function as it was designed. For example, no one should be allowed to dump in or alter drainage watercourses or flood storage basins. The filling of wetlands and property in the floodplain should be restricted because damage to these flood-mitigating natural

Maintenance
See Also: Drainage Culverts

Index Listing

Hazard:
- Erosion
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- City Manager
- Public Works

CRS-Compatible Activity:
- 540: Drainage System Maintenance

North Carolina Region:
- Statewide

features can create new hazards or worsen existing ones. Local officials should distribute public information materials that explain the reasons for the rules as well as the penalties. Regular monitoring and inspections will be necessary to help deter violators.

Examples:

- Marooning County, OH, used television cameras to scan its stormwater and sewage lines for breaks and clogs[57].
- The city of Wilmington and New Hanover County, NC are using federal funding for programs to help ensure that their storm sewers remain clean.

Critique

Drainage system maintenance can be a low priority for local officials since storms that test or exceed a system's capacity are infrequent. Likewise, a lack of awareness among the general public can hinder the maintenance of drainage systems. Residents may fill in front-yard street runoff drainage ditches without knowing their purpose. Roadside drainage ditches can be a significant drowning hazard.

Drains

See: Stormwater Drain Maintenance

Dredging

Definition

Dredging is the technique of deepening a channel by extracting sediment. It is primarily used to maintain the navigability of channels and waterways. Offshore dredging is also used to provide sand for beach nourishment projects.

Index Listing

Hazard:
- Erosion
- Hurricane

Activity:
- Coastal Engineering
- Beach Management
- Shore Protection
- Town/City Manager
- Planning
- Coastal Management

North Carolina Region:
- Statewide

Implementation

CAMA requires that, where appropriate, sandy dredge material should be used to renourish starving beaches. This may be a revenue-generating step that could help offset some of the costs of dredging projects. Dredge spoil not used for nourishment must be contained on land, away from coastal wetlands.

Critique:

Dredging projects, like beach nourishment projects, require repetitive implementation since channels often refill with sediment. Disposing of dredge material may be expensive, especially if it is not suitable as beach fill. Disposal must be done in a way that does not endanger wetlands, shellfish beds or fish spawning and nursery areas[58].

Dredging projects that harvest nearshore sand to be distributed on the beach may be counterproductive. By robbing offshore banks, the project may increase the intensity and erosive power of the waves that strike the renourished beach. Offshore banks of sand may also provide new sediment for these beaches through a natural process of accretion in which sand drifts onto the beach. Dredging removes sediment from this sand "economy."

Dune Gap Plugs

See: Roadway Realignment

Dune Protection and Shoreline Setbacks

Setbacks, Shoreline
Shoreline Setbacks
See Also: Sand Dunes

Index Listing

Hazard:
- Erosion
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Beach Management
- Shore Protection
- Town/City Manager
- Planning
- Coastal Management

CRS-Compatible Activity:
- 400SH: Special Hazard Areas

North Carolina Region:
- Eastern/Coastal

Definition

The beach and its dunes provide coastal development with its first line of defense against storm winds and waves. Dune protection restrictions are designed to protect dunes from damaging development. Shoreline setback requirements establish a minimum distance between the existing shoreline and the buildable portion of a lot.

Implementation

CAMA requires that new development not cause the "significant" removal or relocation of sand or vegetation from primary and frontal dunes. Frontal dunes are the first dunes landward of the beach large enough to provide some measure of storm protection. Primary dunes are the first dunes with a height equal to the mean flood level plus six feet. CAMA requires that small structures be located landward of the toe of the frontal dune or the crest of the primary dune, whichever is further landward[59].

CAMA sets an "erosion setback line" which is located landward of the first stable natural vegetation at a distance equal to 30 times the annual erosion rate or 60 feet, whichever is further. No construction of small structures is allowed to occur seaward of that line. Large structures are subject to a setback of 60 times the annual erosion rate, but no more than 105 feet further landward than small structures.

Local governments may require additional minimum lot size and setback requirements in addition to the CAMA regulations. Setbacks from hardened structures should be required since water can run up to and over seawalls, bulkheads and revetments. On the other hand, landward setbacks may be relaxed after a disaster in order to encourage citizens to rebuild as far from the shoreline as possible[60]. Large lot or cluster development can help protect dune areas and their sand supplies by reducing and concentrating impacts on a portion of each lot.

Any dune ordinance should provide clear guidance for the expected design of new dunes, guidelines for repairing damaged dunes, improving existing dunes or placing structures in a dune zone. Although CAMA allows development on interior dunes, local communities could require that development in these areas be elevated on stilts to preserve the dunes[61].

Critique:

Dune protection regulations generally have weaknesses that seriously impair their performance. For example, these regulations are frequently extended only to the first, or frontal dunes[62]. Interior dunes, which can also absorb storm surge if left undisturbed, are frequently damaged or destroyed by construction.. Dune protections often neglect the fact that dunes are migratory. These regulations should identify and protect areas where dunes often (if not always) are[63]. The impervious surfaces that accompany development can choke off dunes' natural supply of sand.

Because dune protection restrictions are not sufficient to preclude development in hazardous areas directly landward of the dunes, some communities supplement them with shoreline setbacks. Setback requirements can protect near-shore development from serious, but not necessarily severe, coastal storms. Setbacks are frequently measured against mean high tide, rather than observed erosion conditions. This allows buildings to be constructed where they are vulnerable to the sudden erosion often experienced during severe storms. Setback requirements may spur constitutional takings challenges when shoreline lots are shallow. As a result, many communities grant variances, which weakens the regulations' effectiveness[64].

Examples

- Florida has adopted a 30-year erosion setback standard that prohibits the construction of new buildings seaward of the line where erosion is likely to reach in the next 30 years. This line is determined by the Department of Environmental Protection and private consultants[65].
- The Wisconsin Shorelands and Wetlands Act established a minimum setback of 75 feet from shorelines and wetlands to protect property against seasonal high water.

E

Earthquakes

See: Seismic Preparedness and Retrofitting
See: Seis mic Retrofits of Critical Facilities

Easements

Definition

The owner of an easement has one or more of the rights in a property, leaving the rest of the "bundle" in the hands of the land owner. Easements either grant an affirmative right to use property, such as a right of access, or restrict the land owner's right to use the property in a particular way. Local governments can prevent development by purchasing a negative easement against building; essentially, by owning the right to develop the property but not the property itself, local government can prohibit further development on a property that would otherwise be legal.

See Also: Differential Assessment/Taxation

Index Listing

Hazard:
- All

Activity:
- Planning
- Town/City Manager

North Carolina Region:
- Statewide

Implementation

Easements can be written either to allow public access or to prohibit it. For example, easements can be used to ensure recreational access to the beach. In other cases, easements may be used to aid community-run mitigation programs. This technique is more appropriate than a purchase of development rights when mitigation is linked to other community goals, such as open space acquisition, because it allows the community to acquire the rights of public access.

Easements are flexible, in that they can be written to apply to only some portions of a property. They must be clear about the restrictions placed on the property. They should also allow inspection by public officials to ensure compliance with the easement provisions. An administrative process for policing easements should be established[66]. The best incentive for encouraging the donation of a conservation easement is the fact that the donation may qualify the donor for tax credits.

Critique

Easements that prevent development may be nearly as expensive to acquire as fee simple rights. Many governments also prefer to own land in fee simple because easements must be policed. Many governments offer to lower the tax burden for properties that cannot be developed due to an easement. As a result, the local government would see its property tax rolls decrease with each donation. Easements have not frequently been used for hazard mitigation purposes[67].

Education and Training

Public Education
Public Information
See Also: Animal Shelter Location
See Also: Building Codes
See Also: Community Awareness Programs
See Also: Disaster Warning
See Also: Notification of Location of Hazards

Index Listing

Hazard:
- All

Activity:
- Community Development
- Planning
- Emergency Management
- Town/City Manager

CRS-Compatible Activity:
- 330: Outreach Projects

North Carolina Region:
- Statewide

Definition

Education and training to generate awareness of hazards, mitigation steps, and disaster response should be targeted to public employees, agencies, public officials, the general public and the private sector, especially developers and property owners.

Implementation

Workshops can play a valuable role in preparing communities for a disaster. These workshops should include education regarding the potential hazards, possible mitigation steps that can be taken, and instruction on how to respond after a disaster occurs. Specialized workshops are often aimed at those who will be implementing mitigation efforts, including members of the building and development industries.

Examples:

- The Community Sustainability Center at 113 Calhoun Street, Charleston, SC, was designed to show homeowners how to make their home more resilient to hurricane and earthquake damage. The Center is located in an antique house that was renovated using disaster-resilient techniques and environmentally-sound materials and practices. Cut-away walls allow visitors to see how the building was upgraded during its reconstruction. Sponsors include the Charleston, the SC Sea Grant Consortium, Clemson Cooperative Extension, the SC Emergency Preparedness Division and FEMA.
- Since 1993, the city of Santa Barbara, CA, has been holding twice-a-year public workshops on seismic retrofitting for residential structures. The events draw several hundred people each. Funding comes from charging contractors who want to display their products or services at the workshops[68].
- Project Blue Sky is a research and demonstration program located in Southern Shores, NC. The program was designed to demonstrate the use of hurricane-resilient building and roofing techniques.
- The North Carolina Division of Emergency Management developed in 2000 a video and slide show that describes why a community should plan to mitigate the impacts of natural hazards. It is an excellent presentation tool community group meetings, board meetings, council meetings, etc. To receive a copy, contact NCEM at 919-715-8000.

Critique

Studies of education and training efforts in this field have found that they are of uneven quality and effectiveness[69].

Elevation

Definition

Elevation of a building or facility means raising the structure above the flood level. In coastal areas, elevation may be used to raise shore-front buildings above storm surge and storm wave heights. It is also possible to elevate a building's interior components, such as the electrical and heating systems, at a fraction of the cost of elevating an entire structure.

Implementation

Residential structures in the high-hazard flood zone must be elevated to National Flood Insurance Program standards in order to be eligible for federal flood insurance[70]. Open foundations should be required in higher-velocity flood zones to allow water to flow beneath the structure. Pilings may also be used to elevate structures for conservation purposes where dune vegetation exists.

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter

Activity:
- Engineering
- Building Inspection
- Planning
- Public Works

CRS-Compatible Activity:
- 310: Elevation Certificates
- 530: Retrofitting

North Carolina Region:
- Statewide

One less expensive way to reduce flood damage is to elevate only a structure's heating, ventilating, and cooling (HVAC) equipment, such as furnaces and hot water heaters. This equipment can often be moved to an upper floor or attic. However, relocating HVAC systems is likely to involve plumbing and electrical changes. A less desirable method of floodproofing this equipment is to build a concrete or masonry block floodwall around it in its existing location. This kind of floodwall must be strong enough and high enough to protect the equipment[71]. Electrical system components, including service panels (fuse and circuit breaker boxes), meters, switches, and outlets should also be elevated at least 1 foot above the 100-year flood. These components suffer water damage easily and could short and cause fires[72]. By elevating electrical and mechanical equipment, buildings should be able to recover more quickly and less expensively. Property owners should be required to flood-proof the parts of their elevated buildings that remain subject to flooding, such as basements or garages.

Communities should consider elevating bridges and other low-lying structures in the floodplain that could be affected by the force of a flood as well as by wetness. Critical facilities (such as fire and police stations, shelters) should be elevated so that they can continue to function during a hazard event. If elevation will not ensure the emergency functioning of these structures, they should be relocated out of the floodplain. Coastal roads that are subject to flooding should be elevated so that storm surge will not preclude their use. Elevated coastal roads may act as a storm-surge barrier or seawall in a storm.

Mobile homes should not be located in the floodplain. Where such structures already exist, they should anchored to their pads to keep them from becoming a floating hazard or elevated above the base flood elevation. FEMA has developed a set of criteria that may be used to evaluate whether a building can be elevated. It must be accessible below the first floor for placement of jacks and beams, it must be light enough to be lifted, it must be small enough to be elevated in one piece, and it must be strong enough to survive the elevation process[73].

Examples:

- East Providence, Rhode Island has established regulations that differentiate between high- and low-hazards areas, with different elevation standards that apply to structures in each.
- Avalon, New Jersey elevated its municipal building, police headquarters and public works garage above the base flood elevation[74].

Critique

Elevation is one of the best techniques for protecting buildings that are, or for some reason must be, located in areas prone to flooding. Elevation is cheaper than relocation and is less disruptive to the neighborhood.

Elevation of a building increases its vulnerability to high winds and earthquakes. Elevating buildings in areas that are subject to erosion must be done carefully to ensure that the foundation is not swept away in a storm or over time. This problem can be addressed by building on an open foundation and sinking the piles below the anticipated depth of erosion. However, such techniques will not help if the annual rate of erosion leaves the building at sea. Many buildings, including masonry buildings and multi-story commercial properties, are heavy to raise and very susceptible to damage in the process.

Elevation, Fire Hydrant

See: Fire Hydrant Inspection and Elevation

Emergency Shelters

Definition

Identify and strengthen facilities to function as emergency shelters, and/or relocate endangered public food banks to hazard-safe structures. This will promote the adequate access, capacity, and resilience of emergency shelters and will ensure that food storage and distribution services remain operational in times of hazard emergency.

Implementation

While school buildings remain popular locations for emergency shelters, community centers and churches can be upgraded to appropriate standards as well. The emergency shelter farthest from the hospital might function as a first-aid care center if necessary.

Food Banks
Shelters

Index Listing

Hazard:
- All

Activity:
- Planning
- Emergency Management
- Town/City Manager

CRS-Compatible Activity:
- 520: Acquisition and Relocation

North Carolina Region:
- Statewide

Emergency Thoroughfares

Definition

Designate emergency thoroughfares and update to necessary standards. Planning the designation and preparation of the most appropriate roads for an evacuation scenario enables a community to avoid traffic congestion in the event of a hazard-related evacuation. This may be viewed as an opportunity to accommodate unmet local traffic demands, maintain acceptable levels of service, and provide on-street parking for homes and businesses if local traffic demand is already met. On-street parking can, in-turn, serve as a buffer between moving traffic and pedestrians on the sidewalk

Index Listing

Hazard:
- All

Activity:
- Engineering
- Planning
- Public Works
- Emergency Management
- Transportation

North Carolina Region
- Statewide

Implementation

A series of wider roads leading from a major highway to an in-town commercial district can accommodate freight shipping and thus, be a selling point for the chamber of commerce. This may also be an opportunity to rejuvenate interest in the redevelopment of brownfield sites along the upgraded thoroughfare.

Ideally, an evacuation-caliber route is central to or easily accessible by a majority of residential areas. Lastly, ensure that adequate signage to facilitate the proper lane reversals exists.

Environmental Features

See: Natural Environmental Features

Environmental Impact Ordinances

Definition

Environmental review of development proposals is common, especially for projects that impinge on critical areas. Reports to local governments on environmental impacts generally mention alternatives, mitigation strategies, and irreversible changes. It is appropriate for such reviews to consider what steps individual projects can or should take to mitigate for natural hazards. By integrating mitigation review into previously-adopted governmental processes, the idea of mitigation becomes institutionalized into the design and development review process[75].

Ordinance, Environmental Impact

Index Listing

Hazard:
- All

Activity:
- Engineering
- Planning
- Town/City Manager

North Carolina Region:
- Statewide

Implementation

By forcing developers to account for mitigation, local governments gain the opportunity to encourage hazard-resilient building practices. In California, environmental impact assessments almost always include an assessment of seismic hazards. Mitigation of these hazards may be a condition of approval for the development[76].

Critique

To be effective, the local government must have the technical capacity to review the impact statements and the administrative capacity to police any mitigation actions. While such review might be effective on a case-by-case basis, it cannot control the overall pattern of development. For this reason, these ordinances should be used in tandem with a sound land-use plan.

Erosion Control

See: Slope Stabilization
See: Soil Conservation and Steep Slope Preservation

Exactions

See: Developer Exactions

Expenditures

See: Government Expenditure Limitation in High-Hazard Areas

F

Fee Simple Acquisition of Land and Damaged Structures

See: Acquisition

Fees, Permitting

See: Permitting Fees

Fire Code

See: Hotel Room Occupancy

Fire Ecology

See: Prescribed Burning

Fire Management

See: Prescribed Burning

Fire Hydrant Inspection and Elevation

Definition

Routinely inspect the functioning of fire hydrants, and/or raise fire hydrants above base flood elevation to ensure that immediate recourse is available to firefighters in times of structural fires, particularly during hazard emergencies.

Implementation

Hydrant inspections are best conducted by the fire department on at least a monthly basis during the dry season. Local government may also wish to raise fire hydrants above the base flood elevation, similar to the practice of elevating manhole openings, because structural fires often accompany flood events and sometimes must be fought from aboard a boat. As rowboats and other craft available to the fire department on short notice are built for small loads, a fire hose and water pump may be excessive; thus, it is imperative for the fire department to have access to the hydrant nozzle and pressurized flow. For communities vulnerable to deep flooding (five feet or greater), the fire department might purchase a specialized watercraft that can handle the heavier load for such occasions.

Elevation, Fire Hydrant
Inspection, Fire Hydrant

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Engineering
- Fire Prevention
- Public Works

North Carolina Region:
- Statewide

Fire Station

See: Retrofit of Fire Stations and Police Stations
See: Safe Site

Firebreaks

Index Listing

Hazard:
- Drought
- Thunderstorm
- Wildfire

Activity:
- Fire Prevention
- Town/City Manager
- Planning

North Carolina Region:
- Statewide
- Western/Mountains

Definition

Cut firebreaks into public wooded areas at the wildland-urban interface to avert or stall wildland fires from spreading to developed areas and vice versa.
"Wildfire professionals promote the strategic use of fuel breaks—thinned vegetative areas—and firebreaks (or fire safes)—zero vegetation zones such as dirt roadways, paved roads, bridges—to reduce horizontal continuity in parts of the wildland." 14

Implementation

If possible, avoid running firebreaks near rivers, in an effort to retain the flood-absorbing, runoff-filtering characteristics of a vegetated stream buffer.
However, they can be strategically placed to function as connector routes for fire-fighting paths that extend deep into wooded areas. 3 Prescribed burns address the fire hazard attributable to "vertical continuity of vegetation". 14

Critique

Some concerns may exist over devalued land, resulting from unsightly cleared areas that are hundreds of feet wide and perhaps miles long. However, sports fields and revenue- generating recreational areas, such as golf courses, may be located within fuel breaks and firebreaks.

Floating Zones

Zones, Floating

Index Listing

Hazard:
- All

Activity:
- Planning
- Town/City Manager

North Carolina Region:
- Statewide

Definition

Floating zones are written into the zoning code but "float" above the map until triggered by a set of conditions. Unlike overlay zones, floating zones replace the existing code for the places in which they are implemented. Once certain conditions (usually development-related) are met, the ordinance becomes affixed to a particular site. Floating zones are typically used when a community knows that it wants to apply a set of regulations to certain uses (such as a shopping center), but is waiting for events to decide the location for those uses.

Implementation

One of the best uses of floating zones is to reduce the density in areas that have been hit by a natural disaster. For example, areas where structures have suffered, on average, a certain degree of damage could anchor a floating zone that reduces the allowable density in that area. The damage zones where these regulations would be applied could be identified during the recovery phase.

Critique

Since one or several lots are subject to different regulations than their neighbors, floating zones are often attacked as being a form of spot zoning[77]. While the location of floating zones can be subject to special interests and politics, they are usually based on facts, as opposed to speculated future needs.

Floodplain Management Plans

Plans, Floodplain Management
See Also: Vegetation
See Also: Wetlands Preservation and Riparian Habitat Protection

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Engineering
- Town/City Manager
- Planning
- Public Works

CRS-Compatible Activity:
- 510: Floodplain Management Planning

North Carolina Region:
- Statewide

Definition

Floodplain management addresses the hazard risk of communities partially or entirely located in a floodplain. The term also refers to the application of structural mitigation measures and codes to existing or proposed buildings in the floodplain.

Implementation

Studies of successful floodplain management efforts have shown several things: first, developers should be made aware of the regulations before they subdivide land in the floodplain, since this allows them a chance to create parcels that are in compliance. Second, the best time to encourage businesses and residents to retrofit or relocate is in the immediate aftermath of the flood. Third, local mitigation programs often exceed National Flood Insurance Program (NFIP) standards for elevation or relocation. Fourth, pressure to develop in the floodplain is lessened when other options are available[78].

Structures built in the floodplain are subject to damage by rising waters. In addition to increasing the number of properties at risk, development in the floodplain reduces the flood storage capacity of these areas, resulting in greater flood heights. Communities should consider the relocation, elevation or acquisition of buildings in the floodplain. Floodplain management should include structural measures, such as building, rebuilding and retrofitting codes for flood-prone structures. At a minimum, elevation and relocation guidelines should meet NFIP standards.

Floodplain management should incorporate an ecosystem approach to land-use planning. Left to their natural function, floodplains can reduce or absorb seasonal peaks and floods. This function can be encouraged by reserving floodplains for this purpose. Planners may find that conserving floodplain lands can also achieve other environmental goals, such as providing open space and habitat or filtering stormwater runoff. Land susceptible to flooding may be appropriate for limited human uses, such as parks and recreational areas. (See Vegetation and Acquisition.)

A floodplain management plan might define a floodplain overlay district in which specific regulations would apply; it might identify specific properties to be acquired for relocation or wetlands protection; or it might propose structural interventions, such as dikes or levees[79]. Floodplain regulations should restrict development that would increase flood heights[80].

Examples:

- The Association of State Floodplain Managers has a new policy called, "No Adverse Impact." The policy calls for balancing structural and nonstructural flooding solutions to ensure that no construction in a watershed will adversely impact other property by increasing flood depths or velocities upstream or down. For information, read a 2001 paper online by the ASFPM's Executive Director Larry Larsen and consultant Doug Plasencia at http://www.ci.lincoln.ne.us/city/pworks/NAIpaper.pdf.
- Studies following the 1993 Midwest Floods recommended wetlands preservation as a method of mitigating flood hazards[81]. This approach has been used successfully along the Charles River in Boston, where the acquisition and conservation of wetlands precluded the need for expensive flood prevention structures[82].

- South Holland, IL began to develop a floodplain management program following severe floods in 1990. In 1994, a committee of citizens and government officials recommended 37 actions to reduce flood risk, including small flood-control projects, improvements to the flood response plan, stronger regulatory standards, channel clearing projects and preparations for post-disaster recovery and mitigation efforts. The channel clearing project was carried out by an AmeriCorps service team. The committee also established a Flood Assistance Program to provide public information and technical assistance to property owners. Owners that undertake approved floodproofing measures can qualify for rebates from the town[83].
- The Massachusetts Rivers Bill (1997) established a 200-foot protective zone around every river in the state. Areas within those boundaries are under the supervision of local conservation commissions, who also have jurisdiction over the state's wetlands.
- Brattleboro, VT, created a set of regulations to govern mobile home parks located in high-risk floodplains. The rules allow park owners to expand outside the floodplain. However, one unit inside the high-hazard area must be permanently removed prior to the owner's receiving permission to add three new units outside the floodplain[84].
- Dallas, TX, usually requires that subdividers dedicate any portions of a parcel located in the floodplain to the city as a condition of approval. Floodplain areas of apartment parcels can be used as common open space if an easement on the open space is dedicated to the city or maintained as open space by the homeowners' association[85].
- Instead of developing a floodplain management agency, the Denver Metropolitan Region developed standards for local regulation by its 28 member governments with flood problems. These standards were adopted individually by each locality[86].

Critique

Floodplain management plans are less comprehensive than either comprehensive plans or hazard mitigation plans. As a result, they may be more likely to be set aside or overlooked. Floodplain management programs can be foiled by development pressures and a lack of suitable sites outside the floodplain; by a lack of information or monitoring; or by contrary land-use regulations that encourage (rather than discourage) development in the floodplain. Flood hazard risk reduction has often focused narrowly on the protection of structures in the floodplain rather than the preservation of the floodplain's natural functions[87].

Since floodplains rarely fall within a single jurisdiction, floodplain management is often best addressed through regional governing bodies. Such agreements acknowledge that the flood mitigation actions taken by one community can affect its neighbors, both upstream and down. Such multi-jurisdictional management agreements can be very difficult to achieve.

Floodproofing

Definition

Floodproofing can be done in two ways: dry and wet. Dry floodproofing means that all areas below the anticipated flood level are made to be watertight. With wet floodproofing, floodwaters are intentionally allowed to enter a building to reduce the pressure exerted by deep water. The property owner floodproofs the interior by removing water-sensitive items from parts of the building that are expected to flood.

Implementation

Dry floodproofing is typically done by coating walls with waterproofing compounds or plastic sheeting and protecting building openings with removable shields or sandbags. Dry floodproofing cannot extend more than two or three feet above the foundation of the building because the pressure exerted by deeper water would collapse most walls and floors.

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Engineering
- Town/City Manager
- Planning
- Public Works

CRS-Compatible Activity:
- 530: Retrofitting

North Carolina Region:
- Statewide

At a minimum, wet floodproofing involves the removal of valuable items. However, simple and relatively inexpensive steps such as moving furniture, heating and electrical system components, and electrical appliances out of the flood-prone area can dramatically reduce flood damages (see **Elevation**). Fuel tanks and their supply lines should be securely anchored. Unanchored exterior fuel tanks are easily moved by flood waters and may be driven into buildings. Tanks in flooding basements can tear free of their supply lines. Even buried tanks can become a hazard if they are pushed to the surface by the buoyant effect of soil saturated by water. Fuel storage tanks need to be inspected and, if necessary, repaired or reconstructed following hazard events.

Homeowners should be encouraged to install backflow valves, which are designed to block drain pipes temporarily and prevent the reverse flow of sewage into the house. Communities should consider flood proofing manholes and lift stations, elevating sewage access ports and installing backflow preventor valves. Once-mobile structures, such as RVs, can be moved again by high water and driven into nearby objects. For this reason, they should be securely anchored to their pads or moved prior to flooding.

Examples:

- After the 1993 Midwest floods, the City of Darlington, Wisconsin decided to undertake an extensive flood mitigation project to protect 12 historic structures in its downtown from future damage. The floodproofing consisted of filling the basements with sand and suitable fill, elevating the first floors, constructing vestibules, and installing removable floodshields. Floodshields in the interiors of the buildings would allow water to infiltrate the vestibules, which were constructed with drainholes and made of material that could easily be hosed down after a major flood[88].
- South Holland, IL, a village of 5,000 residents, established a Flood Assistance Program to encourage residents to floodproof their property. This program provides public information and technical assistance to property owners. A fund of $100,000 was set aside by the town to provide rebates to residents who undertook approved floodproofing activities. Since 1994, there have been 112 rebates issued at a cost to the village of $69,875[89].

Critique

Although floodproofing raises construction costs, it is an effective mitigation tool and provides a high level of protection from water damage. Floodproofed buildings in the flood zone are still subject to damage from floating debris and may not provide shelter during flood events. The availability of good floodproofing techniques may actually spur development in the floodplain and encourage local governments to be more lenient in zoning for flood hazards.

Floodwalls

See: Dikes

Focused Public Investment Plan

See: Capital Facilities Plans

Food Banks

See: Emergency Shelters

Freshwater Well

Definition

Dig a freshwater well to serve a hospital or other critical facility in times of water outage, in order to eliminate the possibility of water supply interruption to this facility. Vulnerability is exacerbated for aerial, or aboveground, lines.

Critical Facilities
Well, Freshwater

Index Listing

Hazard:
- All

Activity:
- Engineering
- Town/City Manager
- Planning
- Public Works

North Carolina Region:
- Statewide

Fuel Loads

Definition

Fuel loads are anything that may contribute to the life of a fire, and include accumulated masses of dead or dry vegetation, such as grasses, branches, leaves, pine needles and shrubs. In developed areas, check for and clear fuel loads created by downed trees to prevent the formation of natural fuel loads that give rise to rampant forest fire. It is costly to suppress even modest forest fires, and that cost multiplies when aircraft watering is necessitated. Dried trees, particularly those that have fallen and piled, create fuel-loading situations.

Index Listing

Hazard:
- Wildfire

Activity:
- Public Works

North Carolina Region
- Statewide

Implementation

The most important time to check for fuel loads is after periods of relative drought that can dry accumulated, dead vegetation and cause old and less hearty trees to crack and fall.

Critique

Some ecologists warn that the removal of decomposing matter in the forest is the removal of an important link in the biological system, so not developing within or near potential tinderboxes is the better practice. In addition, wildfires are known to play an important role in the revitalization of ecosystems and replenishment of nutrients to the soil; controlled burning is one way for developed or developing communities to allow this natural process to take place while protecting homes and businesses.

G

GIS (Geographic Information Systems)

See: Mapping Hazards

Government Expenditure Limitation in High-Hazard Area

Definition

Regional and local governments should limit their expenditures for roads and other infrastructure in high-hazard areas. This technique will discourage development in these areas, which can greatly reduce disaster-related damage and recovery costs. Government facilities, especially those that house emergency services, should not be located in high-hazard areas. By avoiding these areas, local governments can help ensure these facilities will function during and in the immediate aftermath of an emergency. They can also reduce the cost of post-disaster repairs to public structures.

Expenditures
Infrastructure

Index Listing

Hazard:
- All

Activity:
- Engineering
- Town/City Manager
- Planning
- Public Works

CRS-Compatible Activity:
- 430: Higher Regulatory Standards

North Carolina Region:
- Statewide

Implementation

Especially on barrier islands, the public provision of road access appears to be the primary catalyst for development[90]. While this effect is likely to be less dramatic in more accessible locations, it is almost certainly true that the provision of services facilitates growth. To be effective, expenditure limitations should be used in tandem with other land-use programs and tax policies to discourage development in hazard-prone areas[91]. Ironically, other government policies, such as permitting high-density development through zoning, may make it easier for developers to finance their own improvements. Local governments should make sure that policies present a consistent measure of opposition to development in unwanted locations. High-hazard areas must be specifically identified and mapped.

Examples:

- Nags Head, NC, has implemented a policy not to expend public funds to repair any private road that is damaged or destroyed as a result of a severe storm, except in conjunction with the repair of the town's water system[92].
- CAMA regulations prohibit the construction or placement of publicly-funded facilities (such as sewers, waterlines, roads, etc.) in high hazard areas unless: there is an overriding public benefit; it will not promote development in Areas of Environmental Concern; it will not damage natural mitigating features or worsen hazard risk; and it is designed to withstand erosion and flood damage.
- Dade County, Florida's 1988 Comprehensive Development Master Plan prohibited "public expenditures that subsidize additional development in Coastal High Hazard Areas," and prohibited all public facilities in such areas, with the exception of beach access and evacuation enhancements

(such as bridge and roadway improvements). The plan also prohibited the construction of critical facilities (such as hospitals, emergency services and emergency command centers) in Coastal High Hazard Areas[93].

Critique

Restricting public services will not be popular with property owners who require public services in order to develop their land. Local governments may feel obligated to limit the geographic scope of the program to make it more acceptable politically[94]. Local governments may also count on receiving federal support to rebuild non-critical public facilities in the event of a disaster, and therefore have little reason to spend their own funds on protecting them[95]. Relocating these structures in advance of a disaster may have little effect on the overall pattern of development.

Grassy Swales

Definition

A grassy swale consists of grass beds or grassy expanses at the side of the road where a concrete ditch or other hard structure might have been placed; it filters or treats stormwater in addition to conveying it to the drainage system. Grassy swales along the roadside, and/or natural vegetative beds in stormwater channels, aid in decreasing the velocity of stormwater flow. Velocity is a major component of erosion, runoff amount, and in the case of floods, structural damage.

Implementation

To convey stormwater, the sidewalks should slant slightly away from the streets and toward the grassy swales. Grassy strips and linings also provide a modest degree of absorption and sediment filtration. Additions of vegetation to the environment should be indigenous for ecological soundness and ease of maintenance. These "green" pieces of infrastructure are generally more visually appealing than their "gray" counterparts.

Swales
See Also: Impervious Surface Limits
See Also: Land Treatment
See Also: Porous Pavement
See Also: Stormwater Management

Index Listing

Hazard:
- Erosion
- Flash Flooding
- Flooding

Activity:
- Engineering
- Planning
- Public Works

CRS-Compatible Activity:
- 450: Stormwater Management

North Carolina Region:
- Statewide

Critique

Swales and vegetated channel beds may require insect management techniques (preferably all-natural) and occasional aeration.

Green Infrastructure

Definition:

The word "infrastructure" is customarily applied to the systems and buildings that support a community's most basic functions. These structures and systems, called "built infrastructure," include hospitals, schools, roads and power/sewer lines. In comparison, "green infrastructure" refers to the "network of open space, woodlands, wildlife habitat, parks and other natural areas that sustains clean air, water and natural resources and enriches our quality of life[96]." A key component of the concept of green infrastructure is that due to their life and health-sustaining functions (for example, vegetated stream buffers filter out pollutants in runoff and improve water quality), open space and natural habitat is a necessity for any community, and not merely an amenity. As a result, green infrastructure must be improved, upgraded and expanded in a manner similar to built infrastructure[97]. It should be noted that the term is also used by some engineers and academics to indicate environmentally friendly structures and systems such as solar panels or water treatment facilities.

See Also: Acquisition
See Also: Natural Environemental Features
See Also: Riparian Habitat Protection
See Also: Smart Growth
See Also: Vegetation
See Also: Wetlands Preservation

Index Listing

Hazard:
- Erosion
- Flash Flooding
- Flooding

Activity:
- Parks and Recreation
- Planning
- Town/City Manager

North Carolina Region:
- Statewide

Post Disaster

Implementation:

Green infrastructure is composed of hubs and the links that connect them. Hubs are larger parcels of land that sustain wildlife and ecological processes. Examples of hubs include reserves (national and state parks), working lands (private farms, forests and ranches), regional parks and preserves, and community parks and natural areas[98]. Links are parcels of land of varying size that run between the hubs and act as a source of connectivity for the entire system. They include landscape linkages (protected habitat that is large in size), conservation corridors (protected areas that take a linear shape, such as a stream and its buffer) and greenways (land that is used for conservation and recreation and is also customarily linear in shape[99]). Green infrastructure takes the form of hubs and links because it gives wildlife a larger range rather than isolating it in separate parcels, and because certain ecological features such as watersheds or rivers are best managed on a holistic basis rather than a piecemeal one. See http://www.greeninfrastructure.net/ and http://www.sprawlwatch.org/greeninfrastructure.pdf for more information.

Examples: •

- The State of Florida has created a series of greenways and trails in every region of the state. The Marjorie Harris Carr Cross Florida Greenway is a 110 mile corridor that crosses central Florida, linking habitats and ecologically sensitive areas that range from the Gulf of Mexico to the St. John's River. One of its features is a "land bridge," or landscaped overpass of Interstate 75 that enables hikers and wildlife to safely traverse the road. See http://www.floridagreenwaysandtrails.com for more information.
- Following a period of rapid growth in the 1990s, the Town of Cary, North Carolina created an Open Space and Historic Resources Plan in 2001 to "identify parcels with significant resource value and open space potential and rank them according to the quality and quantity of resources present, threat of loss, and other factors." The plan is meant to act in concert with Cary's Parks, Greenways, and Bikeways Master Plan to develop the town's green infrastructure. Among the benefits of open space preservation listed by the town are the preservation of wildlife and native plant habitat, the protection of water quality and the prevention of floods. In addition, the Open Space and Historic Resources Plan is meant to preserve lands historically used for agriculture and forestry, promote recreation and a sense of place, and improve air quality in the Town. See

http://www.townofcary.org/depts/dsdept/P&Z/openspace/oshrpplan.pdf for more information.

Groins

Index Listing

Hazard:
- Erosion
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Coastal Engineering
- Beach Management
- Shore Protection
- Town/City Manager
- Planning
- Coastal Management

North Carolina Region:
- Eastern/Coastal

Definition

Groins are wall-like structures, built of timber, concrete, metal sheet piling or rock, placed perpendicular to the beach to capture material drifting along the shoreline. Usually constructed in groups called groin fields, their primary purpose is to trap and retain sand, filling the beach compartments between them[100]. Groins can be effective at nourishing eroding beaches when there is a significant littoral drift.

Implementation

A groin's effectiveness is primarily a factor of the length and the spacing of the groin field. The appropriate length for a groin depends on the beach's dominant sediment size: shorter groins for larger grain sizes and longer groins for smaller grain size. The spacing between groins must be wide enough that the updrift groin will not be starved of sand and undermined. On the other hand, the groins must be narrow enough to effectively act as a sediment trap. Ideally, when a groin field fills to capacity with sand, sediment transport along the shore continues at about the same rate as before the groins were built, and a stable beach is maintained[101].

CAMA strictly regulates the construction of groins. In general, groins must not reach more than 25 feet waterward from the mean high water level; they must be spaced at least 100 feet apart; and they must not be taller than 1 foot above the mean high water level. The material used to build the groin must be large enough to resist being dislodged and becoming debris in a storm[102].

Critique

Groins are mainly designed to provide a wider beach for recreational purposes and to reduce the frequency of beach nourishment. A wider beach may cause storm waves to break further seaward, but it is not an effective means of protecting shorefront buildings from coastal surge or high winds. By interrupting normal patterns of drift, groins starve "downstream" beaches of sand and may worsen a shoreline's overall erosion problem. Downdrift landowners whose beaches are narrowing may pursue legal action against the builders of updrift groins[103].

Growth Phasing

See: Slowing Development

H

Hazard Identification

Index Listing

Hazard:
- All

Activity:
- Emergency Management
- Planning

CRS-Compatible Activity:
- 410: Additional Flood Data

North Carolina Region:
- Statewide

Definition

Hazards identification refers to the process of defining hazard-prone areas, estimating the probability and severity of the hazard risk, and evaluating existing mitigation efforts.

Implementation

Hazards identification should define the following: the hazard's impact; the potential magnitude or intensity of an event of each type; and the likelihood of each event. It may be preferable to divide some hazards into their component parts. For example, one method might be to divide hurricanes into wind, high water and wave hazards. Other options include defining each area by its primary hazard risk or creating likely risk groups. An example of the latter might be to group wildfires in areas with steep slopes since fires there may result in landslides.

Many coastal hazard areas have been identified as Areas of Environmental Concern by the Coastal Area Management Act. CAMA categories with high hazard risk include: estuarine shorelines, ocean erodible areas, high hazard flood areas, inlet hazard areas and unvegetated beach areas. (For more information, see Mapping Hazards).

Note: To learn more about the hazard identification step in developing your community's hazard mitigation plan, see *Keeping Natural Hazards from Becoming Disasters: A Mitigation Planning Guidebook for Local Governments*, produced by the North Carolina Division of Emergency Management. To get a copy, go to www.ncem.org/mitigation/document_index.htm.

Critique:

One of the drawbacks to hazards identification is that a degree of inaccuracy is inherent in estimating probability of risk. As a result, these efforts are only a "best guess" at the potential for disaster. Delineating hazard-prone areas is even less effective for non-spatially-defined hazards, such as hurricanes and tornadoes, since their location is harder to predict. This type of program may be difficult to implement on the local level without state or federal support, at least in the form of sources of information.

Hazard Mitigation and Post-Disaster Reconstruction Plan

Mitigation Plans
Plans, Hazard Mitigation and Post-Disaster
Plans, Post-Disaster Reconstruction
Post-Disaster Reconstruction Plans

Index Listing

Hazard:
- All

Activity:
- Town/City Manager
- Planning

Post Disaster

CRS-Compatible Activity:
- 510: Floodplain Management Planning

North Carolina Region:
- Statewide

Definition

A hazard mitigation plan specifies actions a community will take to reduce its vulnerability to natural hazards or to minimize the impact of a hazard event. Post-disaster reconstruction plans outline the policies or planning instruments that community officials will rely on for post-disaster decision-making. The two are often linked because the post-disaster window is considered an opportune time to make a community more disaster resilient. A hazard mitigation plan consists of four major sections: goals and objectives; hazard identification; capability analysis; and implementation, monitoring, evaluation and update[104].

Implementation

Mitigation plans should address pre- and post-event actions. Pre-event mitigation is appropriate for directing future development, while post-disaster mitigation allows for redevelopment in a less hazard-prone manner[105]. Communities should not postpone planning until after a disaster. However, it should be noted that embarking on the mitigation planning process is often more successful in the wake of a disaster, when interest in protecting the community from future events is highest. Planners may find they are able to accomplish more innovative or extensive planning during the post-disaster "window of opportunity" than they can at other times[106].

One way to create pre-event support for hazard mitigation planning is to integrate mitigation policies into already existing and accepted comprehensive plans[107]. If the plan is created independently (after a disaster, for example) it is often possible to integrate it with comprehensive plans at a later date[108]. Stand-alone mitigation plans are preferable when communities lack a comprehensive plan or when their plan is considerably out-of-date.

Natural hazards planning should address all of the hazards that endanger the community and should use approaches that mitigate several natural threats at once (cross-mitigation). Approaching mitigation from a big-picture perspective by, for example, considering the impact of a project on an entire watershed, can result in positive actions that are more sustainable in the long-term than projects with a strictly local scope[109].

Reconstruction plans should be designed to be in concert with the long-range goals of the community (as measured by the comprehensive plan). In particular, they should outline the rules and priorities for any post-disaster acquisition of damaged properties. Two typical targets are buildings that have suffered damage amounting to a certain percentage of their value or properties that lie within the hazard area. The degree of damage that would qualify a building for public acquisition should be identified in the plan, as should any other criteria for prioritizing purchases.

A reconstruction plan should also outline a post-disaster permitting process that facilitates repairs but remains steadfast to the need to mitigate against future disasters. One element of the plan should emphasize the need to obey the building code. One way to create time to assess the damage and plan for recovery is to institute a short-term building moratorium (moratoria). Another is to do much of the planning in advance and create an overlay zone that is triggered by the hazard event.

Mitigation plans should also include a historic preservation element, since the actions taken to save significant buildings may be different than those adopted for other structures. This element should include an inventory that lists historic properties, their owners, the basic construction materials used, and their existing condition and location[110].

Examples:

- Los Angeles' reconstruction plan is divided into pre-event, short-term post-event and long-term post-event actions. The role of every city agency in implementing this plan is defined[111].
- Avalon Borough, New Jersey's 1992 hazard mitigation plan for the Borough identifies goals, objectives, programs, hazard avoidance strategies, and beach protection strategies[112].

Critique:

Hazard mitigation and post-disaster plans allow for a substantial amount of decision-making to occur prior to a disaster event and aid in better decision-making after the event. However, because these types of plans deal with less widely recognized policy problems and less frequently occurring events, they have not enjoyed broad political or administrative support. Non-structural mitigation actions may be particularly unpopular because they require developers and landowners to revise their expectations about development.

There are several problems with stand-alone mitigation plans. First, they are often designed to improve a community's defenses against a disaster of the type that most recently occurred. This approach assumes that the next event will be similar. Such assumptions may lead planners to ignore other appropriate mitigation actions that would be relatively easy to undertake at the same time. Second, the time-frame for constructing stand-alone plans is often too short to allow for sufficient data collection. Third, these plans may be difficult to implement unless they are integrated with other community goals and values[113]. This final critique also applies to post-disaster reconstruction plans. If communities are not dedicated to their post-disaster recovery plan, it may be quickly discarded in an emergency.

Home Inspection Programs

Definition

Couple a hazard-susceptibility checklist with current home inspection programs to offer a personalized vulnerability assessment to homeowners during the course of a requested inspection (for fire safety, carbon monoxide inspection, energy efficiency inspection, etc.

Implementation

Fire department staff or whoever is responsible for employing the inspection checklist must understand the fundamentals of structural hazard vulnerability; this type of assessment should be clearly described or disclaimed as general and liability-free.

Inspection, Home
See Also: Community Awareness Programs
Index Listing
Hazard:
- All

Activity:
- Fire
- Building Inspection
- Planning

CRS-Compatible Activity:
- 330: Outreach Projects

North Carolina Region:
- Statewide

Hotel Room Occupancy

Definition

Permit, through the fire code, only four occupants per hotel room to facilitate the evacuation of crowded and/or tall structures in the case of a fast-onset hazard.

Fire Code

Index Listing

Hazard:
- All

Activity:
- Engineering
- Fire
- Building Inspection
- Planning

North Carolina Region:
- Statewide

Housing Code

Definition

Require, through the housing code, a fire extinguisher in all multi-family structures to present occupants with an accessible fire-fighting tool and to help contain fires initiated in the home to a single structure.

Index Listing

Hazard:
- Drought
- Wildfire

Activity:
- Building Inspection
- Public Works

North Carolina Region:
- Statewide

I

Impact Fees/System Development Charges

Development Impact Fees
System Development Charges
See Also: Developer Exactions

Index Listing

Hazard:
- All

Activity:
- Town/City Manager
- Planning

North Carolina Region:
Statewide

Definition

Impact fees require new developments to share in the financial burden that their arrival imposes on a town. These assessments are typically one-time, up-front charges (although some jurisdictions allow payments over time) against new development to pay for off-site improvements. The fees can also be set up to allow new development to buy into existing services with excess capacity. Impact fees are typically based on ratios that show what services the average new resident will require.

Implementation

Every impact fee must meet a three part legal test. First, the need for improvements funded by the fee must be created by the new development. Second, the amount charged the new development must be proportionate to the cost of its use. Third, all revenues must be spent in proximity to the new development and within a reasonable period of time. If any of these are not met, the community may face legal action. Communities should have a comprehensive plan and capital improvements program in place to defend their use of impact fees or **exactions**[114].

Impact fees can be linked to environmental impact analyses in order to charge proportionate fees for projects that will have broader or lesser impacts. While there are several methods for analyzing impacts (checklists or spreadsheet models, for example), most look only at individual project impacts[115]. An alternative is a cumulative impact assessment, which look at the total effect of all development in a particular environment. This approach might allow planners to estimate the combined effects of several potential developments on reducing the flood storage capacity of a single watershed. The fee in this case would go toward mitigating increased flood heights, perhaps by creating flood storage elsewhere in the floodplain.

Critique:

Impact fees can be applied to a wider variety of services than either exactions or special assessment districts. Unlike land dedications, these can be payments that cover the full costs of needed improvements. They are typically used in place of negotiated exactions because they take less time and are more predictable and equitable. Impact fees do not help with maintenance costs.

Impact Tax

See: Development Impact Tax

Impact Zoning

See: Performance or Impact Zoning

Impervious Surface Limits

Definition

Impervious surfaces such as paved roads and parking lots cause water to run, exacerbating flooding and contributing to water quality problems. Impervious surface limits cap the amount of development-related surface area that is impenetrable by water.

Implementation

Techniques for limiting impervious surfaces include narrowing roads and sidewalks, restricting the clearing of land, limiting parking lot size, and clustering development. Where possible, vegetated islands should be used instead of paved ones and porous paving materials, such as paving bricks, bark or gravel should be used instead of non-porous materials. Impervious surface limits are especially useful in beachfront communities, where dunes depend on the sand that may be buried beneath parking lots.

See Also: Grassy Swales
See Also: Land Treatment
See Also: Porous Pavement
See Also: Stormwater Management

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Engineering
- Planning
- Public Works

CRS-Compatible Activity:
- 450: Stormwater Management

North Carolina Region:
- Statewide

Examples:

- North Carolina's Coastal Area Management Act limits the introduction of impervious surfaces in Areas of Environmental Concern. In these areas, impervious surfaces cannot exceed 30 percent of the parcel. Developers can be exempted if they can show that the requirement would prohibit any use of the lot or if they can propose a design that would achieve an equivalent outcome. Outside the AEC, the regulations require that impervious surfaces be limited to "the minimum size necessary[116]."

Improvement Tax

See: Development Impact Tax

Incentives

See: Tax Abatements

Industrial Park

See: Commercial Park

Infill Development

Definition

Encourage infill development through a streamlined approval process. This will promote development in areas of low hazard risk which are already served by infrastructure, through the promise of reduced hassle and wait in the review process. However, the practice assumes that potential infill areas are not prone to severe hazard.

Development, Infill

Index Listing

Hazard:
- All

Activity:
- Town/City Manager
- Planning

North Carolina Region:
- Statewide

"Effective capture and use of these infill parcels for housing and other uses may take pressure off efforts to develop in virgin lands on the city periphery that may be more hazard prone[117]," which is especially important when those natural lands provide a mitigation buffer.

Implementation

This practice is employed through the site plan review process, so the local planning staff and planning commission should be involved with assessing the appropriateness of streamlined approval and with determining what aspects of review get streamlined. Government should be careful that thoroughness is not sacrificed for expedience: since development will be within an already-populated area, many people will be exposed to the repercussions. A related benefit is that more efficient use of existing roads and utilities can equal more budgetary reserves for use in mitigation.

Other considerations regarding infill development:

- A more concentrated population can allow for better information dissemination in time of emergency.
- The waiving of application or permitting fees could be an even greater incentive.
- "Variance and relaxing of development standards may be necessary to take into account irregular lot configurations or other constraints[118]."

Critique:

Resistance to infill from nearby landowners is unavoidable, and government may have to demonstrate that new development will not harm adjacent land values.

Infrastructure

See: Government Expenditure Limitation in High-Hazard Areas

Inspection, Building

See: Building Inspectors

Inspection, Fire Hydrant

See: Fire Hydrant Inspection and Elevation

Inspection, Home

See: Home Inspection Programs

J

Jetties

Index Listing

Hazard:
- Erosion

Activity:
- Coastal Engineering
- Beach Management
- Shore Protection
- Town/City Manager
- Planning
- Coastal Management

North Carolina Region:
- Eastern/Coastal

Definition

Inlets and areas with significant littoral drift may fill with sand deposits. Jetties are wall-like structures built perpendicular to the coast (often in pairs) to keep sediment from accumulating in these passages, especially those used for navigation[119]. Jetties' main function is to allow safe passage for boats. They must be wide enough to provide a navigable channel (narrow channels can be a hazard to navigation and produce an unacceptably fast current). If they are spaced too widely, they will act like groins and trap drifting sediments in the intended channel.

Implementation

Designing an effective system of jetties requires that the length of the jetty be sufficient to allow enough water in and out of the channel to generate a natural scouring action. This will keep the channel open[120]. It is important to keep in mind that jetties will almost invariably keep sand from reaching downdrift areas. The effects of these systems are sometimes difficult to predict and are frequently not evident until years or decades later.

Examples:

- Engineers at Charleston Harbor installed a jetty system in 1896 to preserve the channel at the harbor entrance. The jetties sand-starved Morris Island, which is on the south side of the channel; traditionally, sand drifted from the north. Erosion rates on Morris Island increased. When the jetties were constructed, Charleston Lighthouse on Morris Island was 2,700 feet inland from the coast. Since then, the shoreline has eroded nearly a mile. Today, Charleston Lighthouse stands 2,000 feet offshore[121].

Critique:

While the primary function of jetties is to protect navigation channels, they incidentally restrict the movement of sediment traveling parallel to the shore. They more completely interrupt this littoral drift than do groins[122]. By stopping the natural cycle of movement, jetties can starve downdrift beaches. Long jetties may also create currents that transfer sand offshore, leading to net sand loss from the beach[123]. While sand bypassing systems have been shown to mitigate the offshore currents created by jetties, these systems do not work during storm events, when most sediment transfer occurs[124].

L

Land Banking

See: Advance Acquisition and Land Banking

Land Gains Taxation, Transfer or Development Taxes

Definition

Land gains taxes are assessed in inverse proportion to the length of time land is held in order to discourage speculation. They apply only to the value of land, not improvements, and there is an exception for the principal residence of seller. Transfer taxes are assessed against the sellers of land devoted to certain designated uses. Development taxes are charged against developers when they convert land in certain categories to more intense uses.

Taxes, Land Gains
Taxes, Transfer or Development
Transfer Taxes
Development Taxes

Index Listing

Hazard:
- All

Activity:
- Town/City Manager
- Planning

North Carolina Region:
- Statewide

Implementation

Land transfer taxes could be used to establish a land bank, which would use these funds to purchase open space, either through easements or in fee-simple. This would be one way to both acquire open space and prevent development in high-hazard areas. Development taxes could be used to discourage the improvement of land in high-hazard areas, such as floodplains.

Examples:

- Vermont is the only state to employ a tax on the profits gained from the sale of land.

Critique:

These taxes discourage conversion to higher density, slow rapid growth rates, and discourage speculation, but they are not effective for long term protection and may limit needed economic development if owners hold their property out of the market. A land gains tax may be vulnerable to legal challenge under the uniformity clause in state constitutions or for discriminating against non-residents (because of the principal residence exception). On the other hand, the Vermont law sustained a Fourteenth Amendment challenge of arbitrary discrimination against owners of less than six years.

Land Treatment

Definition

While retention ponds are designed to slow the rate of runoff, land treatments reduce other effects of runoff, including soil erosion and pollution, through the use of plants and specific planting techniques. Land treatments may help reduce landslide hazards.

Treatment
See Also: Grassy Swales
See Also: Impervious Surface Limits
See Also: Porous Pavement
See Also: Stormwater Management

Index Listing

Hazard:
- Erosion

Activity:
- Engineering
- Planning
- Public Works

CRS-Compatible Activity:
- 450: Stormwater Management

North Carolina Region:
- Statewide

Implementation

Land treatment may help integrate mitigation and stormwater treatment goals by capturing and filtering runoff while also preventing landslides. Typical land treatment measures include: maintaining trees, shrubbery, and vegetative cover; terracing; stabilizing slopes; requiring grass filter strips; contour plowing and strip farming, which is the growing of crops in strips or bands along a contour. The use of perennial vegetation, such as grasses, shrubs and trees provide cover for the soil, prevent erosion, slow the rate of runoff, increase infiltration, and reduce water pollution. Terracing refers to a raised bank of earth with vertical or sloping sides and a flat top for controlling surface runoff. Other measures include vegetated swales, infiltration ditches and permeable paving blocks.

Critique:

Land treatments may mitigate persistent stormwater problems, but they are unlikely to stop the major, storm-related flows that can trigger floods or serious mud- or landslides.

Leaseback

See: Purchase Sellback/Leaseback

Levees

See: Dikes

Library Protection

Definition

Store books on the upper floor(s) of your local library, and/or place books on shelves above the base flood elevation if the library is single-story. This will protect the material resources of the library and avoid any prolonged interruption of library service.

If floodwaters invade a fully-stocked ground floor library, the community stands to lose many irreplaceable items, such as rare writings, genealogy materials, and local newspaper archives. Due to heavy demands on public allocations following a flood, local government may have little choice but to postpone recovery of the library. The result, the absence of an operational library, is the loss of a vital resource for primary and secondary education and the loss of a recreational activity for many.

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Library Services
- Engineering
- Planning
- Public Works

North Carolina Region:
- Statewide

Implementation

If the library is multi-story, the most cost-effective method may involve moving books to upper floor(s). Book sales, late fees, donations, and low-cost children's programs can help pay for the manpower of an "up-the-stairs" move, and local service organizations may be willing to donate time and effort. Some older materials may have to be placed in offsite storage for access by special request in order to compact library holdings into the space provided by the upper floor(s).

Critique:

If books remain on the first floor, but are raised above the flood level, two problems remain: in a flood event, they will be subject to mold and mildew, as well as to bookshelf collapse, and before the flood, the elevated books will be unreachable to those below a given height.

Low-Interest Loans

See: Tax Abatements

M

Maintenance

See: Drainage System Maintenance

Manholes

See: Sewer Manholes

Mapping Hazards

Definition

Applying hazard information, such as vulnerability, risk analysis, and inventories of at-risk populations or structures to maps is an important first step in hazard mitigation.

GIS (Geographic Information Systems)

Index Listing

Hazard:
- All

Activity:
- Geographic Information Systems
- Emergency Management
- Planning

CRS-Compatible Activity:
- 410: Additional Flood Data

North Carolina Region:
- Statewide

Implementation

Hazard mapping can be accomplished in cooperation with a number of federal and state agencies. A number of hazards are already identified through these agencies. For example, storm surge hazard zones are identified through SLOSH and SPLASH models. Flood hazard areas are identified in National Flood Insurance Program flood maps. Local officials may wish to supplement NFIP maps with local knowledge about flood hazard areas. Seismic risk zones are delineated by earthquake fault zone maps. CAMA has identified and mapped a series of high-hazard coastal zones as well as the annual erosion rates for the coast. Geographic information systems (GIS) are especially useful for overlaying these previously-identified high risk areas on existing property maps.

Through the Division of Emergency Management, a technical guidebook for using GIS in hazard mitigation is available as a resource.

Examples:

- North Carolina's Coastal Management Program produces erosion rate maps that show the average rate of erosion on each segment of the coast for the past 50 years.

Critique

Mapping can be an expensive task due because it requires staff time and technical expertise. While maps can be produced effectively using geographic information systems (GIS), these tools require both technology and staff training.

Marginal Cost Pricing

Definition

Under this system, new development is responsible for the incremental cost of the service needs it creates. This is opposed to average cost pricing, which refers to charging everyone the same price regardless of any difference in real costs. Average cost pricing makes it less expensive to develop further from existing services because new development shares the cost with higher density, close-in development.

Index Listing

Hazard:
- All

Activity:
- Town/City Manager
- Planning

North Carolina Region:
- Statewide

Implementation

Marginal cost pricing is best used to contain development within a given area. This technique is most effective when existing development is already concentrated, preferably in a hazard-resilient location. It can then be used to make development that sprawls onto hazard-prone territory, such as a floodplain, pay a higher cost. Marginal cost pricing can help preserve affordable housing by pricing services so they are proportional to the size and value of property. Preserving affordable housing can be a significant challenge in communities where the available property is limited by hazard risks or where mitigation requirements raise the cost of housing.

Critique

True marginal costs can be very difficult to estimate on a case-by-case basis. This may lead some governments to create price districts rather than pricing each development. Problems will arise at the district borders when property owners (understandably) ask why they have to pay more than their next-door neighbor.

Minimum Residential Street Width Ordinance

Definition

Pass a minimum residential street width ordinance to ensure that development sites are reachable by emergency response vehicles. Narrow streets, particularly those with parked cars or debris resulting from a disaster, do not accommodate sizeable fire trucks, ambulances, or other rescue vehicles.

Index Listing

Ordinance, Minimum Residential Street Width
Street Width Ordinance

Hazard:
- All

Activity:
- Engineering
- Town/City Manager
- Planning
- Public Works

North Carolina Region:
- Statewide

Implementation

The ordinance can apply to new development and/or be a policy for corrective improvements. It should additionally apply to dirt and stone roads, as well as paved.

Critique

This practice should not be interpreted as condoning wide streets, only wide-enough streets. Wider streets produce more runoff; however, grassy swales can mitigate such increases.

Mitigation Plans

See: Hazard Mitigation and Post-Disaster Reconstruction Plans

Mobile Home Parks Storm Shelter

Definition

Require that mobile home parks of a given size build a storm shelter for their residents, whose housing is susceptible to destruction by relatively minor high-wind events.

Implementation

The shelter has the potential to be an attractive building that functions as a community meeting room and gives a greater sense of permanence to the mobile home park. As a result, it may increase lot values.

Trailer Parks Storm Shelter
See Also: Tie-Downs

Index Listing

Hazard:
- Hurricane
- Thunderstorm
- Tornado

Activity:
- Planning
- Town/City Manager

North Carolina Region:
- Statewide

Mobility Concerns

Definition

Disallow, within hazardous areas, new facilities housing populations with mobility concerns to avoid the difficulties and complicated logistics of evacuating these citizens.

Implementation Issues:

Prisons, nursing homes, hospitals and mental health institutes are facilities whose populations require special assistance (or controls in the case of prisoners) for evacuation. Schools and day care facilities might also be included on the list. Disallowed uses can be implemented through the zoning ordinance.

Ordinance, Mobility Concerns
Special Populations

Index Listing

Hazard:
- All

Activity:
- Town/City Manager
- Planning

North Carolina Region
- Statewide

Moratoria

Definition

A moratorium is a short-term suspension of the right to develop, usually accomplished by not issuing permits.

Implementation

Moratoria can play an important role following a disaster. They give officials time to assess the damage and set priorities for response, planning and mitigation efforts. They are often used to prevent property owners from building damaged structures before an acquisition program can go into effect. They can also allow officials to expand high-hazard designated areas to reflect the actual damages from a hazard event.

Index Listing

Hazard:
- All

Activity:
- Building Inspection
- Planning
- Town/City Manager

CRS-Compatible Activity:
- 430: Higher Regulatory Standards

North Carolina Region:
- Statewide

Post-Disaster

Examples:

- The Nags Head (NC) Mitigation and Reconstruction Plan calls for building moratoria of various lengths following a disaster. An initial, 48-hour moratorium goes into effect immediately. Replacement of destroyed structures is halted for 30 days. In the meantime, planners and the Board of

Commissioners may adjust the zoning code to reflect new inlets or eroded areas or to incorporate mitigation tools. All replacement construction must comply with the new ordinances and building codes established during the 30-day moratorium. Building permits issued prior to the storm are revoked for at least 30 days.[125]

- Scituate, MA, adopted a moratorium after a 1978 northeaster seriously damaged some 700 buildings. The moratorium was eventually relaxed to allow construction of structures that complied with upgraded building standards, including regulations requiring buildings to withstand wave heights of 21 feet.[126]
- Sanibel Island, FL, applies its moratorium in three grades or degrees, based on the severity of the damage. The "redevelopment" district, which would be defined as the hardest hit areas, would be subject to a complete moratorium. Properties in the "restoration" district could be repaired during the moratorium period only with a permit. Homes and businesses located in the "impacted" district could be repaired without a permit.[127]

Critique

Since moratoria are frequently subject to legal and political challenges, communities must be prepared to show adequate justification for taking this action. With such justification, a moratorium is likely to withstand legal scrutiny.

N

Natural Environmental Features

Environmental Features
Wind Deflection
See Also: Green Infrastructure

Index Listing

Hazard:
- Hurricane
- Thunderstorm
- Tornado

Activity:
- Engineering
- Planning
- Public Works

North Carolina Region:
- Statewide

Definition

Preserve natural environmental features as wind buffers to deflect some of the force of destructive straight-line winds and hurricane currents.

Implementation

Ten to twenty foot coniferous trees provide year-round wind deflection and may help cut heating costs during the winter. This practice is also a useful method of soil retention, which is of particular importance around farmlands: appropriate vegetation might be planted in public easements between road and cropland or the practice might simply be suggested to farmers. It is also advisable to build at a distance from tall trees with thick trunks, to avoid the hazard of toppling trees. On the coast, this practice can be transferred as the preservation of sand dunes to break strong coastal winds, as well as to beautify the coast and deter unnatural rates of shore erosion.

Example:

- Cary, North Carolina has compiled a listing of tools to preserve open space, along with their strengths and weaknesses. This can be viewed online at http://www.townofcary.org/depts/dsdept/P&Z/openspace/thepreservationtoolbox.pdf.

Neighborhood Access

See: Access to Neighborhoods

New Construction

Ordinance, New Construction

Index Listing

Hazard:
- Drought
- Wildfire

Activity:
- Fire
- Planning
- Town/City Manager

North Carolina Region:
- Statewide

Definition

Ban the use of wooden shingles in new construction in areas prone to wildfires to prohibit one of the most flammable elements on residential exteriors.

Critique

A ban on wooden shingles may be difficult for communities to accept if the style has become a tradition, a signature element of local structures.

Notification of Location of Hazards

Definition

The location of hazards and the risks associated with them should be available to public officials, public employees and agencies, the general public, and the private sector. It is important that information on the location of hazards is also shared between public agencies.

Implementation

One good technique is to develop a communication network that can disseminate hazard information to various groups in the community. Notification should also be given through workshops, information pamphlets, brochures, newsletters, literature, videotapes, websites, etc. Another effective form of notification is a **real estate disclosure requirement**.

See Also: Real Estate Disclosure Requirements
See Also: Education and Training

Index Listing

Hazard:
- All

Activity:
- Engineering
- Planning
- Public Works
- Town/City Manager

CRS-Compatible Activity:
- 330: Outreach Projects

North Carolina Region:
- Statewide

Examples:

- Palo Alto, CA, used a notification program to encourage the voluntary seismic retrofitting of vulnerable commercial buildings. The city identified buildings at risk and required their owners to prepare a report outlining potential strengthening actions. These reports were made public, and buildings that did not take action were required to post signs in public places warning that the building could be a risk in an earthquake. The city published an annual report on the status of repairs. After four years, 35% of the at-risk floor area had been retrofitted or destroyed.[128]

Nourishment

See: Beach Nourishment

O

Offshore Breakwaters

Definition

Breakwaters are small structures placed parallel to the shore in relatively shallow water (usually one to three hundred feet out). Unlike seawalls, revetments and bulkheads, breakwaters protect the shoreline by diffusing incoming waves before they reach the shore. Drift material carried by those waves is deposited behind the breakwater. This accumulating sand protects the shore and may also extend the beach.

Implementation

Breakwaters may be either fixed or floating, depending on water depth and tidal range. They must be strong to be effective because they receive the full force incoming waves. The amount of sand deposited behind a breakwater depends on the characteristics of the site and the design of the breakwater.[129]

Breakwaters

Index Listing

Hazard:
- Erosion
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Coastal Engineering
- Beach Management
- Shore Protection
- Town/City Manager
- Planning
- Coastal Management

North Carolina Region:
- Eastern/Coastal

Examples:

- Avalon, New Jersey installed breakwaters off its coast to reduce sand loss from erosion. The community included such beach protection measures in its **hazard mitigation plan**.[130]

Critique

Breakwaters interrupt the littoral movement of sand, resulting in more sand behind the structure, but less in downdrift areas.[131] Consequently, downdrift beaches are deprived of a natural source of sand, thereby transferring the erosion problem from one area to another. Breakwaters can also be a hazard to navigation and to swimmers.

Onsite Sediment Retention

Definition

Require developers to plan for onsite sediment retention to decrease sedimentation and clogging of stormwater channels and reservoirs.

Implementation

Sediment retention practices can be employed during construction and for long-term residency. These measures include the replanting of grass immediately after grading the land, disturbing the smallest portion of the site as possible, and providing a run-off detention pond.

Sediment Retention
See Also: Retention Ponds
See Also: Vegetation
See Also: Wetland Preservation and Riparian Habitat Protection

Index Listing

Hazard:
- Erosion

Activity:
- Engineering
- Planning
- Public Works

CRS-Compatible Activity:
- 450: Stormwater Management

North Carolina Region:
- Statewide

Ordinance, Environmental Impact

See: Environmental Impact Ordinances

Ordinance, Minimum Residential Street Width

See: Minimum Residential Street Width Ordinance

Ordinance, Mobility Concerns

See: Mobility Concerns

Ordinance, New Construction

See: New Construction

Ordinance, Subdivision

See: Subdivision Ordinance

Orientation of New Development

Definition

Regulate the orientation of new development to convey wind or floodwaters. This allows the destructive force of dominant currents to lose momentum through ground friction rather than building interference (and subsequent destruction).

Implementation

To orient buildings properly, government must be able to identify dependable paths of flow. In terms of floodplain development, structures should be arranged with their greater length component parallel to the course of the river.

Critique

Orientation for optimal conveyance does not guarantee structural resilience and should not be viewed as a substitute for hazard avoidance.

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Engineering
- Emergency Management
- Planning
- Public Works
- Emergency Management

North Carolina Region:
- Statewide

Overlay Zones

Definition

Overlay zones are independent zones that co-exist with the base zoning code. Development in these zones is initially regulated by the standard zoning ordinance. However, under certain conditions the unique requirements of the overlay zone take precedence over regular land use controls.

Implementation

A community might create an overlay zone for high-hazard districts that establishes mitigation requirements for development in those districts. Overlays are also useful for periods of reconstruction. A recovery overlay zone would include temporary planning regulations that might strictly limit reconstruction in the hazard area or could require any new development to include hazard mitigation techniques. The overlay zone would remain transparent until it was triggered by a disaster event.

Overlay zones can be used as a short-term fix, to be repealed when the need that triggered them dissipates or after the base zoning ordinance has been fixed. For this reason, overlays are sometimes used to test potential revisions to the base ordinance.[132]

Zones, Overlay

Index Listing

Hazard:
- All

Activity:
- Town/City Manager
- Planning

North Carolina Region:
- Statewide

Examples:

- The coastal community of Fernandina Beach, Florida relies on an overlay zone to enact its mitigation density bonus program, in which density bonuses are granted to new developments that incorporate mitigation techniques. The zone was created as an overlay to allow planners to lift it following a hurricane. While the zone is inactive, planners can evaluate whether the mitigation actions encouraged by the program effectively reduced hazard damage among the new developments. The overlay would go back into effect only once the program had been evaluated and, if necessary, amended.[133]

Critique:

Overlay zones allow communities to isolate and protect certain areas or to devise regulations that apply in specific situations. However, like any zoning ordinance, the protections of overlay zones can be changed or removed.

P

Park, Industrial

See: Commercial Park

Parks

Definition

Acquire parcels of land in hazardous areas to conserve or restore as parks, in order to reduce the number of structures and infrastructure elements vulnerable to natural hazards.

See Also: Fee Simple Acquisition of Land & Damaged Structures
See Also: Relocation

Index Listing

Hazard:
- All

Activity:
- Town/City Manager
- Planning
- Parks and Recreation

CRS-Compatible Activity:
- 520: Acquisition and Relocation

North Carolina Region:
- Statewide

Implementation

In general, purchasing hazardous lands prior to development (and heavy development interest) is a cost-effective method of hazard management: in a post-hazard situation, natural lands can generally recover of their own accord, with recreational uses resuming after the hazard subsides, while developed areas may require expensive recovery.

Performance or Impact Zoning

Definition

Rather than specifying permitted uses, performance zoning sets standards for the allowable effects or levels of impact of development. The standards typically address specific environmental conditions. They may also govern traffic, stormwater runoff, or viewsheds. This technique could theoretically allow any use that meets the standards, but in practice most performance controls are used in conjunction with traditional zoning.

Impact Zoning
Zoning, Performance
Zoning, Impact

Index Listing

Hazard:
- All

Activity:
- Town/City Manager
- Planning

CRS-Compatible Activity:
- 450: Stormwater Management

North Carolina Region:
- Statewide

Implementation:

Performance standards can be used to govern the risk-inducing impacts of development. One standard that local governments might use is to set a maximum allowable degree of stress on mitigating natural features, such as wetlands and dunes.[134] This would permit developers to propose methods for reducing the stress of their projects on on-site

wetlands or dunes. Performance zoning could also be designed as a point system that "counts" impacts. Projects that exceed a certain number of impacts would be disqualified.

Critique

Performance or impact zoning requires that a developer who creates an impact be responsible for mitigating it, but does not restrict the approaches he or she may take. This requires strict review and monitoring to be effective. The number and level of expertise of the staff required to implement performance or impact zoning ordinances depends on the comprehensiveness of the standards and how much of the jurisdiction they encompass. Developers generally enjoy the greater flexibility this technique affords, but planning staffs may find that it is more difficult to enforce standards than typical regulations. In part this is because some impacts are difficult or impossible to quantify. Communities may find that performance-oriented zoning codes may be too flexible to achieve their preferred degree of mitigation.

Permitting Fees

Definition

Waive permitting fees for home construction projects related to mitigation, and/or reimburse a percent of the cost for home hazard retrofit projects. In addition, recruit financial institutions to participate in "good neighbor" lending, through a local government subsidy or favorable loan conditions, to encourage home retrofit projects and hazard resilient development.

Fees, Permitting

Index Listing

Hazard:
- All

Activity:
- Building Inspection
- Town/City Manager
- Planning

North Carolina Region:
- Statewide

Implementation

"Estimate the average per unit or square footage costs for the risk reduction activities and to provide a tax abatement for a period of time to allow property owners to recover all or a portion of that cost in temporarily abated taxes[135]."

"Rebate of hazard reduction retrofit costs at the time of home purchase or construction by giving up a portion of the city's real estate tax revenues for certified retrofit projects[136]." This offer could be extended to small businesses that wish to complete mitigation projects, such as elevation of their heating-ventilation-air conditioning systems above the base flood elevation.

If government is not in a position to sacrifice short term funds, local financial institutions may be willing to offer reduced interest loans to encourage home and business retrofit projects; participating banks would benefit from a heightened local reputation and presumably increased business during the building season.

Pervious Surfaces

See: Porous Pavement

Planned Unit Development/ Average Density/ Cluster Development

Average Density
Cluster Development

Index Listing

Hazard:
- All

Activity:
- Town/City Manager
- Planning

North Carolina Region
- Statewide

Definition

These types of regulations allow the flexible design of large- or small-scale developments that are constructed as a unit. While the actual design is a matter of negotiation, the basic premise is that some areas are developed more intensively than would normally be allowed and others are used less. The average density of the site remains at or near the allowable limit.

Planned unit development (PUD) places regulations on an area rather than on individual lots and allows for mixed use. Since PUDs are typically negotiated between the developer and city officials on a project-by-project basis, this approach allows for flexibility in meeting subdivision regulations. Clustering typically refers to the concentration of housing on a portion of a site. Clustering can be integrated into a zoning code instead of being negotiated.

Implementation

Shifting density away from hazard-prone areas is a good way to limit development in these areas without instigating a 'taking.' In shorefront areas, governments should encourage property owners to cluster buildings on the inland portions of their parcels, while reserving areas adjacent to the beach for recreational open space and parking.[137] Ownership of such hazard-prone areas can be shared among the owners of the remaining properties or dedicated to the community or a conservation organization as an easement. The latter option would prevent the open spaces from ever being developed. Where it is applicable, PUD plans should be negotiated to include hazard mitigation features.[138]

Examples:

- The Portland (OR) Metro draft regional plan calls for allowing cluster development where it would help keep buildings out of the floodplain (1997).[139]
- Kent County, MD, encourages clustering by providing density bonuses to landowners who comply with a series of site guidelines. The incentives allow landowners to double or triple their allowable density from twenty or thirty acres per unit to ten acres per unit.[140]

Critique

The government's goal for this designation is to preserve open space and protect sensitive natural areas. The developer benefits from higher dwelling unit density or floor area ratios. Planned unit developments generally require large areas of undeveloped land, which not all communities have. Intensively clustering development, even on non-sensitive lands, may cause unintended environmental impacts. This technique should be implemented in conjunction with a comprehensive plan to avoid 'leap frog' development. When developers move rapidly outward from an established community in search of large parcels of land, the costs of extending public services to the ensuing developments can be high.

Like any zoning ordinance, clustering is subject to changes in the political environment. It is possible that clustering ordinances could be modified to allow development on the open space portions of clustered parcels.

Plans, Beach Management

See: Beach Management Plans

Plans, Capital Facilities

See: Capital Facilities Plans

Plans, Capital Improvements

See: Capital Facilities Plans

Plans, Comprehensive

See: Comprehensive Plan

Plans, Floodplain Management

See: Floodplain Management Plans

Plans, Hazard Mitigation and Post-Disaster Reconstruction

See: Hazard Mitigation and Post-Disaster Reconstruction

Plans, Post-Disaster Reconstruction

See: Hazard Mitigation and Post-Disaster Reconstruction Plans

Police Station

See: Retrofit of Fire Stations and Police Stations

Porous Pavement

Definition

Substitute porous or open-grid pavement for impervious pavement to limit the amount of stormwater runoff that contributes to localized flooding.

Implementation

Pavement will ideally be pervious enough to absorb rainfall but with pores small enough not to clog with debris or cause problems for pedestrian traffic. Some brands of asphalt or concrete that lack the finer sediment of conventional cement hold promise. Several websites containing photographs and/or useful information regarding porous and open-grid pavement include:

- http://www.gcpa.org/pervious_concrete_pavement.htm
- http://www.greenbuilder.com/sourcebook/PeviousMaterials.html

Pervious Surfaces
See Also: Impervious Surface Limits
See Also: Land Treatment
See Also: Grassy Swales
See Also: Stormwater Management

Index Listing

Hazard:
- Erosion
- Flash Flooding
- Flooding

Activity:
- Engineering
- Planning
- Public Works

CRS-Compatible Activity:
- 510: Floodplain Management Planning

North Carolina Region:
- Statewide

Critique:

Reservations apply to the use of open-grid, or open-cell, pavement: it is treacherous for those with mobility challenges (and those in high heels) and is also expensive to install. However, open-grid pavement is appropriate for limited-use access routes or overflow parking lots.

Post-Disaster Reconstruction Plans

See: Hazard Mitigation and Post-Disaster Reconstruction Plans

Prescribed Burning

Definition:

The term "prescribed burning" or "controlled burn" refers to burning forest, brush, or grassland in a controlled and confined manner to accomplish "planned land managemnt objectives[141]." Frequently, fire management officials use prescribed burning to reduce the amount of biomass and organic fuel (i.e., dry grasses, shrubs, leaves, branches and dead or very dry trees) that can heighten the risk of large-scale, uncontrolled, natural forest fires, which can threaten public safety and personal property.

Controlled Burning
Fire Ecology
Fire Management
See Also: Wildfire Management

Index Listing

Hazard:
- Wildfire

Activity:
- Planning
- Town/City Manager

North Carolina Region:
- Western/Mountains

Prescribed burning has long been used to promote the regrowth of vegetation that will better support new types of flora and fauna. For example, North Carolina's Landowner Hazard Reduction Prescribed Burning Program lists among its goals wildlife habitat improvement for quail, deer and wild turkey. While historically forest fire suppression was practiced by turn-of-the-century foresters such as Gifford Pinchot, who believed that fire's destruction of both standing trees and young seedlings was detrimental to the continued growth and health of the forest, today's foresters recognize fire as contributing a number of benefits to the life of a forest[142]. Among those benefits is fire's ability to "clean" the forest of diseased trees, replenish the soil's nutrients, and remove invasive or competing species of trees.

Implementation:

Under the Landowner Hazard Reduction Prescribed Burning Program, prescribed burns are supervised by the North Carolina Division of Forest Resources. The Division advises landowners on weather conditions suitable for prescribed burns, provides the necessary training on prescribed burn methods, and plows control lines for the landowner at no cost. Please see the following link for more information:
http://www.dfr.state.nc.us/protecting/hazard_reduction.htm

Critique:

One author has argued that prescribed burning should be used not merely to reduce fuel load and suppress future fires, but as a management tool to be applied only to those ecosystems or tree types that naturally rely on fire in their life cycles, such as ponderosa pine and lodgepole pine[143]. Prescribed burning may not be applicable to all forest management situations.

Program, Capital Improvements

See: Capital Facilities Plans

Propane Tanks

See: Tie-Downs

Public Education

See: Education and Training

Public Facilities

See: Capital Facilities Plans

Public Facilities, Adequate Requirements

See: Concurrency

Public Housing

Definition:

Relocate hazard-prone public housing units to areas of non-hazard, and/or
retrofit hazard-intensifying elements within public housing units to protect the welfare and meaningful possessions of residents, for whom personal property insurance may be unaffordable.

Implementation

This proposal must be presented to the public housing authority of the city, county, or region. A Community Development Block Grant (CDBG) could be sought to partially fund the retrofit, relocation, or reconstruction project. This measure may also be seen as an opportunity to:

- replace traditional high-rise design with clustered public housing structures of no more than three stories, which have been characterized as less institutional and more community-oriented,
- place public housing in closer proximity to jobs, education and training facilities, and public transit routes, all of which may have shifted since the original siting of the units, and
- create a showcase for both hazard-wise design and green (environmentally conscious) building practices.

Index Listing

Hazard:
- All

Activity:
- Planning
- Town/City Manager
- Housing

CRS-Compatible Activity:
- 520: Acquisition and Relocation
- 530: Retrofitting

North Carolina Region:
- Statewide

Public Information

See: Education and Training

Public Records

Definition

Perform a hazard-wise retrofit of the primary local government records building, and/or store digital or hard copies of public records in a hazard-free offsite location to protect important or irreplaceable documents.

Implementation

Documents that local government might consider copying and relocating include: original town charters; books of court rulings; local ordinances; deeds and cadastral maps; special use permits; detailed crime records; budget records; birth, death, and marriage certificates; demographic or geographic information collected through intensive research; and historic photographs of local figures, architecture, and events. Other important considerations for local government to note in deciding whether or not to retrofit public records buildings or relocate these documents include:

Records, Public

Index Listing

Hazard:
- All

Activity:
- Library Services
- Planning
- Town/City Manager

CRS-Compatible Activity:
- 520: Acquisition and Relocation
- 530: Retrofitting

North Carolina Region:
- Statewide

- Certain legally defined relationships between a landowner(s) and between the city may not be binding without official documented proof; the further back an agreement was reached or an exception granted, the more difficult the deal is to verify.
- Re-collecting information is a time-consuming and expensive endeavor, often fraught with incomplete mental recollections.
- If City Hall or another downtown records building is architecturally significant, a retrofit might be accomplished in conjunction with historic preservation efforts.
- In the case of a document relocation, this may be viewed as an opportunity to digitize paper documents and build an electronic, and perhaps online, database.
- At a minimum, documents should be moved from flood-prone basements to upper floors.

Public School Buildings

Definition

Retrofit hazard-intensifying elements within public school buildings to ensure the safety of schoolchildren and faculty by minimizing the risk of falling or propelled objects. Due to their dispersion throughout the community, school buildings are also prime candidates to function as emergency shelters for surrounding neighborhoods.

Implementation

For specific measures, refer to the FEMA's "Mitigation How To Series" (http://www.fema.gov/mit/). Note that this is an opportunity to install new and up-to-date audio-visual equipment, as well as energy efficient lighting and air control systems. The retrofit may also be utilized to locate and remove any residual materials that may threaten health, such as lead, asbestos, etc.

School, Public
See Also: Safe Room

Index Listing

Hazard:
- All

Activity:
- Schools
- Emergency Management
- Planning

CRS-Compatible Activity:
- 530: Retrofitting

North Carolina Region:
- Statewide

Purchase of Development Rights (PDR)

Definition

Purchase of a property's development rights (PDR) is similar to acquiring a negative easement against development, in which a holder purchases the right to develop the property but not the property itself. Local governments can use this technique as an alternative to **fee simple acquisition** or **easements** when the only purpose is to prevent development.

Development Rights
See Also: Transfer of Development Rights (TDR)

Index Listing

Hazard:
- All

Activity:
- Planning
- Town/City Manager

North Carolina Region:
- Statewide

Post Disaster

Implementation

PDR is particularly suited to land in forestry or farming, where the current use is compatible with hazard-mitigation goals. In this case, PDR can prevent the land from changing into a higher-risk use. PDR also help preserve or enhance resource development uses by providing the landowner with a lump-sum payment in return for development rights.[144]

PDR is implemented generally through a formal program that sets criteria for prioritizing purchases.[145] Such a program might give preference to the purchase of development rights in hazard-prone areas. Communities may find

it helpful to "lease" the development rights for a certain period of time (until a purchase can be made, or until public facilities can be upgraded) rather than purchasing them outright.[146]

Examples:

- In Maryland, farmers wishing to sell their development rights submit bids to the state Agricultural Land Foundation. The foundation evaluates the bids with the goal of acquiring the highest-value land for the lowest sale prices.[147]

Critique

The purchase of development rights may not be significantly less expensive than fee-simple acquisition. By owning development rights the government assumes a very high level of control over property without being responsible for its maintenance. However, the government does lose money in making the purchase and subsequently reducing tax burden on the property. In North Carolina, PDR property must be taxed at a rate that recognizes the diminution of value resulting from its loss of development rights.[148] The government must also police the easement, since unenforced rights may eventually be forfeited. PDR may not be cost-effective in rapidly suburbanizing areas because the development rights may be very expensive.[149]

PDR is not useful when hazard mitigation is only one part of a multiple-objective approach, such as acquiring open space for recreational purposes, since it allows the owner to maintain the right to restrict public access. It should also be noted that PDR does not preclude all uses of land, which may run counter to some mitigation objectives.

Purchase Option, Right of First Refusal

Index Listing

Hazard:
- All

Activity:
- Planning
- Town/City Manager

North Carolina Region:
- Statewide

Definition

Purchasing a right of first refusal guarantees the government the first opportunity to acquire a property, while an option prevents the sale of the property to any another party for a specified period.

Implementation

It is probably not legal to enact a blanket right of first refusal over all properties within a jurisdiction.[150] As a result, the best use of this technique for mitigation purposes would be to monitor the use of specific hazard-prone properties. The government could acquire an option or right of first refusal to prevent these properties from changing to a more intensive use or to preclude post-disaster sales to developers. This technique might be more effective in conjunction with **sellback/leaseback**, which would allow the local government to recoup some of the costs of purchasing the option. Options may give communities enough time to find or develop sources of financing for a purchase.

Critique

This technique is initially less expensive than an outright purchase. However, if the community is likely to acquire a property eventually, an option may add unnecessary cost to the purchase. Options do not preclude price increases, so the government may have to pay more for a future purchase than an immediate one. If the government marks the property for acquisition and then fails to purchase it, it may be liable for any diminution in value that results from the presence of the option.

Purchase Sellback/Leaseback

Leaseback
Sellback

Index Listing

Hazard:
- All

Activity:
- Planning
- Town/City Manager

North Carolina Region:
- Statewide

Definition

A local government can control the use of its land by selling or leasing it to the private sector with restrictions, covenants or negative easements. This approach allows the government to maintain control of the property or prevent development on it without having to actually manage it.

Implementation

The sellback/leaseback option allows the government to recover some of the cost of acquisition and can be done in conjunction with acquisition, or as a condition of acquisition.[151] Negative easements, in which a holder purchases the right to develop the property but not the property itself, should be used to prevent development on hazard-prone property sold or leased to the private sector, since allowing intensive uses is contrary to the original intent of the public purchase.

These techniques can help restore businesses that have suffered a disaster-related loss of capital. The local government would buy the damaged businesses out of their property, then lease the properties back at a low rate. Local authorities could also use this technique, where appropriate, to permit farming, forestry and similar activities to occur on property that is not suitable for more intensive uses. These techniques can help local governments that want to retain businesses within their jurisdiction.

Examples:

- Lincoln County, MO, established a leaseback program after the 1993 Midwest Floods. Some of the land in the floodplain that the county acquired after the flood will be leased back to its former owners, with the caveat that nothing can be parked on the land from October to April. Regular lots are leased at $50/year and waterfront lots are $300/year. The revenues will be used to pay the salary of a full-time floodplain manager. The county is also leasing wetlands to the state Department of Conservation. The county retains ownership of the property but the state manages it.[152]

Critique

Governments responsible for leasing or selling property must monitor compliance with the terms of the contract, which is probably less of a burden than maintaining the property. If the government sells a property with restrictions, those limits must be reflected in the tax burden on the new owner. As a result, sellback may not be the most lucrative way of returning government properties to the tax rolls.

R

Rate Allocation Systems

See: Slowing Development

Real Estate Disclosure Requirements

Disclosure Requirements
See Also: Community Awareness Programs
See Also: Notification of Location of Hazards
Index Listing
Hazard:
- All

Activity:
- Emergency Management
- Planning
- Town/City Manager

CRS-Compatible Activity:
- 340: Hazard Disclosure

North Carolina Region
- Statewide

Definition

Real estate disclosure laws require that the buyer and lender be notified if property is located in a hazard-prone area. Advocates argue that a better-informed marketplace should result in better decision-making: lenders will be hesitant to extend credit in hazard zones; and well-informed consumers will choose to avoid purchase in hazard areas, demand a lower price or pursue mitigation actions after purchase.[153]

Implementation

Local practices by local real estate boards can make notification practices effective by requiring that newcomers be advised about hazard risks thoroughly and early in the home-buying process. Real estate boards may also require prospective homeowners to disclose past disaster events, regardless of whether the property is in a mapped high risk zone. Terms and maps used for disclosure of hazard risk should be understandable to homebuyers. Notification could be required in newspaper advertisements for the property.

Hazard notification must be clear and easily understood to be effective. One way to simplify the notification process would be to produce a community map or brochure that outlines the areas of high and moderate hazard vulnerability, as well as recommended mitigation techniques.[154] These documents could be made available to prospective residents through real estate offices. Ideally, notification should be paired with community awareness programs to ensure their influence. Sellers should not have the option to make "no representation" about the hazard risk of the property.[155]

Some examples of the hazard conditions that may require disclosure include: settling from any cause, or slippage or other soil problems; flooding, drainage, or grading problems; flood insurance requirements; and property or structural damage from fires, hurricanes, earthquakes, floods or landslides.[156]

Examples:

- There are three states that have adopted mandatory hazard disclosure provisions: California, Tennessee, and South Carolina. In California, the responsibility for disclosure is placed on the real estate agent representing the property being sold. In Tennessee, the owner of the property is responsible for disclosing information about hazards. South Carolina's provision requires only that the purchasing contract include a disclosure statement.[157]

Critique

Studies have shown that notification may have a limited impact on home-buyers. Often this is because notification came too late in the process, the warning message was weak or confusing, the warning message lacked credibility, or because the consumer was not concerned.[158]

Currently, federally-regulated lending institutions must advise applicants for a mortgage or other loan if the building is in a floodplain as shown on the Flood Insurance Rate Map. Since this requirement has to be met only five days before closing, the applicant is significantly committed to purchasing the property when he or she first learns of the flood hazard.

Records, Public

See: Public Records

Regulations, Subdivisions

See: Subdivision Regulations

Relocation

Definition

Relocation means moving a building or facility to a less hazard-prone area, either within the same parcel or on a new parcel. This technique is typically used to avoid coastal or riverine flood hazards. "Relocation" can also be used to describe the process of demolishing a building and reconstructing it outside the hazard area.

Implementation

One way to make relocation work is to adopt what Pilkey *et al*. call a 10/100-year relocation plan. Under this approach, a community develops a relocation strategy for its hazard-prone structures within 10 years, then implements that plan over the ensuing 100 years.[159] Issues that need to be addressed in the planning stage include: cost-benefit comparisons of relocating structures intact or rebuilding; and whether buildings can be relocated on the same property or if new property must be acquired.[160]

Mobile homes and manufactured housing have been shown to be highly vulnerable to floods and should not be located in the floodplain. Where such housing can be relocated, this step should be taken. Communities may wish to require a bond against the damage to public streets and utilities incurred during a move.

See Also: Acquisition
See Also: Parks

Index Listing

Hazard:
- Earthquake
- Erosion
- Flash Flooding
- Flooding
- Hurricane
- Landslide

Activity:
- Engineering
- Parks and Recreation
- Planning
- Public Works
- Town/City Manager

CRS-Compatible Activity:
- 520: Acquisition and Relocation

North Carolina Region:
- Statewide

Post Disaster

Examples:

- Nags Head, NC, is planning with relocation in mind. The town has limited the waterfront development of structures that are difficult to move, such as condominium complexes and hotels. Its building standards are very restrictive and incentives are used to encourage development to occur away from the ocean side.[161] Nags Head also requires that the dunes at the former

site of a relocated building be stabilized or rebuilt. The former sites of relocated buildings are subject to inspection to ensure that these requirements are followed.[162]

- Soldiers' Grove, WI, voluntarily moved itself out of the Kickapoo River floodplain in the mid-1970s. Using federal funds, the town moved its entire central business district and other flood-prone properties a half-mile from the floodplain. The former downtown became a riverside park.[163]
- The city of Darlington, WI developed a business park on a 35-acre parcel south of the city to house some of its repeatedly-flooded downtown businesses. The city relied on Economic Development Administration funds to provide the necessary infrastructure, including a water main, gravity sewer and force main, on-site sewage lift station, an access road and drainage improvements. After completion of these improvements, several of the businesses in the flood prone areas of the city were moved to this parcel and became the heart of the new business park. The former sites of these businesses were acquired by the city and converted to open space.[164]
- Relocating can be the stimulus for other community redevelopment goals. Pattonsburg, Missouri adopted a Charter of Sustainability when it relocated after the 1993 Midwest Floods. The portions of the community that have been relocated outside the floodplain are designed to energy-efficient and resource-conservation standards.[165]
- Brattleboro, VT, created a set of regulations to govern mobile home parks located in high-risk floodplains. The rules allow park owners to expand outside the floodplain. However, one unit inside the high-hazard area must be permanently removed prior to the owner's receiving permission to add three new units outside the floodplain.[166]

Critique

Relocation of some structures or facilities may not be feasible. At the very least, it is costly and inconvenient. The cost of a new lot, a new foundation, new utility connections, landscaping, moving fees and mitigation of the former site (including the removal of foundations, utility connections, concrete and asphalt) may outweigh the value of the structure. Adding to these costs is the fact that prices for lots outside the floodplain are often more expensive. The residents of North Carolina's floodplain are often low-income or members of a minority population or both. Local governments must provide sufficient support for anyone it encourages or requires to relocate. Even so, local officials should be prepared to address issues of equity if residents who must move are distinct from the community at large.

Renourishment

See: Beach Nourishment

Requirements, Adequate Public Facilities

See: Concurrency

Reservoirs

See: Dams and Reservoirs

Retention Basin

See: Stormwater Basin

Retention Ponds

Definition

Retaining or retention ponds (used here interchangeably with detention ponds) are basins designed to catch surface runoff and prevent its flow directly into a stream or river.

Implementation

High volumes of stormwater runoff should be controlled because they can create flood and landslide hazards. A typical stormwater standard is that stormwater must not leave a parcel at a higher rate after the parcel has been developed than it did before. One way to achieve this is to require retaining ponds as a condition of subdivision regulations. It is also possible to create a shared off-site retention pond to collect stormwater from a number of developments. Watershed planners should identify the most effective common location. Developers can be required to contribute to the construction of a facility that will be shared among several projects. On-site retention ponds can be a valuable source of water for fire fighting.

See Also: Onsite Sediment Retention

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Engineering
- Planning
- Public Works

CRS-Compatible Activity:
- 540: Drainage System Maintenance
- 450: Stormwater Management

North Carolina Region:
- Statewide

Critique

Retention ponds are a relatively inexpensive way to prevent localized flooding, provided that ample undeveloped land is available, and have the added advantage of not altering the character of the streams they protect. These ponds can act as groundwater recharge sites and reduce water pollution through soil filtering.

Retrofit of Fire Stations and Police Stations

Definition

Perform a hazard-wise retrofit of fire and police stations to ensure that in times of hazard, emergency service personnel and equipment are not impaired by a damaged facility. Potential scenarios to be avoided include the collapse of roof members onto emergency vehicles and the jamming of bay doors through which vehicles exit.
This practice will ensure that the fire or police station will be able to serve as the operations center in the event of natural hazard.

Fire Station
Police Station
Safe Site
Seismic Preparedness

Index Listing

Hazard:
- All

Activity:
- Fire Prevention
- Law Enforcement
- Planning
- Town/City Manager

CRS-Compatible Activity:
- 530: Retrofitting

North Carolina Region
- Statewide

Retrofitting

See: Seismic Preparedness

Revetments for Beach Management

Index Listing

Hazard:
- Erosion
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Coastal Engineering
- Beach Management
- Shore Protection
- Town/City Manager
- Planning
- Coastal Management

North Carolina Region:
- Eastern/Coastal

Definition

Revetments are created by placing hardened materials atop the existing shore to protect them from high tides, surges and floods. Revetments disperse wave action and backwash and reduce shoreline erosion.[167]

Implementation

Proper revetment design includes a filter cloth backing that prevents sediment from seeping through gaps in the hardened material.[168] Revetments may be constructed out of a number of materials and configurations, from boulders placed along the backshore, to gabions*, to pre-cast armor units.

Critique

Revetments have some advantages over other structural techniques. They absorb waves rather than redirecting their energy to unprotected areas. [169] Most revetments do not significantly interfere with the movement of sand along the shore. However, sand eroding from the shore before the construction of a revetment may have nourished a neighboring area. The installation of a revetment in this case may lead to accelerated erosion on those beaches.[170]

Revetments typically cover sandy spaces previously used for recreational beach activities. Any sandy areas left exposed seaward of steep revetments are prone to erosion. Revetments also require perpetual maintenance, since loose material can become a hazard in storm events.

Revetments for Flood Control Works

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Coastal Engineering
- Engineering
- Town/City Manager
- Planning
- Public Works

North Carolina Region:
- Statewide

Definition

Revetments are created by placing hardened materials atop an existing riverbank or slope to protect it from storm surges, floods or on-going erosion. Revetments disperse waves, improve the flow of water through the channel and reduce erosion of the stream bank.[171]

Implementation

Proper revetment design includes a filter cloth backing that prevents shoreline sediment from seeping through gaps in the hardened material.[172] Revetments may be constructed out of a number of materials and configurations, from boulders to gabions* to pre-cast armor units.

Examples:

- Batavia, NY, used revetments to improve

* Gabions are wire mesh baskets filled with rock or rubble used as "bricks" in retaining walls and erosion control structures. The bricks are tied together with heavy wire as construction progresses to form the complete structure.
* Gabions are wire mesh baskets filled with rock or rubble used as "bricks" in retaining walls and erosion control structures. The bricks are tied together with heavy wire as construction progresses to form the complete structure.

channel flow in Kibbe Creek. Several sections of the stream bank were cleared to reduce snagging. Riprap revetments then placed on some of these areas and stabilized with gabion baskets. These improvements keep the creek waters from eroding the shore and also prevent floating objects from snagging on the bank and causing backups.

Critique

Revetments require perpetual maintenance, since they are typically constructed of loose material that, if dislodged, can become a hazard during storms or floods. Unlike vegetation, revetments may reduce resistance to water in a channel. This can increase the velocity of the water and discourage its infiltration to groundwater.

Review of Site Plan by Specialist

Definition

Retain services of a qualified specialist for technical review of site plans; this enables a site-by-site review of structural resilience to hazards and the development proposals' potential for the exacerbation of a hazard. Technical review is a particularly good option when a hazard is highly unlikely but the consequences could be devastating.

Consultant
Site Plan Review by Specialist

Index Listing

Hazard:
- All

Activity:
- Engineering
- Planning
- Town/City Manager
- Public Works

North Carolina Region:
- Statewide

Implementation

The lead reviewer may be a scientist, engineer, or planner by trade, but should have a special knowledge of hazard-resistant design pertinent to the locality. The local planning director or other official with an understanding of the larger community and economic context should coordinate with all development review individuals and boards. Finally, one source cautions that, "It is important to use (hazard) information before lots are subdivided. Once this opportunity is lost, it becomes very difficult to deny individual lot owners the use of their unstable property." [11]

Critique

Specialists come at a price; however, if development pressures are mild, quality of reviewers may be substituted for quantity.

Riparian Habitat Protection

See: Vegetation
See: Green Infrastructure

Risk Assessment

Definition

Risk assessment is a tool that evaluates the likelihood of a hazard event and the probable degree of damage that would result. Risk assessment may also take into account secondary damage, such as the likelihood of well contamination following a flood. Assessment should be based on hazard identification to target more accurately the areas and properties that are most at risk.

Index Listing

Hazard:
- All

Activity:
- Engineering
- Emergency Management
- Planning

CRS-Compatible Activity:
- 410: Additional Flood Data

North Carolina Region:
- Statewide

Examples:

- Portland, OR's regional Metro government is evaluating earthquake risks using geographic information systems software. Officials have produced maps showing areas subject to liquefaction, ground motion amplification and slope instability. They combined these maps to highlight areas with one or more of these hazards. The maps were then compared with maps showing buildings and lifelines to evaluate the risk to these facilities, to prioritize retrofit programs, to improve emergency response and to minimize the risk from future development (1993).[173]
- FEMA conducted a hazard assessment for Beebe Medical Center in Lewes, DE. The assessment found that floods could close the two primary access roads leading to the center. FEMA also discovered that disaster-related loss of power, water supply or wastewater treatment failure, flying debris, or wind or water penetrating the building could impair the hospital just when it is most needed. As a result of the assessment, the center began to acquire temporary and permanent wind shutters for its windows and doors.[174]

Roadway Realignment, Dune Gap Plugs and Sediment Mounds

Definition

Roadway realignment is the technique of re-orienting near-shore roads so that they are parallel to the beachfront rather than perpendicular to it. The latter orientation tends to channel storm surge and wind inland. Dune gaps are breaks in the dune field that are created to provide beach access or ocean views. These can also act as channels for the elements. Sediment mounds are large piles of material, usually sand, that act as artificial dunes or plugs for these gaps in the natural system. These mounds are an inexpensive way to slow the inland progress of storm-related wind and water.

Dune Gap Plugs
Sediment Mounds

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricane
- Erosion
- Nor'easter
- Thunderstorm

Activity:
- Beach Management
- Shore Protection
- Engineering
- Planning
- Public Works
- Transportation
- Coastal Management
- Town/City Manager

North Carolina Region:
- Eastern/Coastals

Implementation

Planners must determine whether rearranging or eliminating roads that are in improper alignment would preclude access to private property. In the event that realignment is not possible, one alternative is to construct sand dunes or seawalls at the beach end of through streets. It is also possible to create sediment mounds in the shape of the letter "t" at some through street intersections. While these mounds will slow or stop overwash, they do require the reorientation of traffic. T-shaped sediment mounds can be

used as flood dams to prevent finger canals * from becoming flood conduits.[175] Other communities may wish to dam these canals entirely at their oceanfront ends.

It is important to note that flooding along streets works in both directions: water that washes inland will likely retreat along the same path back to the sea. It has been noted in some cases that sound-side boat ramps can channel returning water back onto barrier islands.[176] This could be prevented by locating T-shaped sediment mounds located near these ramps.

Where mounds have been built to plug dune gaps, access can be restored by providing public dune walkovers. Walkovers not only provide a public route to the beach, they also help preserve the integrity of the dunes as natural mitigation structures (see **Sand Dunes**).

Examples:

- Planners for Emerald Isle, NC, designed that community's roads to be curved (rather than straight) to prevent water from coursing inland along them during storms. Emerald Isle's roads cross dunes; they go over them instead of creating a gap in the dune system. The roads were also designed to not end on the beach.[177]
- A pilot study for Fernandina Beach, FL, called for plugging street-end dune gaps with artificial dunes. Since these gaps had long provided pedestrian access to the beach, planners anticipated that visitors would try to walk over the new dunes. To protect the dunes and the vegetation that stabilizes them, the Fernandina Beach study recommended building dune walkovers and installing sand fencing to direct and minimize the effects of pedestrian traffic.[178]

Critique

Blocking or re-aligning roads will change the local traffic pattern. This can raise issues of access to private property, which may in turn raise constitutional takings challenges. Such challenges can often be avoided by providing alternative routes of access for property owners. Since many roads provide public access to the beach, realignment can inadvertently restrict access to the shore unless careful planning takes place.

* Finger canals are ditches or channels that are dug across a barrier island in order to maximize the number of waterfront lots.

S

Safe Room

Definition

Require construction of a "safe room" in new schools, daycares, and rest homes to provide a room, or adequate space, that is capable of withstanding extreme wind forces and the force of collapsing or propelled materials.

Implementation

The room should be large enough to hold the anticipated number of daily occupants of the building. Existing schools, daycares, and rest homes could potentially receive government subsidy (see Section 12) to reinforce a room or hallway to function as a safe room.

See Also: Public School Buildings

Index Listing

Hazard:
- Earthquake
- Hurricane
- Nor'easter
- Thunderstorm
- Tornado

Activity:
- Engineering
- Building Inspection
- Planning
- Schools

North Carolina Region:
- Statewide

Safe Site

Definition

Determine whether or not public facilities such as fire and police stations are currently located on a hazardous site; if they are, acquire a safe site for a future fire or police (sub)station to ensure that public safety services are sited outside hazardous areas, while still within range of development that is threatened by natural hazards. Residential areas tend to proliferate around new fire and police stations, creating the potential for the site to be exploited as a development guidance tool. Co-location would also facilitate ease of transition to an emergency response center when need arises.

Fire Station
Retrofit of Fire Stations and Police Stations
School Facility

Index Listing

Hazard:
- All

Activity:
- Engineering
- Fire Prevention
- Planning
- Law Enforcement
- Public Works
- Town/City Manager

CRS-Compatible Activity:
- 520: Acquisition and Relocation

North Carolina Region:
- Statewide

Sand Dunes

Definition

Dunes can provide a significant level of protection against building damage from severe storms and long-term shoreline erosion. They prevent overwash* flooding during storms and minimize the scouring that occurs when this water retreats to the sea. Dunes also shelter buildings from high winds. In the long term, dunes help replenish beach sands and maintain beach width. Dunes can be constructed artificially by trapping sand with fences or by piling sand into dunes with bulldozers. Dune stabilization is a technique for anchoring sand in dune form using plants.

See Also: Dune Protection
See Also: Sediment-Trapping Vegetation, Coastal

Index Listing

Hazard:
- Erosion
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Beach Management
- Shore Protection
- Planning
- Coastal Management
- Town/City Manager

CRS-Compatible Activity:
- 400 SH Special Hazard Areas

North Carolina Region:
- Eastern/Coastal

Implementation

Constructing new sand dunes requires an understanding of the biological and physical processes of the coastal zone. The most effective method of creating new dunes is to interrupt airflow with fences made of porous materials. This technique encourages sand to deposit where the airflow has been disrupted. It is important that the fences alter the airflow but do not halt it. One note: other factors can also affect airflow and the subsequent shape of the dune field. Predominant among these is construction on the shoreline.

Dunes can also be built using vegetation. It is important to note the distinction between vegetation used for dune construction and for dune stabilization, as they are usually of different species. It is also important to note that such methods are less likely to work at restoring interior dunes, since much of the sand that would feed them is covered by buildings, lawns and roads.[179] In these cases, it is necessary to create dunes by depositing sand manually. Sand used for this purpose should match the existing sand type. New dunes should resemble and be in line with existing dunes.[180]

Dune stabilization can be achieved through grading or the rapid construction of new dunes with earth-moving equipment. It is also possible to anchor the surface of the dune by adding chemicals or planting vegetation (such as grasses, shrubs and trees).

Shorefront dunes are often protected by state legislation; however, interior dunes rarely receive the same degree of protection.[181] CAMA requires that new development not cause the "significant" removal or relocation of sand or vegetation from primary* and frontal* dunes. CAMA also requires that small structures be located landward of the toe of the frontal dune or the crest of the primary dune, whichever is further from the water.[182]

Examples:

- A 1994 hazard mitigation study for the City of Fernandina Beach, FL, called for reconstructing damaged dune fields through sediment capture with sand fencing. The capture stage is to be followed by the planting of native sea oats that will anchor the dunes. The Fernandina plan notes that the end of the sand fencing should be connected with neighboring dunes to establish a continuous dune system.[183]
- Duxbury, MA created two "sacrificial" dunes to protect the town's inner bay. The two 16-foot artificial dunes consist of 60,000 cubic yards of sand.

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* Overwash is when ocean-side waves are driven onto an island, usually through gaps in the dune field. Because of their vulnerability to overwash, dune gap areas should be considered hazardous.
* Primary dunes are the first dunes with a height equal to the mean flood level plus six feet.
* Frontal dunes are the first dunes landward of the beach large enough to provide some measure of storm protection.

> Town administrators recognize that the dunes could wash away in the next major storm. However, they hope that the dunes will absorb the impact of that storm and that the sand will continue to exist within the local sand "economy" to be brushed back onto the beach over the following years.[184]

Critique

Dune fields can be difficult to integrate with existing beachfront residences. To provide any storm protection, dune fields must be wide. A study of dune fields in South Carolina following Hurricane Hugo discovered that the minimum effective field size was 100 feet wide, with dunes 10 feet high on average.[185] Dune fields must be intact in order to protect the structures behind them. Dune gaps created for public access and for ocean views are vulnerable to storm overwash.[186] Dunes migrate as part of their natural life cycle. Attempts to anchor dunes in place generally result in "seawall" dunes that narrow beaches and may cause erosion at their ends.[187] Areas with low sand supplies will have trouble building dunes artificially.[188]

Sand-scraping

Definition

Sand scraping is a technique for reinforcing the beach without adding new sand. The top foot of sand is scraped from the beach with bulldozers and deposited above the high-tide line. This may result in new sand drifting onto those parts of the beach that are below the high-tide line.

Implementation

Scraping should dig no deeper than one foot below the existing surface to prevent the beach from becoming too steep. Stipend beaches erode more quickly than those at their natural slope.

Critique

While sand-scraping is less expensive than beach nourishment, it is also only a temporary solution to beach erosion. Scraped beaches continue to erode, and may erode more quickly than natural beaches in storms. [189] If so, this technique would not be well-suited for mitigation. Some research has shown that beach scraping may actually help beaches recover after a storm event.[190] However, since no new sand is added to the system, gains on scraped beaches amount to a net sand loss on downdrift beaches.[191]

Index Listing

Hazard:
- Erosion
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Coastal Engineering
- Beach Management
- Shore Protection
- Engineering
- Town/City Manager
- Planning
- Coastal Management

North Carolina Region:
- Eastern/Coastal

Scenario Analysis

Definition

Scenario analysis is a method of consciously recognizing both immediate and secondary impacts of undertaking a particular activity. Many of the beneficial impacts associated with hazard mitigation are not easily quantified by traditional methods of benefit-cost assessment. While a formal hazard vulnerability assessment provides a nice foundation for scenario analysis, general knowledge of the community's political, economic, and social atmosphere is integral to this forecasting exercise. Below are five questions to ask in conducting a scenario analysis to aid in selecting the most vital mitigation practices for your

Analysis

Index Listing

Hazard:
- All

Activity:
- Planning
- Town/City Manager

North Carolina Region:
- Statewide

community.

1) If a "worst-case" hazard occurs, what does my community stand to lose?

- Human casualties (including residents, tourists, and rescue personnel)
- Pet and livestock casualties
- Infrastructure damage and loss of critical facility function
- Damage to historic structures
- Loss of vital records and documents
- Temporary business closings
- Personal property loss

2) What reactionary expenses and further losses are associated with original set of losses?

- Facility and infrastructure repairs
- Debris and contamination clean-up costs
- Lost wages and sales tax revenue from prolonged closings
- Permanent business closings and economic stagnation
- Environmental costs (often from secondary technological hazards)
- Homeowner relocation costs

3) Can any of the suggested mitigation practices reduce primary or secondary losses?

4) Can any mitigation practices also enhance local livability or sustainability?

- Conservation of natural lands
- Enhanced recreational opportunities
- Reduced overhead costs for emergency preparation
- Improved access to community facilities
- Heightened efficiency of utilities or introduction of better technology
- Attraction of business and industry
- Improved air and water quality
- "Green" building practices in private development
- Increased transportation choices and reduced congestion

5) Are the most promising mitigation practices feasible in the context of local constraints?

- Technical feasibility
- Affordability (potential for enterprise funding or general obligation bond)
- Political willingness and public acceptance
- Maintenance or management requirements
- Environmental repercussions
- State enabling legislation or special permission

School Facility

Definition

Acquire a safe site for a future school facility to ensure that schoolchildren are not exposed to any degree of natural hazard that is avoidable within the local context.

Implementation

Advance acquisition may actually lead development away from hazards: homebuyers tend to value proximity to a new school building (or promise thereof), and developers tend to listen to homebuyers.

Safe Site

Index Listing

Hazard:

- All

Activity:

- Planning
- Schools

CRS-Compatible Activity:

- 520: Acquisition and Relocation

North Carolina Region:

- Statewide

School, Public

See: Public School Buildings

Seawalls and Bulkheads

Bulkheads

Index Listing

Hazard:

- Erosion
- Hurricane
- Nor'easter
- Thunderstorm

Activity:

- Coastal Engineering
- Beach Management
- Shore Protection
- Planning
- Coastal Management
- Town/City Manager

North Carolina Region:

- Eastern/Coastal

Definition

Seawalls are vertical coastal walls designed to protect buildings against shoreline erosion. They may or may not also protect against storm wave attacks. Bulkheads are vertical walls set back from the shoreline, often constructed of wood or steel. Unlike seawalls, bulkheads are primarily designed to *retain* loose fill and sediment behind them. Despite their differences, the terms seawall and bulkhead are often used interchangeably.

Implementation

Seawalls must be constructed of durable, immovable materials in order to withstand the power of storm waves. They should be tall enough to prevent being overtopped, but extend deep enough into the sand to prevent being undermined.[192] Seawalls may be curved or stepped in design. These shapes help dissipate waves.

CAMA strictly regulates shoreline stabilization measures. In general, bulkheads must be located above the mean high water level and landward of marshland. They cannot impede public access to the shore. CAMA regulations state a preference for the use of riprap (revetments), gabions and vegetation rather than seawalls because the former are less expensive and more effective at mitigating erosion impacts.[193]

Critique

Seawalls are costly to build and strictly regulated by CAMA. Seawalls reflect waves and intensify currents, steepening the profile of the beach and inducing erosion in front of the wall and on property located beyond the ends of the wall. Seawalls require continual maintenance and investment since loosened materials can become a hazard during storms.[194] Temporary seawalls constructed from sandbags are unlikely to withstand the force of a storm and should be used only to repel normal erosion until the structure they are protecting can be relocated.

Since the purpose of bulkheads is to retain material rather than provide protection from the sea or lake, they do not provide good protection from storms or other flooding events.

Sediment Mounds

See: Roadway Realignment

Sediment Retention

See: Onsite Sediment Retention

Sediment-Trapping Vegetation, Coastal

Vegetation, Coastal
See Also: Sand Dunes

Index Listing

Hazard:
- Erosion
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Beach Management
- Shore Protection
- Planning
- Coastal Management
- Town/City Manager

CRS-Compatible Activity:
- 400 SH Special Hazard Areas

North Carolina Region:
- Eastern/Coastal

Definition

Plants help make the coast more resilient to severe storms by collecting sediment in protective features such as dunes or barrier islands. Dunes absorb waves, slow the inland progress of storm surges and shield coastal buildings from high winds. Plant roots and stems help build and preserve dunes by trapping sand grains and forming an erosion-resistant surface. Sound-side marsh plantings can help trap sediments, leading to increased barrier island width and height.[195]

Implementation

Planting for sediment-trapping mitigation purposes may include introducing new vegetation, replanting removed vegetation, and preserving existing vegetation. Several steps should be followed when developing a planting program. These include: identifying the type of vegetation to be planted; finding a source for the plants; and creating a post-planting maintenance program.[196] Native plants fare better than other species, especially in the harsh coastal environment or in marshes.

Officials should take several steps to protect vegetation from human traffic. Dune walkovers should be constructed prior to the planting of vegetation. The walkover should not rest on the dune. Any plants that are disturbed in the construction of dunes should be replaced as quickly as possible.

It is possible to encourage maritime forest to grow on dunes that are first stabilized with grasses. Marshes, like wetlands, can be created artificially for mitigation purposes. Existing coastal wetlands are considered Areas of Environmental Concern under CAMA and, as a result, are granted many protections against development.

Examples:

- In an effort to preserve the maritime forest where it still remains, Pine Knoll Shores, NC requires a permit to cut down any tree over two inches in diameter.[197] Much of the town's maritime forest is protected as publicly-owned conservation areas. Pine Knoll Shores has experienced moderate success slowing sound-side erosion by using artificially-cultivated salt marshes.[198]
- Dune grass planting can be planned as part of a beach preservation program, as was done in Avalon, New Jersey.[199]

Critique

Vegetation is an effective and inexpensive way to stabilize dunes and protect marshes from erosion. In addition to mitigating against storms, plants enhance the natural beauty of the landscape and provide food and habitat to many types of animals.

While vegetation may reduce some storm impacts, it does not protect against hurricanes and is more fragile than hardened structures like groins or jetties. Shoreline plants are sensitive to human intervention and must be protected, wherever possible, by restricting pedestrian and vehicular traffic.[200]

Seismic Preparedness and Retrofitting

Earthquakes
Retrofit of Fire Stations and Police Stations
Retrofitting

Index Listing

Hazard:
- Earthquake

Activity:
- Engineering
- Planning
- Public Works

North Carolina Region:
- Western/Mountains

Definition

Seismic retrofitting means preparing existing and new buildings to withstand the shaking force of an earthquake. Preparedness also includes non-structural improvements to reduce earthquake damage within a structure.

Implementation

Nearly every structure, both public and private, is a candidate for seismic retrofitting of some sort. Public buildings, especially those that also serve as shelters, should be made earthquake resilient. Structural improvements typically include adding braces and removing overhangs. Bridges, water towers and other non-occupied structures should also be retrofit with earthquake-resilient materials. Sources of secondary damage, such as sprinkler pipes, water and gas service lines should be secured or fitted with shutoff valves. Fuel tanks and their supply lines should be securely anchored so that they are not dislodged by earthquakes. Unanchored basement tanks can tear free of their supply lines. Fuel storage tanks need to be inspected and, if necessary, repaired or reconstructed following hazard events.

Homeowners should be encouraged to undertake relatively simple but effective non-structural mitigation actions. These might include: securing bookcases, light fixtures and computer monitors; covering high-hazard windows with shatter-resistant film; and locating hazardous materials where they are unlikely to be spilled in an earthquake. Government and public buildings should be inspected for equivalent mitigation opportunities. Education and awareness programs can help raise public interest in mitigation activities.

Examples:

- Officials in San Leandro, CA, offer (for a minimal charge) an inspection of residents' homes for earthquake preparedness, a handbook and videotape outlining possible retrofits, and a post-retrofit certification of the upgrades.[201] Such certification could be an asset for home sellers in earthquake-prone communities.
- In 1996, officials in Bartlett, TN, are planning to retrofit the wells that provided the public water supply with seismic fittings to resist earthquake-induced failure. Memphis Gas, Light and Water intends to install emergency generators as a part of its seismic retrofitting program.[202]

Critique

While effective, seismic retrofitting can be expensive and may be a low public priority in areas that are rarely affected by serious earthquakes. However, some analysts believe the risk of earthquakes in North Carolina, especially in the western counties, has been grossly underestimated. As a result, most communities in the state have not taken any of the many simple, inexpensive steps that could significantly increase their earthquake resilience.

Seismic Retrofits of Critical Facilities

Definition

Brace generators, elevators and other vital equipment in critical facilities such as hospitals to ensure that the usual operations of hospitals are not disturbed by the jarring associated with an earthquake. There are numerous procedures taking place at any given moment in a hospital that cannot be interrupted by equipment or power-source failure.

Implementation

Earthquake retrofits are most valuable for unprepared hospitals in regions such as western North Carolina, where earthquake risk abounds but seismic activity has been dormant for many years.

Critical Facilities
Earthquakes

Index Listing

Hazard:
- Earthquake

Activity:
- Engineering
- Health Services
- Planning
- Public Works

North Carolina Region:
- Western/Mountains

Sellback

See: Purchase Sellback/Leaseback

Service Areas

Definition

Local governments, under their taxing authority, can designate areas that will receive services and ones that will not, and tax the former at a higher rate. (For a variation on this, see **Special Assessment Districts**.) Local governments could use this technique to provide differing levels of services to higher and lower-risk areas.

Index Listing

Hazard:
- All

Activity:
- Engineering
- Planning
- Public Works

North Carolina Region:
- Statewide

Implementation

This technique should be used in conjunction with a regulatory program, such as zoning, that actively limits development in areas with lower, more attractive tax rates.

Critique

Ironically, under-served areas may be more attractive to residents because of their lower tax rate. This would run counter to the intent of a program that limits services in hazard-prone areas. This technique may face uniform taxation legal challenges under the uniformity of taxation provision.

Setbacks, Slopes

See Also: Slope Stabilization

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Landslide

Activity:
- Engineering
- Planning
- Public Works
- Transportation

North Carolina Region:
- Western/Mountains

Definition

Use large setbacks when building roads near slopes of marginal stability in order to steer development away from a potential hazard while protecting drivers and roads. Roads built near dynamic slopes will eventually require removal, indicating an incompatibility with the business activity, residential life, and traffic patterns that have been built around this assumed-permanent infrastructure. The intermittent weight-loading of heavy traffic volume may contribute to slope instability, and slopes immediately adjacent to roads present a hazard for drivers who are forced to veer from the roadway.

Implementation

This is a concern to be expressed to the Municipal Planning Organization or responsible road authority. Natural geographic features to take into consideration in planning the placement of a new roadway or evaluating the stability of the previous one:

- The risk of earthquake multiplies the risk of landslide and should consequently increase length of the setback applied.
- Riverbanks are exceptionally dynamic by nature and are suspect as structural supports.
- When siting a road near the coast, consider erosion rates, the potential for hurricane-accelerated erosion, and how erosion can undermine the base of slopes.
- Know the qualities of the underlying rock and water table to avoid placing roads on potential liquefaction sinkholes (water-saturated soils temporarily lose support capability). [12]

Employ similar considerations when siting scenic overlooks at the roadside, and note that roads that are not set back from slopes will likely require the purchase of reinforced guardrails. Finally, road placement can influence the course of development: if a new road is located at a distance from a landslide hazard, subsequent development will also tend to be sited farther away from the hazard area.

Setbacks, Shoreline

See: Dune Protection

Sewage Lift Station

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Engineering
- Planning
- Public Works

CRS-Compatible Activity:
- 430: Higher Regulatory Standards

North Carolina Region:
- Statewide

Definition

Raise electrical components of the sewage lift station or stations above base flood elevation, and/or install a flood telemetry system. Furnish the station with "quick connect" emergency generator hook-ups to keep sewage lift pumps operational during a flood event. Commonly situated at low elevations, sewage lift stations often fall victim to flooding. Simple telemetry equipment offers early detection of high water levels at the lift, and timely response can keep the station operational.

Implementation

Even if some floodwaters infiltrate the pipes, as long as pressurization is avoided, sewage flow will continue in the proper direction. Inundation and malfunction of a sewage lift station

marks the seizure of motion in the sewage system: waste is no longer ushered up inclines and toward the treatment plant and widespread surcharging is possible. Raise the electronics of the lift station above base flood elevation to protect the vital and costly switchboard. If the lift has become disconnected from the city's electrical grid, yet the onsite electronics remain dry and functional, service personnel can safely use a "quick connect" hook-up installed in the station to access power from an elevated onsite generator. Consider using customer fees to fund these improvements, a practice used to finance watertight manhole covers.

Sewage Treatment Plant Retrofit

Water Treatment Plant Retrofit
See Also: Dikes, Levees, Floodwalls and Berms

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Engineering
- Planning
- Public Works
- Town/City Manager

CRS-Compatible Activity:
- 530: Retrofitting

North Carolina Region:
- Statewide

Definition

Build an earthen dike around a flood-threatened water or sewage treatment plant to avoid inundation of the local water or wastewater treatment plant, two of the most crippling occurrences wrought by flood.

Businesses served by the plant, even those outside hazardous area, might be forced to cease operations. Moreover, if a water treatment plant becomes inundated by floodwater, residents may have to find a substitute source of potable water for days or weeks. Chemicals to fortify the tainted treatment process are expensive.

Implementation

The state can assess a fine to the water treatment authority for prolonged failure to regain adequate drinking water standards after a disaster. In planning the dike's construction, a local earthmoving company might wish to charitably assist as an excellent advertising opportunity and perhaps more compellingly, a tax write-off. Finally, an earthen dike may hide lots and structures, deflect some odors associated with treatment plants, and raise nearby property values in the process.

Critique

Each flood may wear away layers of the rammed-earth dike and warrant significant maintenance. However, an earthen dike can be strengthened several-fold with concrete lining, corrugated metal, or masonry stone, particularly around the base.

Sewer Manholes

Definition

Install watertight covers or inflow guards on sewer manholes, and/or raise manhole openings onto concrete pillars to prevent floodwaters from infiltrating sewerage pipes and causing sewer overflow, pipe pressurization, and household surcharge of untreated wastewater. Watertight manhole covers or inflow guards prevent floodwaters, as well as common stormwater runoff, from infiltrating sewerage pipes. Surcharge can result in damage to home interiors via sinks, toilets, and basement drains. While surcharge can be partially controlled with household backflow guards, sewage that surcharges onto streets during a flood is quickly disbursed by floodwater and can contaminate yards and gardens; outdoor recreation and the health of family pets are threatened by the subsequent contamination. In addition, the sewer plant may process more efficiently with less runoff volume occupying pipe space and consuming treatment chemicals.

Manholes

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Engineering
- Planning
- Public Works

CRS-Compatible Activity:
- 430: Higher Regulatory Standards

North Carolina Region:
- Statewide

Implementation

If relatively few manholes lie in the floodplain, the cost of watertight models/ inflow guards should be modest and within the scope of wastewater service revenue. A temporary increase in sewage system user fees is possible if a great number of manholes are at risk. For sewer lines running alongside a river, a common practice is to raise manhole openings onto concrete pillars, well above base flood elevation.

Shelters

See: Emergency Shelters

Shoreline Setbacks

See: Dune Protection

Sideyards

Definition

Require large sideyards between adjacent buildings in residential and commercial areas to increase the distance between susceptible structures and lessen the potential for adjacent ignition. Non-structural buffers between buildings can buy time for fire service response and improve the chances of fire containment. "Urban settings with short sideyard setbacks may increase fire hazard and intensity since ignition from adjacent structures becomes feasible through multiple channels—radiative heat, convection and firebrands." [14]

Index Listing

Hazard:
- Drought
- Wildfire

Activity:
- Planning
- Town/City Manager

North Carolina Region:
- Statewide

Implementation

Vegetation should be minimized in sideyards if they are to be maximized as defensible spaces.

Site Plan Review by Specialist

See: Review of Site Plan by Qualified Specialist

Slope Stabilization

Erosion Control
See Also: Setbacks, slopes
See Also: Soil Conservation

Index Listing

Hazard:
- Landslide

Activity:
- Engineering
- Planning
- Public Works

North Carolina Region:
- Western/Mountains

Definition

Most slopes greater than 15 degrees have enough soil and loose rock to cause a landslide. Slopes can release debris at any time, but are most stable when dry. Avalanche risk greatly increases when steep slopes and loose soils are drenched with water. While the most common source of excess water is intense rainfall, broken water pipes and misdirected runoff concentrated by roads, roofs, or large paved areas have also been known to cause landslides.

Slope stabilization refers to a variety of methods for reducing the risk of landslides by reinforcing dangerous slopes or those slopes weakened by development. The practice of slope stabilization is applicable for both "land-locked" slopes and riverbanks, since a collapsed bank can severely hedge or pinch the flow of a river. This is also a wise practice in recreational lands for the safety of hikers.

Implementation

There are a wide variety of bio-engineered methods of slope stabilization. To learn about mattressing, blanketing, living revetments, and other plant-related stabilization techniques, see the North Carolina State University Water Quality Group's suggestions at:
http://h2osparc.wq.ncsu.edu/estuary/rec/strmbnks.html. 10

Some methods of stabilization involve changes to the structure of the slope, such as reducing its steepness, placing additional support material at its foot to prevent a slide, or reducing the load by removing some of the materials high on the slope. The hazard from debris flows that occurs in modified slope cuts can be decreased by 1) limiting the height and slope of cuts and fills, 2) properly compacting fills and keying them into bedrock, and 3) properly controlling the flow of water onto slopes.[203]

Other stabilization techniques are designed to anchor loose material in place on the slope. It is possible to either cement potential slide material or bolt loose rocks. Reforestation or **vegetation** may also help to anchor loose slopes. Vegetation that is disturbed during hillside development should be replaced as quickly as possible.

Another set of techniques are designed to contain slide materials behind a solid structure, such as a retaining wall. The most successful of these tend to be low, thick walls placed at the toe of a slide. In some cases, walls can be built to deflect potential mudflows away from or around structures. To be effective, diversion walls must be carefully designed, properly built and regularly maintained.

Since water greatly increases the risk of landslides, wise water management can help reduce the hazards associated with steep slopes. One method is to cover the surface with impermeable material to prevent water from reaching the loose material beneath it. This technique will increase stormwater runoff and may create flood hazards downstream. A more promising technique is to keep excess water away from steep slopes, either by redirecting runoff or by installing a subsurface drainage system. Officials could conduct a stormwater "audit" to discover any unnecessary sources of water, such as misdirected runoff from streets. Improperly designed highway culverts and watering of lawns can create unstable slopes. **Subdivision regulations** should require stormwater management programs that prevent runoff from filtering onto steep slopes and loose soils.

Critique

Many erosion problems can be prevented through proper site design or with regulations that limit development on severe slopes. These measures can help avoid costly stabilization work.[204]

Slowing Development: Rate Allocation Systems, Growth Phasing, Total Population Charter Limits; Development Caps

Development Caps
Growth Phasing
Rate Allocation Systems
Total Population Charter Limits

Index Listing

Hazard:
- All

Activity:
- Planning

North Carolina Region:
- Statewide

Post Disaster

Definition

These terms all refer to techniques for limiting a community's rate of growth. Unrestrained growth can spread communities into hazardous areas; the pressing need for housing and community space may outweigh the inclination to identify hazardous areas and enact the appropriate ordinances and policies for the community's protection. The rate allocation and growth phasing tools are annual caps on the percentage of total growth or a cap on the number of units or square footage allowed per year. Total population charter limits and development caps are absolute limits on population or housing units. To be legal, they must be applied on an annual basis. As a result, they are essentially another rate allocation mechanism.

Implementation

There are two predominant approaches to slowing development: a "cap" on total future growth; and an annual limit to growth. The former, in which some upper limit is defined and the zoning set to match that limit, is likely to be considered too arbitrary to be constitutional. An annual cap could be implemented by restricting the number of building permits issued each year. Communities could use the time granted by the latter approach to finance the purchase of hazard prone property or install emergency facilities, such as upgraded evacuation routes.[205]

These limits may be particularly applicable where hazards are geographically concentrated and where emergency facilities are limited, such as barrier islands. They are more commonly used to protect the aesthetics of a community or to ensure that a natural resource is not overburdened.[206] Rate limits can also be used to ensure that "lumpy" investments, such as water treatment plants, that cannot be provided incrementally are adequate for the demand.

Rate limiting growth systems allow communities to establish a competition for a limited number of annual permits. In some cases developers try to accumulate a certain number of points, which will allow them to build. In other cases, the proposals are evaluated against specific criteria, with the best plans being granted permits. These competitions can be used to affect the quality, type and location of growth. For example, a developer could earn approval by including mitigation actions into his or her proposal. Another approach to limiting the speed of growth is to make the conditions of building permit approval very stringent.[207] Such an approach is likely to meet with resistance from local residents.

Examples:

- Petaluma, CA, enacted an annual limit to the number of building permits issued each year. Development permits are evaluated according to the city's general plan and environmental design plans.[208]
- A rare attempt to use a total population cap was invalidated by the courts in Boca Raton, FL. The legal challenge argued that substantive due process had not been observed since no rational link between the limit and the actual capacity of the city had been established. Opponents also argued that

the cap amounted to a taking of property without compensation, and that it impeded the right to travel. The courts found that Boca Raton had violated due process and that the limit failed to meet a rational municipal objective.[209]

Critique

Competition-based allocation systems can be complex and time-consuming to administer. On the other hand, limits that are not based on competition do not address the quality, type and location of growth. If the rate or phases are slower than market rate, property values will increase, which can affect the character of the community. A slower-than-market growth rate can also cause development to leapfrog to neighboring jurisdictions.

While limiting the speed of growth through an annual cap may reduce hazard risk in the short run, in the long run the total growth of a community will be unchanged. (A cap on total growth is unlikely to withstand legal scrutiny.) Communities must take advantage of the extra time afforded by these growth slowing mechanisms to reduce their hazard risk through land use and hazard mitigation planning.

Small Business Audits

See: Audits of Small Businesses

Smart Growth

Definition

When a community experiences a disaster, there exists a unique window of opportunity to redevelop the community using the principles of smart growth. By reducing vulnerability to natural hazards and adhering to smart growth principles, a community can become even better than it was before.

See Also: Green Infrastructure
See Also: Sustainable Development

Index Listing

Hazards:
- All

Activity:
- Planning
- Town/City Manager

North Carolina Region:
- Statewide

Post Disaster

The definition of smart growth differs fromcommunity to community, but essential principles of smart growth, based on those from www.smartgrowth.org, are as follows:

1. Mix land uses.
2. Take advantage of compact building design.
3. Create a range of housing opportunities and choices.
4. Create walkable neighborhoods.
5. Foster distinctive, attractive communities with a strong sense of place.
6. Preserve open space, farmland, natural beauty, and critical environmental areas.
7. Strengthen and direct development toward existing communities.
8. Provide a variety of transportation choices.
9. Make development decisions predictable, fair, and cost effective.
10. Encourage community and stakeholder collaboration in development decisions.
11. Protect life, property, and the economy by minimizing present and future vulnerability to all natural hazards.

Because the definition of smart growth varies from community to community, one person's "smart growth" is not another's. Not all definitions of smart growth adhere to the principles mentioned above. In fact, in some cases the term "smart growth" has been captured for political reasons and does little to promote the principles. As such, it is necessary to judge smart growth initiatives by its policies, not by the title alone.

Examples:

- Asheville, NC created its own definition of smart growth and revised its

comprehensive plan to reflect the principles. For more information, see http://www.ci.asheville.nc.us/business/smart.htm

- Kinston, NC suffered widespread damage during Hurricane Floyd, and many of the city's properties were part of the state buy out program. Kinston recognized the need to apply smart growth principles when redevelopment began. By encouraging infill development and redevelopment within the city limits, Kinston began the process of planning to mitigate the impacts of natural hazards using principles of smart growth. For information on the city's smart growth hazard mitigation plan, see http://www.p2pays.org/ref/14/13614.pdf

Soil Conservation and Steep Slope Preservation

Definition

Soil conservation and steep slope preservation are measures that are typically implemented as ordinances that place restrictions on the grading of hillsides and that establish development limits on landslide-prone slopes.

Implementation

It is often possible to reduce erosion and stabilize slopes using non-invasive structural measures. For example, planting vegetation or maintaining slope terraces can slow slope runoff. See **Slope Stabilization** for further discussion.

Erosion Control
See Also: Slope Stabliziation

Index Listing

Hazard:
- Erosion
- Landslide

Activity:
- Engineering
- Planning
- Public Works

North Carolina Region:
- Western/Mountains

Examples:

- The North Carolina Sedimentation Pollution Act specifies several soil conservation and slope preservation actions. These include: planting erosion-restraining ground cover within 30 days of final grading of a site and requiring that no project shall include a slope too steep to be retained by vegetation or other erosion-control devices.[210]

Special Assessment Districts

Definition

Special assessment districts apply to property owners who directly benefit from a specific public improvement. These owners of both new and existing development in the district are charged a fee that is proportional to the benefits received from the improvement.

Index Listing

Hazard:
- All

Activity:
- Planning
- Town/City Manager

North Carolina Region:
- Statewide

Implementation

There are a number of ways to apply this technique, from temporary assessments that raise revenue for a specific improvement to indefinite assessments that fund independent, special purpose governmental entities. The former could be used to fund structural projects, such as a seawall, while the latter could be used to establish a regional floodplain management organization. Another example might be the creation of a "special storm services" district, where funds would go toward mitigation, recovery and response activities. In other cases, the fee could be used to pay for the upkeep of stormwater management system or as a way of providing for the future replacement of roads and utilities at the public expense. These charges may or

may not have the effect of discouraging development in the assessment district. However, they do transfer some of the cost of living or doing business in a hazard-prone area to those who choose to do so.

Critique

This technique shifts the financial burden for improvements from the general public to those directly benefiting. The revenues are more predictable than sources that depend on development cycles, which makes it easier to issue bonds for the improvement. Since this is not a tax, special assessment districts are free from constitutional requirements regarding uniformity, equality and double taxation. However, communities should be prepared to the cost estimates on which any assessment is based.

Special Exceptions

See: Contract Zoning

Special Populations

See: Mobility Concerns

Stormwater Basin

Definition

Increase the capacity of stormwater retention/detention basins to reduce the potential for localized flooding through the storage and gradual release of runoff. As a general definition, detention basins hold water for less than 24 hours while retention basins hold water for more than 24 hours, and sometimes indefinitely. Release of stormwater occurs through evaporation, infiltration, and/or engineered methods.

Basin
Detention Basin
Retention Basin

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Engineering
- Planning
- Public Works

CRS-Compatible Activity:
- 510: Floodplain Management Planning

North Carolina Region:
- Statewide

Stormwater Drain Maintenance

Definition

Routinely clean and repair stormwater drains to avoid unnoticed clogs that may hamper the efficiency of the stormwater system. Drains are the major entryways into the stormwater system and the filters of large floating debris. When drain covers are broken or clogged, the stormwater system does not function well and localized flooding is possible.

Implementation

Service announcements via utility bills can recruit citizens as surveillance of the drains in their respective neighborhoods, as well as remind them that poor stormwater collection can lead to flooded yards and basements. The task of inspection and maintenance, particularly of remote drains, could be on the monthly schedule of the public works staff, with a special round of drain inspections after major storm events.

Debris
Drains
Maintenance

Index Listing

Hazard:
- Erosion
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Engineering
- Planning
- Public Works
- Town/City Manager

CRS-Compatible Activity:
- 540: Drainage System Maintenance

North Carolina Region:
- Statewide

Stormwater Management

Definition

Drainage can be affected naturally by the geology of an area, but development that results in an increase in impervious surface will impair the ability of the land to absorb water:. The result will be an increase in the volume and peak flow rate of runoff. Without effective stormwater management, excess runoff can cause flooding, erosion and water quality problems.

Implementation

Effective stormwater policies call for both structural and non-structural measures to control runoff. Structural measures should include retention and detention facilities that minimize the increases in runoff caused by impervious surfaces and new development. Detention systems store water during peak runoff periods to be released at off-peak times. Retention facilities hold stormwater long enough to allow it to seep into the groundwater. Non-structural stormwater mitigation projects include maintaining existing drainage systems and establishing policies that restrict the amount of new impervious surface.

See Also: Grassy Swales
See Also: Impervious Surface Limits
See Also: Land Treatment
See Also: Porous Pavement

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm

Activity:
- Engineering
- Planning
- Public Works

CRS-Compatible Activity:
- 450: Stormwater Management

North Carolina Region:
- Statewide

Examples:

- Pattonsburg, MO, has planned a system of built wetlands and land treatment to act as a natural filter for stormwater runoff. The town is creating wetlands adjacent to existing streams and altering existing farm ponds to act as detention basins. In addition to filtering pollutants and slowing flood velocities, the program will provide a site for recreational trails and corridors for wildlife.[211]

Street Width Ordinance

See: Minimum Residential Street Width Ordinance

Subdivision Ordinance

Definition

Include setback regulations in subdivision ordinances to keep development clear of the most hazardous areas. The borders of natural hazard areas are often "fuzzy," or difficult to define: setbacks provide a margin for error in assessing where damage is likely to occur.

Ordinance, Subdivision

Index Listing

Hazard:
- All

Activity:
- Planning
- Town/City Manager

North Carolina Region:
- Statewide

Implementation

The length of the required setback varies with the type and degree of hazard, as well as the type of development.

Subdivision Regulations

Definition

Subdivision regulations govern the division of land for development or sale. In addition to controlling the configuration of parcels, they set standards for developer-built infrastructure. Many communities include **developer exactions** and **impact fees/system development charges** in their subdivision regulations.

Regulations, Subdivision

Index Listing

Hazard:
- All

Activity:
- Planning
- Town/City Manager

North Carolina Region:
- Statewide

Implementation

Subdivision regulations can be used for mitigation purposes in several ways. They primarily prohibit the subdivision of land subject to flooding. When hazard zones can be identified on a map of the parcel, communities may require minimum distances between those zones and development. If land dedications are required as part of the subdivision regulation, they can be used to reserve hazard-prone land for non-intensive uses.

Subdivision regulations may also set a standard for public infrastructure that ensures it is adequate for the assessed risk. For example, the installation of adequate drainage and stormwater management facilities should be required in flood-prone or landslide-prone areas. If local governments are responsible for managing of developer-built infrastructure, they should require that all improvements be built to hazard-resilient standards. This may help reduce the public cost of post-disaster reconstruction.

Subdivision regulations can require that developments be built in a hazard-resilient manner. In order to reduce fire risk, for example, subdivision ordinances may require wide building spacing, fire breaks, on-site water storage, and multiple access points. They should require "deep" lots in shorefront areas. These lots allow homes to be moved inland on the same parcel in the case of shoreline erosion. [212] The site plan review stage is another time at which it is possible to require developers to site buildings away from hazard-prone portions of the area. Local governments may require mitigation actions, such as the protection or creation of wetlands, dunes or natural vegetation, as a condition of subdivision approval.[213]

Some experts recommend establishing land use restrictions for each property before it is subdivided. After a property is subdivided, the various owners may demand compensation for the loss of use of their property. As a result, the city might have to acquire land that it could have otherwise regulated without a purchase.[214]

North Carolina's enabling statute authorizes cities and counties to exact from developers adequate recreation areas within a subdivision to serve its residents. Cash exactions may give a community more flexibility in where it purchases land to serve the subdivision. Subdivision plans can be rejected where it is shown that the development will cause undesirable off-site problems, including the creation of hazards or the overloading of public facilities (such as roads).[215]

Examples:

- The Portland (OR) Metro draft regional plan calls for subdivision regulations that require developers to locate public facilities and utilities (such as sewer and water systems) in a way that would minimize flood damage to those structures (1997).[216]

Critique:

Subdivision regulations are not as broad as zoning and only indirectly affect the quality and type of development that occurs on subdivided land. Since these regulations apply only when land is subdivided and sold, they do not address development of small or undivided parcels of land.

Subsidies

See: Tax Abatements

Sustainable Development

Definition

Two primary concepts drive the definition of sustainable development – environmental protection, and economic development. The most commonly sited definition is from the Brundtland Report: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs[217]."

See Also: Smart Growth

Index Listing

Hazards:
- All

Activity:
- Planning
- Town/City Manager

North Carolina Region:
- Statewide

Examples:

- Following Hurricane Floyd, the North Carolina Division of Emergency Management put forth principles of sustainability to guide the quality redevelopment of Eastern North Carolina. These principles include the following:
  Community Sustainability: Encourage people to work together to create healthy communities where people have opportunities to improve their lives and those of future generations through preserved resources, available jobs, limited sprawl, secure neighborhoods, lifelong education, and accessible transportation and health care;
  Housing: Ensure that all persons have equal access to safe, affordable, and adequate housing;
  Infrastructure: Ensure that efficient public infrastructure is provided and maintained in a way that avoids sprawl, yet achieves safe, responsible and desirable patterns of community development;
  Agriculture: Stimulate productivity for the agriculture industry through economic benefits and advantages for large and small farming operations;
  Vulnerability to Natural Hazards: Protect life, property, and the economy by minimizing present and future vulnerability to all natural hazards;
  Conservation of Nature and a Healthy Environment: Protect, conserve, use,

and restore natural resources to ensure long-term social, economic, and environmental benefits for present and future generations.
Economic Prosperity: Sustain a growing healthy economy that creates meaningful jobs, reduces poverty, nurtures agriculture and small business, thus providing a high quality of life;
Justice and Opportunity: Provide equal access to education and life-long learning to give all people the means to achieve social, economic, and environmental well-being, preparing them for meaningful work, and allowing them to participate in the decision-making processes that affect them;
Aesthetics: Maintain the unique and attractive aesthetic features of the physical environment that cultivate a community's sense of place and beauty.
Stewardship: Maintain an ethic that strongly encourages individuals, institutions, and corporations to take full responsibility for the social, economic, and environmental costs of their actions.

Swales

See: Grassy Swales

"Sword of Damocles" Provision

Index Listing

Hazard:
- All

Activity:
- Planning
- Town/City Manager

North Carolina Region:
- Statewide

Definition

This refers to a situation in which a government or agency with the power of eminent domain condemns a parcel covered by a comprehensive plan, but suspends the condemnation as long as the land use remains compatible with the plan. If the landowner proposes a use not compatible with the plan, the land is taken into public ownership.

Implementation

Rising land values may encourage property owners to develop incompatible uses. At the same time, the increasing price of land may make the cost of condemnation prohibitive. On the other hand, if land values are suppressed by the fear of condemnation, governments may be pressured to remove them.

Critique

This type of provision allows land to remain in private ownership and is an effective, inexpensive protection tool in the short run. However, it is heavy-handed and may engender significant community hostility over time.

System Development Charges

See: Impact Fees

T

Tax Abatements, Subsidies, Low-Interest Loans, and Other Incentives

Definition

Incentives (such as tax abatements or low-interest loans) can be used to encourage landowners and developers to integrate mitigation into the process of building new developments or retrofitting existing properties.

Implementation

These tools can be especially effective at encouraging the mitigation of existing structures. Incentives have been used for storm proofing, flood proofing, wind mitigation, and seismic retrofitting programs.

Subsidies
Low-Interest Loans
Incentives

Index Listing

Hazard:
- All

Activity:
- Building Inspection
- Planning
- Town/City Manager

North Carolina Region:
- Statewide

Examples:

- Dade County, FL, encouraged homeowners to retrofit existing homes by offering a subsidy for upgrades. Participants in the Dade County Home Inspection and Retrofit Program were eligible for up to $1500 in retrofits to their home, including the installation of shutters, structural bracing and the elevation of the electrical box. The homeowner was required to pay only the cost of the initial inspection.[218]
- The South Florida Strategic Regional Policy Plan calls for local governments and insurance companies to provide incentives for homeowners outside the storm surge area to retrofit their homes to serve as shelters in the case of a storm. It recommends establishing a revolving low-interest fund to help low-income homeowners prepare shelters.

Taxes, Impact

See: Development Impact Tax

Taxes, Improvement

See: Development Impact Tax

Taxes, Land Gains

See: Land Gains Taxation

Taxes, Transfer or Development

See: Land Gains Taxation

Tie-Downs

Definition

Mandate standard tie-downs of propane tanks and mobile homes to prevent tanks and mobile homes from being lifted by floodwaters or winds and becoming ballistic hazards. Due to inexpensive land values, mobile homes are often located in floodplains; elevated mobile homes are at an increased risk of wind uplift and should be securely attached to foundation.

Implementation

Enforcement of a tank tie-down ordinance may need to be coordinated with the State Agriculture Department. However, even with tie-downs, residents should not remain in mobile homes during severe storms.

Propane Tanks
See Also: Mobile Home Parks Storm Shelter

Index Listing

Hazard:
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm
- Tornado

Activity:
- Fire Prevention
- Planning
- Public Works

North Carolina Region:
- Statewide

Total Population Charter Limits

See: Slowing Development

Traffic Lights and Other Traffic Controls

Definition

Protect traffic lights and other traffic controls, and/or install resilient street signs for navigation in an emergency to avoid traffic signal malfunction, which can produce backups and accidents at intersections and subsequently impede evacuation or emergency response.

Implementation

Housing for electronics should be watertight, and traffic lights securely connected to suspension wires. Arching or "trunk-and-branch" metal poles used to suspend traffic lights are more expensive; however, they are also more durable than wooden poles in the face of strong wind and water forces. For earthquake hazards, traffic hardware should be resistant to malfunction associated with jarring. The local government might simultaneously install crosswalk equipment to aid the blind and/or pedestrian signals that offer a countdown of the time remaining to traverse the street safely. Finally, signs with street names should be resilient: emergency service crews from neighboring towns might join the rescue effort; presuming that personnel from outside the locality are unfamiliar with the road network, the survival of street signs could promote a timely response.

Index Listing

Hazard:
- Earthquake
- Flash Flooding
- Flooding
- Hurricane
- Nor'easter
- Thunderstorm
- Tornado

Activity:
- Engineering
- Planning
- Public Works
- Transportation

North Carolina Region:
- Statewide

Trailer Parks Storm Shelter

See: Mobile Home Parks Storm Shelter

Transfer of Development Rights (TDR)

Development Rights
See Also: Purchase of Development Rights (PDR)

Index Listing
Hazard:
- All

Activity:
- Planning
- Town/City Manager

North Carolina Region:
- Statewide

Post Disaster

Definition

Like Purchase of Development Rights (PDR), TDR programs treat development as a commodity separate from the land itself. The local government first awards each property owner in the sending area a set of development rights based on the value or acreage of land. The sending areas contain land the local authority seeks to protect. The government then establishes a receiving area for these rights that is a preferred site for development. Landowners in the sending area are typically prohibited from developing their land; however, they can sell their rights to developers in the receiving areas. Developers who acquire development rights can build to higher densities than would otherwise be permissible.

Implementation

TDR could be used for mitigation purposes by designating high hazard areas as sending zones. The development rights for parcels within this zone would be targeted at a receiving zone located outside the hazard area. The zone would need to have sufficient room to accommodate the sending rights. In jurisdictions with limited available space, the program could be aimed at redevelopment rather than new development. Alternatively, the community could completely downzone itself.[219] Both options could help create a market for development rights.

One way to ensure that people participate in the program is to make it mandatory, although the legality of mandatory TDR programs is currently under challenge. In a mandatory program, the marketability of the rights would have to be guaranteed. One way to do so would be to create a municipal land bank that would purchase the rights and resell them when demand was sufficient to generate value.[220] Suitable receiving areas outside the hazard area must be available for TDR to be successful. TDR can be used to achieve a variety of associated community goals, including promoting compact development with less **impervious surface** and preserving agricultural, rural or open spaces. Since TDR can be applied to areas of a community, rather than individual parcels, it can be more thoroughly effective than **acquisition** or **cluster development** techniques.

Implementation

TDR is a complex system, which makes it difficult for planning staffs to implement and for landowners to understand and accept. It is frequently unpopular with residents in the receiving zone, who are subject to development that exceeds the apparent zoning limits. Perhaps most importantly, a region must have a significant amount of development pressure to make the rights marketable.

Examples:

- Collier County, FL, began a TDR program in the 1980s to protect 40,000 acres of coastal barrier islands, mangroves, salt marshes and beaches. These areas were designated as sending zones. The receiving zones were already set for multi-family housing, but could be built to a higher density using the development rights. Parcels for which the development rights have been sold must be protected by a restrictive covenant or by donation to the county or a conservation organization. A moratorium was placed on the program when the transfer resulted in density concentrating in only one receiving site and overwhelming it.[221]

Transfer Taxes

See: Land Gains Taxation

Treatment

See: Land Treatment

Tree Limb Removal

Definition

Routinely clear tree limbs hanging in the right-of-way to prevent trees from damaging utility wires during high wind events. Nationwide, falling trees and swinging tree limbs are the greatest source of power outages. In addition, tree limbs entangled in a frayed and sparking electrical wire create the perfect conditions for an uncontrolled fire.

Implementation

Take care not to trim more than is necessary to avoid denying citizens the shade and beauty that a full tree offers.

Index Listing

Hazard:
- Earthquake
- Hurricane
- Nor'easter
- Thunderstorm
- Wildfire
- Winter Storm

Activity:
- Engineering
- Public Works

North Carolina Region:
- Statewide

U

Utility Lines

Definition

Bury electric, telephone, and cable lines, and/or reinforce the connections on existing utility lines to avoid line damage resulting from high winds. The force of tornadoes and hurricane winds is strong enough to torque high-tension wires from their connections on utility poles. Even if the wind does not break the wires, objects lifted by the high winds can catch upon and tear utility wires. Better connections between lines and support structures are also a means of ameliorating the vulnerability, but the burial of lines can avoid the aforementioned risks, as well as prevent damage due to winter weather (hanging ice formation). In addition, utility poles are susceptible to uplift by floodwaters. Finally, if lines are buried, neither reinforced utility connections nor the practice of regular tree trimming near utility lines is necessary.

Burial of Utility Lines

Index Listing

Hazard:
- Earthquake
- Flooding
- Flash Flooding
- Hurricane
- Nor'easter
- Thunderstorm
- Tornado
- Winter Storm

Activity:
- Engineering
- Public Works

North Carolina Region:
- Statewide

Implementation

When reinforcing the connections, ground electrical, telephone, and cable lines to reduce the possibility of fire being ignited by downed lines.[14] When ground is broken to bury lines, there is an opportunity to install high- speed internet lines that are attractive to both business and the current generation of homebuyers. Strips of easement land above buried wires are available as pedestrian or cyclist pathways, and this may also be seen as an opportunity for streetscape beautification by eliminating industrial-looking poles and overhead lines. Coastal communities may wish to consider whether pipes could be placed further from the shoreline, and whether increasing pipe burial depths would minimize erosion-related impacts.

V

Vegetation

Riparian Habitat Protection
See Also: Floodplain Management Plans
See Also: Green Infrastructure
See Also: Wetlands Preservation
See Also: Onsite Sediment Retention

Index Listing

Hazard:
- Erosion
- Flash Flooding
- Flooding
- Hurricane
- Thunderstorm
- Landslide

Activity:
- Engineering
- Parks and Recreation
- Public Works
- Planning
- Town/City Manager

CRS-Compatible Activity:
- 450: Stormwater Management

North Carolina Region:
- Statewide

Definition

Plants provide natural mitigation against storm-related hazards and landslides. They capture and slow the pace of stormwater, which can promote infiltration and reduce the volume of flooding. In salt marshes, wetlands, and along stream banks, plants absorb waves and slow flood currents. On hillsides, plants anchor loose soils. Dense vegetation, such as maritime forest, can provide significant protection from high winds and wind-driven debris. Planting is a natural and often inexpensive technique for reducing hazard risk. (see also: **Wetlands Preservation**, **Sediment-Trapping Vegetation**) However, plants offer many benefits in addition to mitigation. They enhance the natural beauty of the landscape and provide food and habitat to many types of animals. On barrier islands, sound-side marsh plantings can help trap sediments and stimulate growth in island width and height.[222] Retaining a thick vegetative cover on public lands flanking a river increases the absorption of floodwaters and reduces sedimentation of the river, while also achieving wildlife preservation objectives.

Implementation

Planting for mitigation purposes may include introducing new vegetation, replanting removed vegetation, and preserving existing vegetation. Several steps should be followed when developing a planting program. These include: identifying the type of vegetation to be planted, preferably native species; finding a source for the plants; and creating a post-planting maintenance program that does not involve mowing or thinning the vegetation.[223] Steps should also be taken to protect plants from human traffic. When disturbed, plants should be replaced as quickly as possible. Many communities require that vegetation disturbed during construction be replaced within a few weeks of completing the building.

It is possible to encourage maritime forest to grow on dunes that are first stabilized with grasses. For this purpose, as well as many others, native plants fare better than other species. This is especially true in harsh coastal environments or in marshes. Marshes, like wetlands, can be created artificially for mitigation purposes. Existing coastal wetlands are considered Areas of Environmental Concern under CAMA and, as a result, are granted many protections against development.

Within riverside vegetated zones, also called riparian corridors, thick foliage can retain greater amounts of water than bare soil and thus help to mitigate flood level. The roots of plants hold soil in place and slow the velocity of floodwater, lessening erosion, sedimentation, and the resultant embankment of a river, while increasing groundwater infiltration. If thick enough, vegetation deters human activities near the river, which contribute to sedimentation. An additional benefit is the ability of a vegetated river buffer to provide greater filtration of run-off, reducing the amount of sediment and pollutants flowing into the stream or river and thereby improving water quality.

Communities might require dedications or easements from all new subdivisions along the river, and long, continuous buffers might function as greenways or linear parklands, often among waterways or abandoned rail lines [11]. These parklands "connect different parts of the community, and when equipped with good trail systems, provide safe, long-distance transportation routes for bicyclists and pedestrians. Because of their linear form, they maximize parkland access for a large population, in many different parts of town. They may connect larger parks together, and serve as migration corridors for wildlife." [13]

Examples

- Napa County, California, has an ordinance protecting natural riparian cover located within a specific distance of a stream from being cut or planted over.[224]
- The Massachusetts Rivers Bill (1997) established a 200-foot protective zone around every river in the state. Areas within those boundaries are under the supervision of local conservation commissions, who also have jurisdiction over the state's wetlands.

Critique

While vegetation may reduce some flood impacts, it is more fragile than hardened flood control structures. Shoreline plants are sensitive to human intervention and must be protected, wherever possible, by restricting pedestrian and vehicular traffic.[225]

Vegetation, Coastal

See: Sediment-Trapping Vegetation, Coastal

Vegetation- None or Slow-Burning

Index Listing

Hazard:
- Drought
- Wildfire

Activity:
- Fire Prevention
- Planning

North Carolina Region:
- Statewide

Definition

Require no vegetation or slow-burning vegetation in easements to help create a defensible space around each residential structure. A "defensible zone" is term, most applicable during fire season, that refers to a vegetation-free area encircling a structure. Easements are one element of the defensible zone that government can control.

Cleared vegetation is especially important in easements lying on downslope lot lines: "As a fire moves up slope, it spreads much more rapidly than on flat terrain as a result of the flame front preheating upslope fuels." [14] Inform residents of native plant types that function as fire-stalls: "Vegetation with high resin or oil content tends to burn more intensely and quickly in dry conditions than other fuels." [14]

Vulnerability Assessment

Index Listing

Hazard:
- All

Activity:
- Emergency Management
- Planning
- Town/City Manager

CRS-Compatible Activity:
- 410: Additional Flood Data

North Carolina Region:
- Statewide

Definition

Vulnerability assessment is the process of estimating disaster potential in terms of what in the community is susceptible to damage. Typical indicators include: the number of people living or working in a hazard-prone area; the amount and value of property; and the amount, value and emergency necessity of public buildings and facilities.

Implementation

A vulnerability assessment should evaluate the following: the number of people at risk; the value of property at risk; the number and function of exposed critical facilities; the danger of secondary hazards (hazards caused by the onset of the first event), including the danger from hazardous facilities located in the risk area; the danger of exposure to hazardous materials in the wake of the disaster; the potential demand for shelter; evacuation needs and capabilities; and potential environmental impacts.[226] It may be preferable to divide populations into specific risk groups, such as the elderly, the hospitalized, the handicapped and children in schools, so their needs can be addressed directly.[227] A vulnerability assessment should also evaluate the effectiveness and reliability of existing mitigation methods.

Vulnerability assessments need to consider growth trends and any existing development management policies that will effect growth. As density in an area increases, so does vulnerability. Real estate property can be divided into improved and undeveloped parcels since impacts on developed and undeveloped land vary.

Examples:

- Portland, Oregon's Metro regional government is working with the National Institute of Building Sciences and the Oregon Department of Geology and Mineral Industries to develop earthquake vulnerability scenarios. These scenarios would allow planners to forecast the number of casualties, the need for emergency shelter, potential for utility outages, demand for medical facilities, repair and replacement costs, and potential economic losses from earthquakes. This program began in 1993.[228]

W

Warning

See: Disaster Warning

Water Mains

Definition

Install shut-off valves and emergency connector hoses where water mains cross faults to avoid the loss of system pressurization, which can render nearby fire hydrants useless in times of emergency and interrupt water service to homes and businesses.

Index Listing

Hazard:
- Earthquake

Activity:
- Engineering
- Fire Prevention
- Planning
- Public Works

North Carolina Region:
- Statewide

Water Treatment Plant Retrofit

See: Sewage Treatment Plant Retrofit

Well, Freshwater

See: Freshwater Well

Wetlands Preservation and Riparian Habitat Protection

Definition

Wetlands are areas that are cyclically inundated with water. These ecosystems are essential habitat for a variety of species of fish and wildlife. Wetlands have been shown to be an effective pollutant filter. Wetlands also act as natural flood controls by storing tremendous amounts of floodwaters and slowing and reducing downstream flows.

Implementation

Wetlands can serve many environmental purposes in addition to providing flood mitigation, including providing habitat and filtering pollution. As a result, the number of funding sources available for wetlands acquisition or restoration may be greater than those dedicated to mitigation purposes.

Typical restrictions on activities in wetlands include the prohibition of or limits to filling or dredging. Some jurisdictions allow the use of fill to elevate existing buildings at the edge of the floodplain.

See Also: Floodplain Management Plans
See Also: Green Infrastructure
See Also: Onsite Sediment Retention
See Also: Vegetation

Index Listing

Hazard:
- Erosion
- Flash Flooding
- Flooding
- Hurricane
- Thunderstorm

Activity:
- Coastal Engineering
- Engineering
- Planning
- Public Works
- Coastal Management
- Town/City Manager

CRS-Compatible Activity:
- 400 SH Special Hazard Areas

North Carolina Region:
- Statewide

Examples:

- CAMA permits only water-dependent uses, such as navigation channels, dredging projects, boat ramps and bridges, to occur in coastal wetlands. Nags Head, NC defines water-dependent to include "uses which enhance the estuarine shoreline experiences," including restaurants and wildlife observation areas.[229]
- The US Army Corps of Engineers elected to acquire and preserve 8,500 acres of natural wetlands in Massachusetts' Charles River watershed as a flood control measure. The approach has been successful at mitigating floods for one-tenth the cost of the structural alternative.[230]
- A 1995 study in Illinois has found that 5.7 acres of recreated marsh can absorb the natural runoff of a watershed area of 410 acres.[231]
- The Massachusetts Rivers Bill (1997) established a 200-foot protective zone around every river in the state. Areas within those boundaries are under the supervision of local conservation commissions, who also have jurisdiction over the state's wetlands.

Critique

A major study following the 1993 Midwest Floods found that wetlands restoration could be effective for small and medium floods, but its usefulness as a mitigation technique diminished as the size of the flood increased.[232] Stand-alone wetlands preservation programs have had varied success. Coastal wetlands and marsh protection efforts have been more successful, largely because they are part of broader federal and state management programs.[233] Many analysts believe that engineered wetlands, which are often used to replace natural wetlands destroyed by development, do not function as well as natural wetlands.

Wildfire Mitigation

See Also: Prescribed Burning

Index Listing

Hazard:
- Drought
- Wildfire

Activity:
- Emergency Management
- Fire Prevention
- Planning

North Carolina Region:
- Statewide
- Western/Coastal

Definition

High rates of construction along the edge of forests (known as the urban-wildland interface), combined with a century-long policy of fire suppression in these areas are creating an ever-growing risk of damaging fires.[234] Wildfire mitigation techniques reduce this risk by limiting the number of structures in high-risk areas or by increasing their fire resistance.

Implementation

Most structures that are destroyed in a fire are lost in the first few hours. Many of these losses could be prevented or reduced through the use of fire-resistant landscaping and building practices. Flammable vegetation should be removed or relocated away from buildings and facilities. Where necessary, fire-resistant plant species can be planted as a replacement. Building codes may require that roofs be finished with fire-resistant materials such as slate, tile or metal roofing.

Clearing brush, creating fuel breaks and staging controlled burns are all excellent methods for reducing flammable material and limiting the area in which a fire could spread. Fuel break construction should be a part of any open space management program. However, it should be noted that fuel breaks alone will not stop a fire: the 1991 Oakland Fire jumped an eight-lane highway. Rather, fire breaks are designed to allow firefighters a chance to attack a fire.

Fires can increase the risk of landslides by destroying the vegetation that anchors steep slopes, so fires should be addressed as part of a multi-hazard approach. Communities should consider increasing their fire-fighting capacity through equipment purchases, **capital facilities planning** or **subdivision regulations**.

Critique

The factors that determine adequate fire protection include: **zoning** regulations, fire and **building codes**, and basic fire protection infrastructure. Buildings that are close together, poorly constructed, or difficult to reach with fire-fighting equipment are most at risk for fire damage. However, the cost of improving code compliance, equipment, access, and water delivery may exceed the ability of many communities to pay for them. Many effective fire mitigation efforts, such as planting and re-roofing, require the cooperation of individual homeowners. Other techniques, such as mandatory large-lot zoning, clearing vegetation or replacing native species may raise equity or environmental concerns.

Wind Deflection

See: Natural Environmental Features

Windproofing

Index Listing

Hazard:
- Hurricane
- Thunderstorm
- Tornado

Activity:
- Engineering
- Emergency Management
- Building Inspection
- Planning

North Carolina Region:
- Statewide

Definition

Windproofing is the modification of the design and construction of buildings to withstand wind damage. It typically involves improvements to the aerodynamics of a structure, the materials used in its construction, or the addition of features such as storm shutters. Windproofing can also help protect a building's occupants and their possessions from broken glass and flying objects.

Implementation

Several structural measures can significantly increase buildings' windproofness without raising the cost of construction by more than a few percent. These include: using larger than usual timbers; using bolts instead of nails; and strengthening wood frames with cross-cables. Roof braces should be reinforced and rafters should be anchored with screws. Diagonal bracing should be installed on metal buildings. Building tie-downs and foundation bolts should be used to secure roofs to buildings and buildings to their foundations. Similar steps can be taken to reinforce existing buildings.

Property owners should properly prepare the exterior of their homes. Garage doors should be reinforced to prevent them from blowing open. Roof-mounted structures should be securely attached to buildings. Residents should reduce the number of potential airborne objects around their homes, since such items can puncture a home and render it vulnerable to the elements. Doors and windows should be strengthened to resist flying debris. In the case of a severe storm warning, home and business owners should cover their windows with plywood boards or storm shutters. Other techniques include securing fan and light fixtures to ceilings and strapping or bolting generators to walls.

Taller buildings are more subject to wind damage than lower buildings because wind velocity increases with altitude.[235] Manufactured housing has also been shown to be very susceptible to wind damage. These structures should be securely anchored to their foundations. Mobile homes should be tied down to their pads to prevent them from being blown apart. Windblown debris from mobile or manufactured housing can be a hazard to structures located nearby.

Windproofing will not protect structures from tornadoes. As a result, tornado shelters should be provided in areas with high tornado likelihood, or where structures lack basements and underground protection (such as mobile home parks). Manufactured housing has proved to be especially vulnerable to damage from tornadoes.

Public facilities and structures also need to be windproofed. Traffic lights should be protected from high winds to prevent them from becoming airborne.

Examples:

- Project Blue Sky, a private-public partnership in Southern Shores, NC, researches and tests hurricane-resilient construction practices, including wind-resistant roofing construction. These voluntary standards generally exceed typical building codes. North Carolina coastal building codes require that new construction be built to withstand 120 mph winds.
- The South Florida Building Code (1957) requires that structures be able to withstand wind pressures of 120 m.p.h. at a height of 30 feet. Dade County, FL, updated the code in its jurisdiction following Hurricane Andrew (1992) to reflect the 116-mile national wind standard that takes into account gusts and the lift on building edges and corners created by wind pressure. The updated code requires protection for windows and doors on all new homes; requires that all structural plans be reviewed by a structural engineer;

requires concrete columns in single-story homes; requires gable ends to be built of concrete block when the home is built of concrete block; and required a final roof inspection of all new homes.[236]

- Dade County, FL, also encouraged homeowners to retrofit existing homes by offering a subsidy. Participants in the Dade County Home Inspection and Retrofit Program were eligible for up to $1500 in retrofits to their home, including the installation of shutters, structural bracing and the elevation of the electrical box. The homeowner was required to pay only the cost of the initial inspection.[237]

Critique

Residential structures are never completely windproof, only wind-resistant. Nonetheless, windproofing may encourage people to build in hazardous areas or to believe that their homes provide effective shelter from serious storms. Shingle design is generally poor and shingles may fail in high winds even if installed properly to high-wind standards. These shingles can become wind-borne projectiles. Roofs are subject to uplift from wind and could come off entirely, leading to failure of the entire structure. However, many buildings that remain intact can suffer serious interior damage as a result of tears in the roof. These tears allow water to run in and soak the interior.

Z

Zoning, Agricultural Use

See: Agricultural Use Zoning

Zoning, Bonus

See: Bonus and Incentive Zoning

Zoning, Conditional

See: Contract Zoning

Zoning, Contract

See: Contract Zoning

Zones, Floating

See: Floating Zones

Zoning, Impact

See: Performance or Impact Zoning

Zoning, Incentive

See: Bonus and Incentive Zoning

Zones, Overlay

See: Overlay Zones

Zoning, Performance

See: Performance or Impact Zoning

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