9/26/03

Session No. 13

Course Title: Breaking the Disaster Cycle: Future Directions in Natural Hazard Mitigation

Session Title: Hazard Areas Definition and Risk Notification: Smart Growth and Hazard Mitigation

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Time: 150 minutes + 15 minute break

Objectives:

13.1 Understand the current system of mapping hazards as a means of risk notification
13.2 Discuss the strengths and weaknesses of the present system
13.3 Describe innovative approaches to mapping and managing floodplains
13.4 Assess the Charlotte floodplain remapping initiative
13.5 Understand the context of relocation during disaster recovery
13.6 Discuss methods of achieving community resiliency through application of smart growth principles

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Scope:

This session describes how flood and earthquake hazard areas are mapped and how the maps can be used to notify the public about the nature and extent of risk. The first part of the session describes the current system of mapping flood and earthquake hazard areas or zones and some of the strengths and weaknesses of relying on maps to notify property owners, or potential property owners, about the presence of natural hazards. This is followed by a discussion of innovative mapping initiatives in some communities in the U.S. In the second part of the class, the possibility for introducing smart growth principles into relocation during the disaster recovery process is reviewed. Students take part in a discussion on a recovery initiative in Kinston, NC that seeks to achieve the goals of smart growth and hazard mitigation.

Reading:

Instructor and Student Reading:

Godschalk, David R., et al. 1998. Ch. 1. Introduction and Definition of Hazard Areas, and Ch. 2. Hazards Notification, pp. 1-38. *Coastal Hazards Mitigation: Public Notification, Expenditure Limitations, and Hazard Areas Acquisition*, Center for Urban and Regional Studies, University of North Carolina at Chapel Hill.

Deyle, et al., Hazard Assessment: The Factual Basis of Planning and Mitigation, Chapter 5 in Burby ed., *Cooperating with Nature: Confronting Natural Hazards with Land-Use Planning for Sustainable Communities. 1998. Joseph Henry Press, Washington, D.C.*

FEMA Map Services website: http://www.msc.fema.gov

Geographic Technologies Group, Inc. *Lenoir County Hazard Mitigation Plan*. Draft. n.d.

FEMA. 1997. *Multi Hazard Identification and Risk Assessment*. Washington, D.C.

Handouts:

Overheads:

13.1 Flood Insurance Rate Maps (FIRMs)
13.2 Features of FIRMs
13.3 Grifton, NC Flood Hazard Map
13.4 Earthquake Shaking Hazard Maps
13.5 California Earthquake Zone Map
13.6 California Disclosure Requirement
13.7 Weakness of Current Mapping/Notification System
13.8 Mecklenburg County Watersheds
13.9 Using Relocation to Achieve Smart Growth Objectives
13.10 Principles of Smart Growth

General Requirements:

Remarks:

In previous classes, students examined the damages caused by natural hazards and the federal programs that exist to mitigate such hazards, including the National Flood Insurance Program. Students also discussed the pros and cons of floodplain buyout programs. In this session, students will learn about federal and state programs to map natural hazard areas, particularly floodplains and earthquake hazard zones, and how developers, landowners, realtors, insurers, lenders and the general public can use the

information from the maps to make informed decisions about buying, developing, insuring, protecting and regulating property in hazard-prone locations.

13.1 Understand the current system of mapping hazards as a means of risk notification

In order to take steps to reduce risks posed by natural hazards, individual property owners, developers, insurers, emergency management personnel as well as local governments need to know the location of hazard-prone areas. Maps of flood hazard areas are readily available from FEMA. In addition, more generalized maps of earthquake hazard areas are also available from federal government as well as some states.

Flood risk information is presented on Flood Insurance Rate Maps or FIRMs (*Figure 13.1, Flood Insurance Rate Maps (FIRMs)*). Such maps are based on historic, meteorologic, hydrologic and hydraulic data, as well as flood control works and the level of development in a community. To prepare FIRMs, FEMA conducts engineering studies, referred to as Flood Insurance Studies, and uses the information gathered to delineate Special Flood Hazard Areas on FIRMs. Special flood hazard areas (SFHAs) are those areas subject to inundation by a flood that has a one-percent or greater chance of being equaled or exceeded in a given year. This type of flood is referred to as the base flood or the 100-year flood. The base flood is used by the National Flood Insurance Program as the basis for insurance requirements and may be used by local governments in establishing floodplain management regulations.

FIRMs depict special flood hazard areas, the base flood elevation, areas subject to 0.2 percent flood, floodways, the location of highways, roads, railroads and waterways, flood insurance risk zones, and for coastal areas, undeveloped coastal barriers or COBRA zones (*Figure 13.2: Features of FIRMS*). COBRA zones are areas designated under the Coastal Barrier Resources Act (1982). These designated zones are ineligible for federal flood insurance as well as federal expenditures for most infrastructure. An example of a FIRM for a municipality is shown in *Figure 13.3: Grifton, NC Flood Hazard Map*.

Flood risks have been assessed for more than 20,400 communities nationwide, resulting in the publication of more than 80,000 individual FIRM panels.

Similarly, maps depicting the location of earthquake hazard areas have been prepared by the federal government and a few state governments, notably California. The U.S. Geological Survey (USGS) prepared "shaking-hazard" maps as part of the National Earthquake Hazard Reduction Program or NEHRP (*Figure 13.4: Earthquake-Shaking Hazard Maps*). According to USGS, national maps of earthquake shaking hazards have been produced since 1948 (USGS, 2001:1). The most recent series of shaking-hazard maps were prepared in 1996. Each of these maps shows the severity of expected earthquake shaking for a particular level of probability. For example, the map may show the level of earthquake shaking that have a 1-in-10 chance of being exceeded in a 50-year period. Local governments across the country rely on these maps to establish the seismic design standards in building codes. Shaking-hazard maps are available at http://geohazards.cr.usgs.gov/eq/index.html.

California has the most extensive state system of mapping for earthquake hazards. The state maps seismic hazard zones and fault zones. The seismic hazard zones show areas subject to earthquake-induced landslides and liquefaction. The fault zone maps show the location of active faults on a city and county basis. They are used to regulate new construction and to make the public aware of existing fault-movement hazard (*Figure 13.5: California Earthquake Fault Zone Map*).

Most flood and earthquake hazard maps are typically available from local governments (e.g., as the local planning office) or from the federal government (e.g., FEMA). The public typically finds out about the location and severity of hazards during the process of purchasing property located in a hazard-prone area. For example, several states require that potential buyers be notified, in advance, that the property they are about to acquire is located in a natural hazard zone such as a SFHA. California's Natural Hazards Disclosure Act requires that sellers of real property and their agents provide prospective buyers with a "natural hazard disclosure statement" when the property being sold lies within one or more state-mapped hazard areas, including a Seismic Hazard Zone (*Figure 13.6: California Disclosure Requirement*).

In addition, lenders issuing federally-backed mortgages are required to notify homebuyers that they must purchase flood insurance if the property they are buying is locate in a SFHA. Note, however, that property owners in communities that do not participate in the National Flood Insurance Program are not permitted to purchase federal flood insurance (and thus, property owners in non-participating communities are not subject to the federal requirement to buy flood insurance).

13.2 Discuss the strengths and weaknesses of the present system

One of the strengths of the current hazard mapping systems is that they provide a way for developers, lenders, insurers, local governments and the public in general, to determine whether the property they own or are thinking of buying is located in an area vulnerable to natural hazards. This information allows people to make informed, rational decisions about buying, insuring, developing or protecting property in hazard-prone areas. In addition, local governments can use the maps to develop hazard mitigation plans.

Unfortunately, the information is not always accurate, or is not conveyed at the right time. In general, there are three main weaknesses with the current system of mapping, as described below (*Figure 13.7: Weakness of Current Mapping/Notification System*).

1. Outdated maps. Communities change. And as they grow and develop, their flood boundaries may change. For example, as a community develops, the increase in impervious surfaces (parking lots, streets, driveways, and sidewalks) can increase the rate and amount of runoff into nearby streams and exacerbate flooding downstream. In addition, development in floodplains reduces their natural flood-storage capacity. And the effect is cumulative. The more disruption that takes place in a floodplain, the greater the elimination of the natural functions and the greater the potential for floods to cause damage to people and property (Morris, 1997:12). Over time, the FIRMs become

outdated. In 1999, when Hurricane Floyd struck North Carolina, many homes located outside the SFHA were flooded, in part because upstream development had changed the extent of the floodplain.

Section 575 of the National Flood Insurance Reform Act of 1994 mandates that FEMA must:
"... once during each 5-year period... assess the need to revise and update all floodplain areas and flood risk zones identified, delineated, or established (under Section 1360 of the Act) based on an analysis of all natural hazards affecting flood risks."

Although FEMA updates several thousand FIRMs each year, many remain out-of-date.

2. Risk perception. People may be made aware of the location of hazard areas, but may choose to ignore or discount the risks anyway. Often people view the SFHA—typically referred to as the 100-year flood area--as an area where a major flood occurs only once every 100 years. Along the coast, people seem particularly willing to build in high-risk areas in exchange for the privilege of living close to the ocean. Thus, despite the availability of maps depicting flood or earthquake hazard areas, many investors and homebuyers will make what appears to be irrational decisions and buy property in a hazard-prone location.

3. Timing of notification. There is no systematic procedure for ensuring that potential purchasers will be notified about the location, nature and extent of natural hazards. Buyers of property in hazard-prone areas are not always notified of the potential risks or they are notified too late in process of acquisition. Often, a buyer is notified during the final closing, if at all, about the threat of natural hazards. Ideally, potential buyers should be informed about relevant hazard conditions on property during the process of information gathering and evaluation, i.e., when a person begins to evaluate a spectrum of properties available for purchase, not at the time the purchase agreement is signed (Godschalk, et al.,1998:16)

A number of states have adopted mandatory hazard notification requirements. For example, California realtors are required to notify potential buyers if the property the buyer is purchasing lies in an earthquake fault zone. Similarly, South Carolina requires notification to potential purchasers of properties that would be affected by the state's coastal setback regulations (Godschalk, et al., 1998:iv). In addition to timing (notification should be given as early as possible in real estate transactions), two other factors influence the effectiveness of such notification requirements:

- The clarity of the disclosure. Notification should be clear and specific so the purchaser understands the content, using standard forms and explanatory manuals, and

- The perceptions created by the real estate agents or other professionals involved in the purchase decision. Real estate agents can influence buyer decisions about the nature of the risk posed by natural hazards.

13.3 Describe innovative approaches to mapping and managing floodplains

Mapping Floodplains:
FEMA has launched an ambitious Map Modernization program to speed flood map updates. The agency is in the process of creating digital versions of FIRMs that are designed for use with digital mapping and analysis software. Like the paper FIRMs, the digital maps will enable users to determine the flood zone, base flood elevation and the floodway status for a particular location. The digital maps also include base map information (e.g., roads, streams). Thus far, however, digital FIRMs have been completed only for a relatively small number of communities.

In addition, the agency is also moving toward multi-hazard maps that would depict the areas prone to various types of natural hazards, including floods, hurricanes and earthquakes. Through its multi-hazard mapping initiative, FEMA has created a website (www.hazardmaps.gov) where users can assemble hazard maps on-line for just about any location in the United States.

Some state and local governments have implemented programs to develop more up-to-date map of their flood hazard areas. For example, in 2001, the Ohio Department of Natural Resources (ODNR) began development of a Geographic Information Management System, which will include scanning of Flood Insurance Rate Maps, Flood Hazard Boundary Maps and floodway maps for the 88 counties in Ohio. Once scanned, selected features (including 100 and 500-year floodplain boundaries, floodway limits and cross sections) will be digitized and incorporated into the GIS system. The new mapping system will allow users to access floodplain and other community data interactively and to create custom maps.

In North Carolina, over half of the FIRMs are at least 10 years old (www.ncfloodpmaps.com). Hurricane Floyd revealed the shortcomings of relying on outdated maps. In response, the state Division of Emergency Management has initiated a statewide remapping of its floodplains using digital technology. The maps will be developed using high-resolution topographic data and digital elevation models. These models will be used to perform engineering studies to develop up-to-date, accurate flood hazard data and floodplain mapping.

The digital format of the FIRMs will allow them to be used with Geographic Information Systems (GIS) for analysis and planning. In addition, updated flood hazard data will alert those at risk of flooding of the need to purchase flood insurance. The total estimated cost for the Floodplain Mapping Program is $65 million.

At the local level, the city of Charlotte and Mecklenburg County, North Carolina jointly initiated a re-mapping and rezoning program in 1997, as described in section 13.4 below.

Managing Development in Floodplains

In addition to mapping flood hazard areas and notifying people of their presence, communities also need to develop policies and programs to limit or prevent development in floodplains. There are several tools communities can use to accomplish this, such as acquiring property in flood-prone areas, prohibiting the use of public funds for infrastructure that would support development in flood hazard areas, and regulating development in such areas, e.g., requiring all structures to be elevated above base flood elevation.

One of the most comprehensive floodplain management programs in the country is in Tulsa, Oklahoma. The program combines investment in flood management infrastructure, strict regulations on development in floodplains, acquisition of structures in flood hazard areas, an active public awareness program and an early warning system for flash floods. For its efforts, Tulsa has earned the highest rating under the NFIP's Community Rating Service (www.cityoftulsa.org).

Built along the Arkansas River, Tulsa has a long history of flooding. From the early 1970s to the mid 1980s, Tulsa has been declared a flood disaster area nine times. One of the worst floods occurred in 1984. In response, Tulsa developed a comprehensive program that includes converting floodplains to parks, building sports fields in stormwater detention basins, and developing greenways along streams. It also includes dedicated funds for maintenance and operation of the city's stormwater management facilities. All property owners (commercial, residential and industrial) in the city pay a fee to cover the costs of maintaining the city's inventory of detention basins and other facilities.

The city's regulations exceed the minimum standards required under the NFIP. For example, NFIP regulations require finished floors of new structures to be at or above the base flood elevation. As an additional margin of safety, Tulsa requires finished floors to be at least one foot higher. Also, the city's floodplain regulations are based not on the current level of development, but on the projected boundaries of the flood hazard areas at build-out. In addition, its extensive system of detention ponds, (over 85 in all), help detain floodwaters and reduce flooding downstream. Finally, Tulsa has an active acquisition program. Since the 1984 flood, the city has purchased over 900 buildings in floodplains.

In addition to Tulsa, numerous other communities have adopted innovative approaches to discouraging or restricting development in flood-hazard areas. For example, the Vision 2005 plan of Winston-Salem/Forsyth County, North Carolina recommends that all designated floodplains in the county be set aside as greenways. The county's subdivision ordinance requires a 40-foot minimum greenway easement for all development along floodplains (Morris, 1997:23). And on the North Carolina coast, the town of Nags Head's subdivision ordinance requires lots on ocean side of State Road 12 to have an ocean-to-road configuration, which allows houses to be moved landward when coastal erosion threatens the structures.

13.4 Assess the Charlotte floodplain remapping initiative

The City of Charlotte, North Carolina has grown rapidly over the past twenty years or so. According to the 2000 Census, population in both Charlotte and Mecklenburg County as a whole increased 72% from 1980 – 2000. The county, which includes the City of Charlotte, includes two major rivers--the Catawba and Yadkin--and more than 30 watersheds or portions of watersheds within its boundaries (*Figure 13.8: Mecklenburg County Watersheds*).

For years, Charlotte relied on NFIP maps to regulate development in floodplains. These maps were developed based on 1975 land use data. But as the Charlotte area expanded, the increase in impervious surfaces resulted in greater rate and volume of runoff. Over time, the NFIP maps proved increasingly inaccurate. Rainfall that did not reach 100-year levels pushed floodwaters well beyond the 100-year flood boundaries. Many properties that stood outside the designated SFHAs experienced flooding.

Two tropical storms in the mid-1990s (Jerry, 1995 and Danny, 1997), prompted Charlotte-Mecklenburg to conduct their own analysis of flood potential within their watersheds. The mapping initiative updated the maps to reflect current conditions and also incorporated the anticipated level of development at buildout, based on current zoning, and incorporated these maps into the Land Use District Plan for 2030.

One of the strengths of the program is that the city-county area can now rely on more accurate maps of its flood hazard areas to notify property owners, and to develop policies and programs to reduce the vulnerability of property in the (expanded) floodplain. The maps should also serve notice of the impact of impervious surfaces on stormwater runoff. In addition, the extensive public involvement that took place over the three-year re-mapping initiative helped raise awareness about the nature and extent of flood hazards in the Charlotte-Mecklenburg area and the need to take steps, both individually and as a community, to reduce the risk of flooding.

Finally, Charlotte-Mecklenburg agencies initiated a water quality initiative nearly simultaneously with their push to re-map the floodplain to address water quality problems. The result was a comprehensive approach to water resource protection and flood prevention.

One of the weaknesses of the program is that the re-mapping is technically complex and time-consuming. Also, developers fear a reduction in property values or development opportunities if their land is designated as part of a flood hazard area. And there have been some concerns over the equity of the stormwater fees, which are used in part to fund the development of the new maps (MacDonald, 2002:3).

Despite its shortcomings, the re-mapping initiative will help Charlotte-Mecklenburg become a more resilient community by identifying, more accurately, the extent of the flood hazard areas, taking into account changes likely to occur due to development. In addition, the initiative increased public awareness of flood hazards in the community and

led to the formal adoption of the Mecklenburg Floodplain Management Guidance in 1997. Among other things, the guidance calls for the preparation of flood hazard mitigation plans for each watershed in the city-county region.

13.5 Understand the context of relocation during disaster recovery

As discussed in Session 4, one way to break the disaster cycle is through public acquisition of developed and vacant floodplain property, also known as buyouts. The buyouts typically involve relocating people from hazard-prone areas to safer locations. In some cases, people participating in buyouts will move to another part of the community. In others, they may relocate to another part of the state or leave the state entirely.

One of the concerns of communities participating in buyouts is the loss of tax revenues from those who relocate to other areas. Other concerns include finding suitable places to accommodate those who moved out of the hazard area and maintaining the character of the community following the relocation. Rather than simply move households to safe locations, some communities view buyout programs as an opportunity to achieve the twin goals of hazard mitigation and smart growth, for example by relocating buyout participants to infill areas, where infrastructure is already in place. Thus, buyouts can help achieve smart growth goals such as protecting open space, steering development away from hazard-prone areas, and promoting more compact communities (*Figure 13.9: Using Relocation to Achieve Smart Growth Objectives*).

For example, both Kinston, North Carolina and Grand Forks, North Dakota, provided financial incentives to encourage buyout participants to stay with the town. And as discussed in Session 4, Kinston has used the buyout program as a means to revitalize run-down neighborhoods near its downtown and to create a greenway along the river. Under its Call Kinston Home initiative, the city provided financial incentives of up to $10,000 to buyout participants who bought a home within the city. It also relocated numerous homes to vacant or in-fill lots in existing neighborhoods outside the floodplain. As a result, only about two percent of buyout participants left the city.

13.6 Discuss methods of achieving community resiliency through application of smart growth principles

Smart growth calls for compact, mixed-use development that provides a range of housing and transportation choices. It also calls for protecting open space and steering clear of hazard-prone areas (*Figure 13.9: Principles of Smart Growth*). Many hazard mitigation plans also seek to preserve hazard areas in their natural state, for example, as parks or greenways. Local governments have used a variety of techniques to achieve the goals of smart growth and hazard mitigation, such as zoning and subdivision ordinances that limit development in hazard-prone areas or acquisition of property to create open space while keeping people and property out of harm's way. Smart growth for hazard areas might include reduced development or "backward growth."

Some zoning ordinances contain a specific flood hazard zone with a discreet list of permitted land uses and standards that apply to the siting, placement, density, and other uses (Morris, 1997:17). Local governments can zone floodplains for very low density development, e.g., 1 dwelling unit per 20 acres or require, as part of the subdivision ordinance, minimum setbacks from hazard areas. The CRS program offers credit to communities that create minimum lot sizes of 1 to 10 acres or more per dwelling unit.

However, low-density development runs counter to the principles of smart growth, e.g., compact development. Some local governments allow houses to be clustered on the upland portion of a site while leaving the low-lying, flood-prone areas undeveloped. This is the principle behind what are often called "conservation subdivisions," where clustering allows the majority of a site to be preserved as open space, while maintaining the same overall density that would be achieved using more conventional subdivision design (see Arendt, 1996, 1999).

In addition, a growing number of communities have purchased properties in hazard-prone areas and created greenways or parks in the floodplain. The advantage of such programs, often called buyouts, (see Session 4), is that they can permanently remove people and property from harm's way. The disadvantage, of course, is that buying hazard-prone property can be expensive.

Buyout programs have been implemented in communities across the country. For example, the town of Boone, located in the mountains of western North Carolina, developed a multi-objective flood hazard mitigation plan in 1997 that sought to acquire the most vulnerable properties and create a park on the newly-vacated floodplain. Steep mountainous terrain along with rapid development led to repeated flooding: 15 floods in the previous two decades (NCDEM, undated). In 1997, the town began purchasing 30 homes located in a repetitively damaged subdivision. Twelve of the homes were relocated to an area outside the mapped floodplain and will be used to provide affordable housing.

Finally, local governments can use their infrastructure policies and programs to steer growth away from hazard-prone areas. In general, development follows infrastructure. Thus, building roads and extending water and sewer lines into floodplains or earthquake hazard zones will encourage development in such areas and results in market inefficiencies by creating a market bias in favor of development, rather than preservation of, hazard areas. Some states, e.g., Maine and Florida, restrict public spending for infrastructure in coastal hazard areas.

Whatever the methods used, the goals of smart growth and hazard mitigation are generally compatible, such as promoting compact development, protecting open space and steering growth away from hazard areas. Achieving these goals will help communities become more resilient.

As used in relation to natural disasters, resiliency means being able to bounce back fairly quickly from an extreme natural event (such as an earthquake, tornado, hurricane, or

flood) without permanent, intolerable damage to or disruption of natural, economic, social, or structural systems and without massive amounts of outside assistance (Association of State Floodplain Managers, 2000:5). By adopting the principles of smart growth, a community should be able to withstand natural extremes such as floods without experiencing them as "catastrophic" or "disastrous" events. That is, they should be able to roll with nature's punches.

Exercise
Review Kinston, North Carolina's flood recovery program discussed in Session 4 and shown again below. The instructor will lead a discussion in which the class will be asked to answer the following questions about the Kinston program.

- What obstacles have they had to overcome in order to carry out this program?
- How has the state assisted them?
- Identify the innovative initiatives being tested in the program.
- Do you believe that this smart growth approach could be used in other communities as part of an overall pre-disaster mitigation strategy?

Background
The City of Kinston, which sits on the banks of the Neuse River in eastern North Carolina, has long been vulnerable to flooding. Most of the city lies within the 50-year floodplain. When Hurricane Floyd struck in 1999, causing major flooding, the city was still recovering from devastating flooding caused by Hurricane Fran just three years earlier. According to the North Carolina Division of Emergency Management, flooding from Fran caused major damage to over 400 homes, dozens of businesses and public infrastructure. Total losses exceeded tens of millions of dollars. Floyd also damaged hundreds of homes and submerged the Central Business District under several feet of water, causing damage to about 200 businesses. When Hurricane Floyd struck, the city had already acquired and demolished nearly 100 homes damaged by Fran, the vast majority of which would have been flooded again by Hurricane Floyd. The removal of these homes saved the city an estimated $6 million in avoided costs.

The City's recovery effort following both Fran and Floyd has been guided by several key objectives, including reducing the city's vulnerability to future flooding, revitalizing existing neighborhoods, preserving the tax base and creating open space. That is, to link hazard mitigation with community redevelopment and smart growth. The centerpiece of the recovery effort is the acquisition of more than 400 residential structures, three mobile home parks and 68 vacant lots. According to NCDEM, the buyout project will cost approximately $31 million, half of which will come from the Hazard Mitigation Grant Program. The rest will be funded by HUD ($12 million) and from state funds.

Kinston has used the buyout program as a means to revitalize run-down neighborhoods near its downtown and to create a greenway along the river. Under its Call Kinston Home initiative, the city provided financial incentives of up to $10,000 to buyout participants who bought a home within the city. It also relocated numerous homes to vacant or in-fill

lots in existing neighborhoods outside the floodplain. As a result, only about two percent of buyout participants left the city.

Overall, Kinston has worked to integrate hazard mitigation with affordable housing, economic development, parks and open space, and the protection of natural resources. In 1999, the adopted a comprehensive Urban Growth Plan to guide its efforts. In particular, the city has adopted more stringent controls on development in the floodplain, expanded its buyout program, steered new development to vacant or underutilized land near its downtown, and enhanced its tax base by encouraging development within its boundaries.

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Figure 13.1. Flood Insurance Rate Maps (FIRMs)

Source: FEMA

Figure 13.2. Features of FIRMs

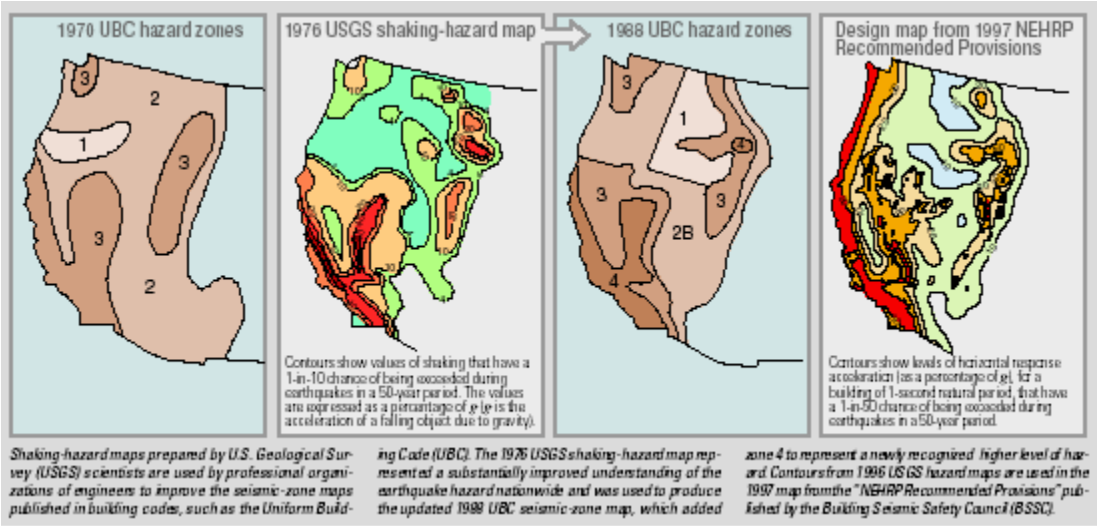
- **Special flood hazard areas**
- **Highways, roads, lakes railroads, waterways)**
- **Base flood elevation (1% chance)**
- **Flood insurance risk zones**
- **Areas subject to 0.2 % flood**
- **Floodways**
- **Undeveloped coastal barriers (COBRA)**

Figure 13.3. Grifton, NC Flood Hazard Map

Gray areas indicate special flood hazard areas. Hashed areas within SFHA is floodway.

Source: FEMA Map Store (http://store.msc.fema.gov)

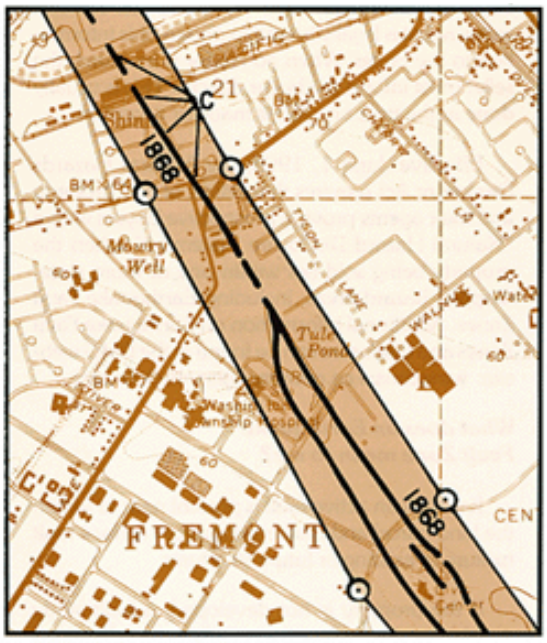
Figure 13.4. Earthquake Shaking Hazard Maps



Note: Map shows integration of Uniform Building Code (UBC) maps with USGS shaking-hazard map for western U.S.

Source: USGS, 2001. "Hazard Maps Help Save Lives and Property." Fact Sheet 183-96

Figure 13.5. California Earthquake Fault Zone Map



Source: California Geological Survey

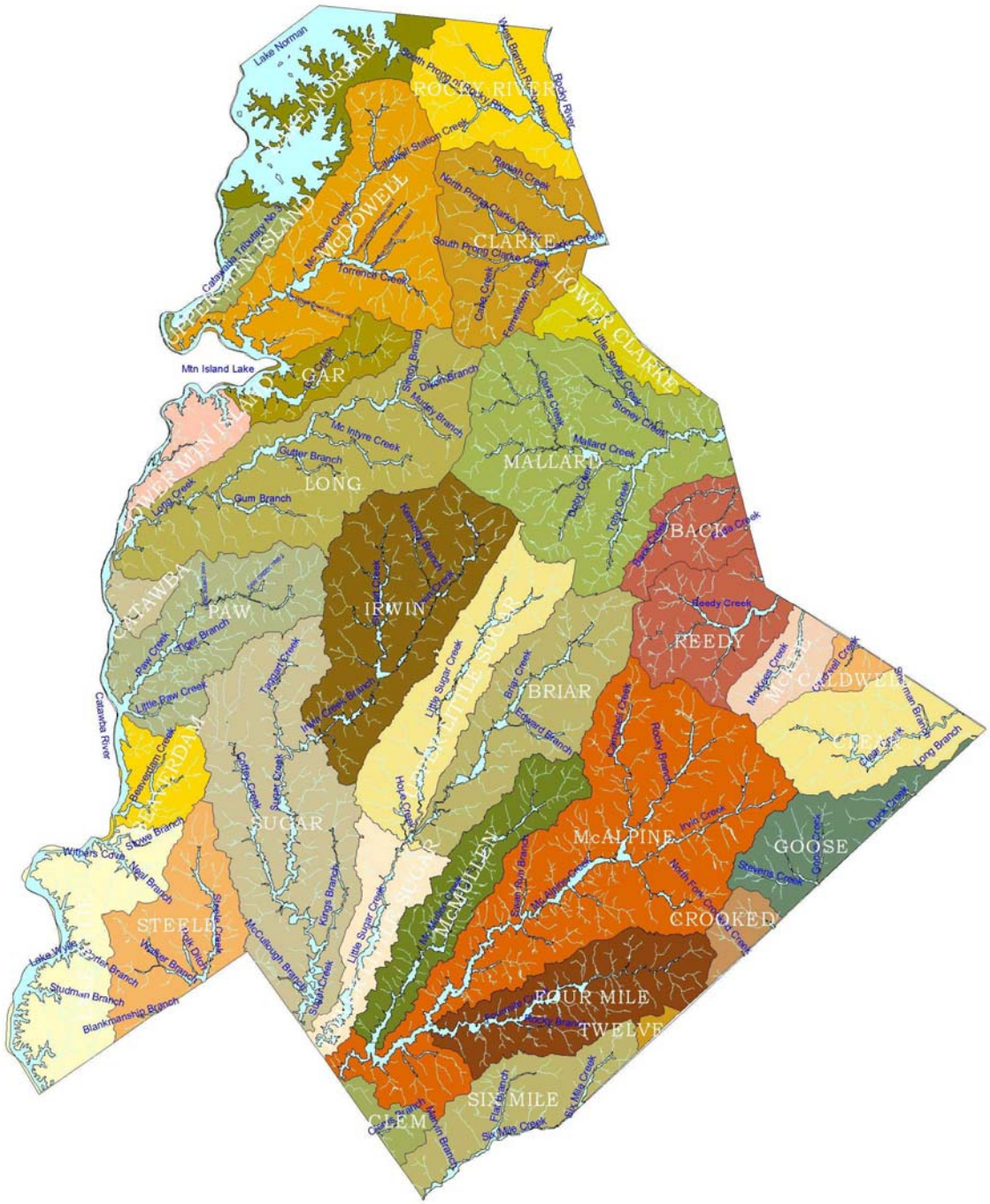
Figure 13.6. California Disclosure Requirement

A person who is acting as an agent for a seller or real property that is located within a seismic hazard zone, of the seller if he or she is acting without an agent, shall disclose to any prospective purchaser that the property is located within a seismic hazard zone.

Figure 13.7. Weaknesses of Current Mapping/Notification System

- Outdated Maps
- Risk Perception
- Time of Notification

Figure 13.8. Mecklenburg County Watersheds



Source: Charlotte-Mecklenburg Stormwater Services

Figure 13.9. Using Relocation to Achieve Smart Growth Objectives

- Promote infill and compact development
- Protect open space, build greenways
- Steer growth away from natural hazard areas
- Improve quality of life

Figure 13.10. Principles of Smart Growth

- Create a range of housing opportunities and choices
- Provide a variety of transportation choices
- Create walkable neighborhoods
- Encourage community and stakeholder collaboration
- Foster distinctive, attractive places with a strong sense of place
- Take advantage of compact building design
- Make development decisions predictable, fair, and cost-effective
- Strengthen and direct development towards existing communities
- Preserve open space, farmland, natural beauty, and critical environmental areas, including natural hazard areas.
- Mix land uses