CHAPTER 3

The Problems of Containment and the Promise of Planning

Raymond J. Burby, Arthur C. Nelson, and Thomas W. Sanchez

When the expansion of cities is constrained either by natural barriers, such as New Orleans, or by policy efforts to limit urban sprawl, development pressures in hazardous areas can markedly increase. As floodplains, steep slopes, earthquake fault zones, and other hazardous locations are converted to urban uses, the locality's vulnerability to hazard events increases as does the potential for serious losses of lives and property in natural disasters. The devastation of New Orleans from Hurricane Katrina is an extreme example of the phenomenon. But this threat can be neutralized if hazards are recognized in advance of exposure and appropriate counter-measures are adopted. The difficulty is that in the absence of state planning and hazard mitigation requirements, many localities ignore hazards in planning for and regulating urban development, as shown most recently by Steinberg and Burby (2002).

New Orleans and Miami, Florida, provide excellent examples to evaluate the effects of adequate planning and preparation for cities in hazardous areas. New Orleans provides an example of what can occur in a city with severe constraints on buildable land and a lack of adequate public concern for hazards or urban development planning. In contrast, decisions made by policy makers in the State of Florida and by the Miami-Dade County Government illustrate how concern for hazard avoidance and resource protection can lead to policies that sharply limit development in flood-prone areas. To see if lessons revealed by these two cases could be replicated nationwide, we examine natural disasters and associated property damages in samples of metropolitan counties with varying degrees of containment brought about by policy decisions or natural conditions and with varying degrees of planning. And our findings are extremely telling. Metropolitan counties with either natural or policy containment experienced higher property losses in disasters when states left planning and development decisions wholly to local government discretion. Where states intervened and demanded that localities plan and manage development with hazard mitigation in mind, property losses are strikingly lower.

These findings are significant for several reasons. Urban containment programs are proliferating throughout the United States as governments attempt to counter various adverse effects of urban sprawl (Nelson and Dawkins 2004). Yet with the exception of our earlier work on containment and hazards (Burby et al. 2001), planning literature makes virtually no mention of the potential for containment programs to foster unsafe development patterns. In fact, a recent paper published by the Brookings Institution (Pendall et al. 2002) enumerates a number of issues related to containment that the authors believe require the attention of planning scholars, but they make no mention of the potential for larger losses in disasters. This is a serious oversight. Natural hazards on average result in economic losses of approximately $26 billion per year in the United States (Mileti 1999), and, rather than decreasing, losses are increasing as urban development continues unabated in areas at risk (Cohn et al. 2001; Cutter 2001; Mileti 1999).

Beginning with a description of urban containment programs and noting their increasing use in urban areas of the United States, this essay then explains the rationale for our hypotheses that containment, either by natural features or by sprawl-busting public policy, may accelerate development in hazardous areas and why state planning mandates may provide an antidote to this peril. This is followed by a discussion of the methods we employed to test these propositions and their limitations. The research findings follow in two stages. An examination of the experience of New Orleans shows that as the growth of the city came face to face with natural constraints, it chose to allow development in its very hazardous backswamps. The result, obviously, was quite poor. We contrast this with the growth of Miami and Dade County, where policy makers in the 1970s decided to limit the expansion of the city into low-lying hazardous areas by enacting an urban growth boundary. Following these case studies, we examine the magnitude of property losses in natural disasters in U.S. counties that have various degrees of natural containment and that have and have not adopted urban containment policies. This essay concludes with a discussion of the implications of our findings for state and local efforts to manage urban growth, and for federal disaster policy.

Urban Containment

Unbounded urban growth is constrained in many places by various natural features that limit or channel urban development. Typically, urban development in these cities occurs at fairly high densities, reflecting limits on the land supply. For example, urban expansion in Los Angeles, considered by some to be an exemplar of urban sprawl, is constrained by the Pacific Ocean to the west and mountains to the east. Surprising to some, at more than 7,000 people per square mile, densities in Los Angeles are higher than in most U.S. metropolitan areas. Other U.S. cities with a high degree of natural containment and relatively high densities include Miami, New Orleans, New York City, San Diego, and San Francisco.

Community efforts to contain urban development within legislatively prescribed boundaries trace their roots to the origins of urbanization, as human settlements used walls to provide protection from hostile neighbors and gates to control entry and exit. Medieval walled cities continued this practice, and it persisted even after the creation of modern nation states. In England in 1580, Queen Elizabeth I forbade building within three miles of London to limit the spread of plague and protect farmland from urban encroachment (Easley 1992). European efforts to contain urban sprawl have continued ever since.

The idea of containing urban expansion originated in the United States in the early years of the twentieth century (Scott 1969), and it was vigorously argued for by Lewis Mumford and other urbanists in the years before World War II (Daniels 1999). The first formal urban growth boundary in the U.S., however, was not adopted until 1958, when Lexington, Kentucky, put in place policies to limit urban development to a core area of 67 square miles. The goal was to protect blue grass farms and horse breeding operations from urban intrusions (Porter 1997). Outside the boundary, residential density was limited to one dwelling unit per ten acres. Three years later, in 1961, the State of Hawaii created the Hawaii State Land Use Commission to zone all land in the state into three classifications: urban, agricultural, and conservation (Healy 1976). The state's primary goals were to curb urban sprawl and protect land for agricultural production (De Grove 1983).

During the 1970s, other states and cities began to initiate urban containment programs. Oregon's Land Conservation and Development Act (1973) requires urban growth boundaries for incorporated cities and urban areas of counties and restricts the use of land outside the boundaries to rural activities (Leonard 1983). In 1975, Dade County, Florida, implemented a containment program by enacting a growth boundary (Freilich 1999). That same year, Sarasota County, Florida, adopted a boundary plan with three tiers for development: urban, semi-rural, and rural (Freilich 1999).[1]

Urban Containment and Exposure to Hazards

As urban containment programs limit land available for development, one of their first effects is usually an increase in land values (Hall et al. 1973; Whitelaw 1980). This initially leads developers to use land more efficiently, building housing and other projects at higher densities than before (Landis 1986; Howe 1993; Nelson 2000). Another potential effect is pressure to develop land exposed to natural hazards that prior to the containment program developers avoided when looking for sites for residential and nonresidential projects. This occurs for several reasons. First, as vacant land for development begins to become scarce, hazardous land may be some of the only vacant property readily available. Second, because development constraints such as hazards should have been capitalized into land values, hazardous land may be the lowest price land available, all other factors being equal. If developers invest in measures to reduce the risk of hazards, such as elevation of roads in floodplains, construction and maintenance of flood control works, installation of slope-stabilization measures on hillsides, and strengthening of infrastructure system components, vulnerability to damage from natural hazards may remain relatively constant. However, if local governments have inadequate development and infrastructure design regulations in place or regulations are inadequately enforced, which is not uncommon, losses in hazard events should escalate.

There are a number of steps local governments can take to counter the potential effects of containment programs on the vulnerability of development to damage in disasters: (1) *preventive* policies and actions, such as conservation zoning, to limit the exposure of new development to losses from hazards; (2) *property protection* policies and actions, such as building standards and assistance to property owners to retrofit buildings to increase their resilience to hazards; (3) *structural protection* policies and actions such as flood control works to provide areawide protection from hazards; (4) *emergency services* policies and actions to lessen the impact of a hazard after its onset; and (5) *information* programs to build awareness of hazards and knowledge of actions that can be taken to reduce the risk of loss (Burby et al. 2001). The problem is hazard mitigation tends to be a very low priority for local governments as revealed by numerous studies (Rossi et al. 1982; Burby and May 1998; and Burby 2006). In fact, Burby et al. (1997) found that local governments are not likely to pursue such measures vigorously without being forced to do so through mandates imposed by state governments.

Containment of urban growth, in sum, either by natural topographic and hydrologic features or through conscious public policy, will lead to increased development of hazardous areas and increased losses in natural disasters. This effect can be countered if states require that local governments pay attention to hazard mitigation in planning for and managing urban growth. These expectations are illustrated in Table 1.

Investigating the Effects of Containment

Increased vulnerability to natural hazards should manifest itself first through changes in the value of land in hazardous areas and then in the likelihood and intensity of development of those areas. In the face of a hazard event, this should in turn result in higher losses in the contained jurisdiction than would

TABLE 1. Predicted Losses with Varying Degrees of Urban Containment and State-Mandated Local Government Hazard Mitigation

Local hazard mitigation mandated by state	**Containment of urban growth**	
	Low	**High**
Yes	Lower losses	Intermediate losses
No	Intermediate losses	Higher losses

have occurred if urban expansion had not been contained by natural features or by policy makers through enactment of an urban containment program. In the research undertaken for this essay, we focus on the association of containment programs and property damages experienced in natural disasters.

Our case studies of Miami/Dade County and New Orleans are based on secondary data sources that include, among others, historical treatments of the development of New Orleans and Miami, government documents detailing efforts to plan for and manage urban development and mitigate flood and hurricane threats, insurance claims data assembled by the National Flood Insurance Program and the Institute for Business and Home Safety, and newspaper accounts of various events related to the vulnerability of the cities to disasters. Our accounts of development and hazard mitigation decision making were shared with various experts to help avoid errors in our descriptions of events and in our interpretations of them.

Our national cross-sectional data come from a number of sources as well. The Institute for Business and Home Safety (IBHS) provided data on property losses in natural disasters. The data were developed by IBHS from loss claims data provided by member insurance companies for claims stemming from natural disasters during the period January 1, 1994, through December 31, 2000. Member company claims data represent a significant portion, but not all, of the losses by insurance companies that paid claims for disaster events during this period. IBHS expanded these losses to develop estimates of *total* insured losses paid (in constant 2000 dollars) using data on the market share of the member insurance companies. The loss data exclude two significant sources of losses: earthquake losses to residential and commercial property and flood losses to residential property. We excluded earthquake losses because they are concentrated narrowly in a few states (principally California due to the Northridge earthquake in 1994). Flood losses to residential property are excluded because for the most part these are handled by the National Flood Insurance Program rather than private insurers.

The degree of natural containment was measured for a random sample of metropolitan counties as the sum of the lengths of the natural containment boundaries of each county divided by this sum plus the length of the county boundaries less the length of any of the county boundaries that are coincident with natural containment boundaries. The natural containment boundaries we measured include lakes, rivers, mountains, and ocean and Great Lakes coastlines. The degree of policy containment was measured using data obtained from surveys of local government growth management policies conducted by Nelson and Dawkins (1999) and Pendall et al. (2001). Based on the enumeration of places with containment policies from those sources, Nelson and Dawkins (2004) collected 100 local plans to verify that, in fact, the jurisdictions had developed policies to contain urban growth. They found that the most widely used approaches to containment were the adoption of formal boundaries to physically constrain urban expansion, followed by use of urban service extension boundaries and various growth phasing policies. Because it takes some time for growth management policies to translate into significant effects on urban development patterns, we limited our study to the sixty-eight counties in which containment policies were adopted in 1990 or earlier. Counties were counted as having containment policies in effect if containment programs were adopted at the regional level (such as Portland and Twin Cities metropolitan areas), county level (such as Dade County), or by one or more cities within the county (such as Eau Claire, Wisconsin). In many cases, city and county governments jointly pursued containment programs (such as San Diego and San Diego County). Because of the small number of places with policy containment, we adopted a simple 1 (containment exists) / (containment does not exist) coding scheme, although we recognize that there are a number of ways in which containment manifests itself that may influence the effects of these programs on urban development patterns.

Data on state planning mandates and state hazard mitigation policy were provided to us by the Institute for Business and Home Safety, which contracted in 2002 with the American Planning Association (APA) to survey state planning legislation related to local planning and hazard mitigation. These data include information on whether the state requires cities and counties to develop comprehensive plans and whether the state requires that local plans include hazard mitigation elements. The data developed by APA revealed that twenty-four states require all or some counties to prepare comprehensive plans and ten states require that these plans attend to hazards. We used a simple coding scheme to reflect the existence of these state mandates, coding these variables 1 in counties in states with the mandates and 0 for counties in states without the mandates.[2]

Contrasting Choices Made by New Orleans and Miami/Dade County

New Orleans and Miami provide a sharp contrast in how urban areas with similar degrees of natural containment confront natural hazards and plan for and manage development. Historically, urban expansion in New Orleans has been constrained by wetlands and Lake Pontchartrain to the north of the initially settled area along the Mississippi River, the Mississippi River to the south and beyond that additional wetlands, Jefferson Parish to the west, and wetlands and Lake Borgne to the east. Historically, urban expansion in Miami has been constrained by Biscayne Bay to the east and the Everglades to the west and south; in fact, 45% of the county is designated as wetland and 56% is located in regulatory floodplains. Because of their coastal locations and extensive areas of low-lying wetlands, both areas are highly vulnerable to natural hazards. Over the past 135 years, New Orleans experienced 36 hurricanes that struck or came with sixty miles of the city (a recurrence interval of 1 every 3.8 years); Miami experienced 50 hurricanes over the same period (a recurrence interval of 1 every 2.7 years).[3]

Prior to 1965 the development history of both of these areas was also similar in many respects. Faced with hostile natural environments, state officials, city leaders, and developers strove to create urban development opportunities by draining and filling wetlands, which resulted in severe vulnerability to flooding as the drained land subsided, often to levels well below sea level.

After 1965, their paths diverged. Urban growth in New Orleans exploded into the swamps of eastern New Orleans to take advantage of development opportunities created by the construction of Interstate Highway 10 and the concurrent efforts of the U.S. Army Corps of Engineers to enhance hurricane storm surge protection by extending levees to the east of the Industrial Canal. In doing this, it continued a century-long process of accommodating population pressures by draining wetlands. In contrast, after 1965, the Florida state government intervened with a series of laws that sought to strengthen local governments' ability to plan for and manage urban development and to protect wetlands and other flood hazard areas.

The effect of natural containment on development in New Orleans began to be felt toward the end of the nineteenth century. Lewis (2003, 20) notes that the city was "shoehorned into a very constricted site," but nevertheless initially capitalized on the natural levees of the Mississippi River and two abandoned distributaries of the river (Bayou Metairie and Bayou Gentilly) as sites for urban expansion. "The hideous alternative," he notes, "was to build in the backswamp: the low, perennially flooded area back from the river a mile or two—during most of the city's history a pestilential morass . . . the soil being a black slimy material that varies in consistency between thin soup and dense glue" (Lewis 2003, 27). By the turn of the century, however, land on the relatively flood-free natural levees had been built out, and the city began to expand into the backswamps. This became feasible with the invention of the Wood pump by New Orleans city engineer A. Baldwin Wood. Wood's invention made it possible to remove large amounts of swamp water very quickly, so that the backswamps could be drained effectively and provide sites for new housing. In rapid order, New Orleans developed steadily to the north toward Lake Pontchartrain through a succession of wetland drainage projects, pumping and storm water drainage improvements to remove runoff from periodic rainstorms, and levee building to keep out storm surges from lakes Pontchartrain and Borgne. These efforts were capped in the 1920s, when the Louisiana legislature authorized the Orleans Levy Board to create a 5.5 mile stepped levee, not along the shoreline of Lake Pontchartrain but 3,000 feet out into the lake, and to reclaim the land between the new levee and old lake shoreline for a series of new residential subdivisions (and later a branch of the state university and modern airport).

By the 1950s, urban development occupied most of the land between the new lakefront levees and older parts of the city. Suburban sprawl was well underway in adjoining Jefferson Parish to the west. To compete with its neighbor, New Orleans looked to the swamps and already drained swamps of eastern New Orleans as the next site for urban expansion.

Three developments, each aided by the federal government, made this financially feasible. First, the passage of the Interstate Highway Act in 1957 promised federal aid (interstate highways are built with 90% federal funding and 10% state and local funding) for the highway improvements that would be needed to provide access. In short order, Interstate 10 was under construction from the Rigolets through the heart of eastern New Orleans to the city's downtown to the southwest. Second, Hurricane Betsy in 1965 (America's first billion-dollar hurricane) revealed the highly hazardous nature of the area chosen for urban growth when it flooded the already developed Lower Ninth ward and most of eastern New Orleans, which at that time was largely undeveloped. The Army Corps of Engineers was ready with a solution to the problem with its plan for Lake Pontchartrain hurricane protection. The Lake Pontchartrain and Vicinity Hurricane Protection Project, authorized by Congress in 1965 (see U.S. House 1965), directed the Corps to assume responsibility for building levees to protect the undeveloped eastern part of Orleans Parish (79% of the benefits that justified the project were to come from new development that would be made possible by the project) (U.S. GAO 1976). The Orleans Levee Board (a state agency) was to strengthen levees to protect older parts of the city to avoid flooding by storms similar to Hurricane Betsy. The Corps assumed major responsibility for this as well, when the Lake Pontchartrain project was reformulated in the mid-1980s (U.S. Army Corps of Engineers 1984). Third, in 1968 Congress enacted the National Flood Insurance Act, which would provide federally subsidized insurance to cover flood risk to older development in the city and would cover, at actuarially sound rates, the residual risk of flood damage to new homes protected by the new

Corps levees and new drainage works constructed in the developing eastern part of the city by the city's sewerage and water board.

The New Orleans City Planning Commission facilitated the urbanization of the eastern part of the city with plans endorsing this site for urban expansion enacted in 1966 and 1970. With the planning commission's blessing, Lewis notes,

> By the 1970s suburban construction was already under way on a grand scale. . . . The largest was called "New Orleans East," fifty square miles (32,000 acres) owned by a single corporation. . . . According to promotional literature, it will be a "totally planned community where 250,000 people will eventually live, work, and play." (Lewis 2003, 76)

The bust in the oil industry in the 1980s deflated the New Orleans economy and quashed these dreams. Nevertheless, by the year 2000 some 22,000 new housing units had been built in the former swamps of the eastern part of the city, and the city planning commission wanted more. In its 1999 New Century New Orleans Land Use Plan, the city planning commission argued,

> Moreover, there are extensive opportunities for future development of the vacant parcels that range from single vacant lots to multi-thousand acre tracts. Long term, these development opportunities represent not only population increases but also significant potential employment for the city. (City of New Orleans 1999, 201)

Ironically, in the New Century plan the commission made absolutely no mention of the extreme flood hazard facing the city, ways of mitigating the hazard through land use or building regulations, or how the city might recover from an event such as Hurricane Katrina. Equally ironically, just six years later, the entire area of urban growth in the newly drained swamps of the eastern part of the city was under water.

In contrast to the recent urban development history of New Orleans, in Miami the past thirty-five years have seen a concerted effort by the State of Florida and the Miami-Dade County Government to limit urban development in hazardous areas similar to eastern New Orleans. This was not always the case. In earlier years and with an economy based on tourism and land speculation, in 1906 the State of Florida embarked on an ambitious program to drain the Everglades. George (2006), notes,

> Everglades reclamation (or drainage) led to the birth of a feverish real estate industry for Miami and much of southeast Florida as large speculators purchased millions of acres of reclaimed land from the State of Florida, then marketed it

> aggressively in many parts of the nation. The unsavory sales tactics of promoters who sold unwitting investors land that was underwater earned for Miami an enduring reputation for marketing "land by the gallon."

The consequences for Miami of building on unsafe land, like those experienced by New Orleans, were grave. The hurricane of 1926 left 373 killed, 811 missing, and 40,000 homeless, and hurricanes in 1935, 1945, 1947, 1948, 1950, 1964, and 1965 caused considerable damage.

With the advent of the environmental movement in the 1960s and mounting population pressures on available resources, the state dramatically changed course. In 1972, the legislature enacted laws to protect the Everglades from exploitation and required the state government to develop a plan for sound future growth. In 1975, additional legislation was passed to require local governments to prepare comprehensive plans. This requirement was strengthened by the State and Regional Planning Act of 1984 and the 1985 Omnibus Growth Management Act. These laws put in place a top to bottom planning system in which the state formulates broad policy objectives that are then implemented through multicounty regional plans and local government comprehensive plans. The state directed that the coastal management provisions of local comprehensive plans must: (1) limit public expenditures that subsidize development in high-hazard areas unless the expenditures are related to the restoration or enhancement of natural resources; (2) direct population concentrations away from known or predicted high-hazard areas; (3) maintain or reduce hurricane evacuation times; and (4) include post-disaster redevelopment plans to reduce exposure of human life and property to natural hazards (Burby et al. 1997, 52–65). In Dade County, in addition to complying with the state's planning and resource protection requirements, the Miami-Dade County Government in 1975 adopted a regulatory urban growth boundary to concentrate future land development in core areas of the county and to prevent further urban expansion into the wetlands in the western portions of the county. This act stands in sharp contrast to the New Orleans city government's wholesale exploitation of the flood-prone wetlands of eastern New Orleans from the mid-1960s onward.

The benefits in terms of reduced exposure to property losses in natural disasters of Florida's and Miami-Dade County's proactive approach are striking. Our data on claims paid by property insurance companies for disaster losses between 1994 and 2000 indicate that they are much lower in Dade County ($33 per capita for residential claims; $6 per capita for commercial claims) than in Orleans Parish ($287 per capita for residential claims and $101 per capita for commercial claims). National Flood Insurance Program claims payments over the twenty-five-year period between 1978 and 2002 are equally revealing: $72 per capita in Dade County versus $708 per capita in Orleans

Parish. In sum, this brief comparative case study of two places with natural containment suggests that with adequate planning and attention to hazards, losses from natural hazards can be sharply curtailed. Without such planning, catastrophes of the dimensions of Hurricane Katrina can result.

Containment and Disaster Losses Nationwide

The experiences of New Orleans and Miami-Dade County have been repeated in metropolitan counties across the U.S. In comparison to counties without containment programs, contained counties experienced greater total insured losses to residential property between January 1, 1994 and December 31, 2000 (an average of $37.3 million per county for contained counties versus $30.7 million for uncontained counties) and greater losses per housing unit ($293 versus $291). Although they are in the direction predicted, none of these differences are statistically significant. This anomaly, however, is due to the effect of state planning and hazard mitigation mandates that limit the impact of containment on losses in a portion of the counties with containment programs.

Commercial losses present a similar picture. Average losses to commercial property are higher in counties with containment ($9 million versus $7.8 million), but losses per capita are somewhat lower in contained counties ($24 versus $31). Again the differences are not statistically significant.

State hazard mitigation mandates have a strong effect in reducing insured losses, as shown in Table 2. Average losses per county over the study period were $40 million in states that do not require attention to hazards in local comprehensive plans but only $16 million per county in states with hazard mitigation mandates. Average losses per housing unit were also more than twice as high in states without hazard mitigation mandates. Commercial losses present a similar picture.

The combined effects of containment and state planning mandates are shown in Table 3, which is constructed to mirror the table of hypothesized effects presented earlier. In the top panel for residential losses and bottom panel for commercial losses, we see that, as predicted, losses are highest in jurisdictions that have enacted containment programs and are located in states that do not require attention to hazards in local planning programs. Contrary to our expectations, losses are lowest in counties *with* containment programs in states that require attention to hazard mitigation in local planning. The differences between the two groups of contained counties are striking.

Average per county residential losses per housing unit are $491 in contained counties without state hazard mitigation mandates versus only $95 in contained counties with a mandate. Differences in commercial losses are equally striking, with average losses per capita of $41 in contained counties

TABLE 2. State Hazard Mitigation Mandates and Insured Losses (2000 dollars) to Residential and Commercial Property in Natural Disasters, January 1, 1994–December 31, 2000[a]

State hazard mitigation requirements[a]	Residential losses		Commercial losses	
	Total insured losses	Insured losses per housing unit[b]	Total insured losses	Insured losses per capita
Counties in states that *do not* mandate local hazard mitigation (n = 115)	Mean: $40,288,000 Median: 9,700,000	Mean: $360 Median 176	Mean: $9,531,000 Median: 2,115,000	Mean: $32 Median: 11
Counties in states that do mandate local hazard mitigation (n = 45)	Mean: $16,180,000** Median: 8,475,000	Mean: $118*** Median: 87	Mean: $5,116,000* Median: 895,000	Mean: $18* Median: 4

* p = .10 ** p = .05 *** p = .01 (one tailed, difference of means test)

[a]Sample consists of metropolitan counties with containment programs established 1990 and earlier and a random comparison sample of metropolitan counties without containment programs. Counties that did not experience losses in a natural disaster between January 1, 1994 and December 31, 2000 are not included in the analysis.

[b]Calculated by dividing total insured losses by the total number of housing units in a county. Since all housing units are included rather than just those that carried insurance for property losses, the losses per insured housing unit shown are smaller than those per housing unit carrying insurance (i.e., insurance companies experience higher losses per insured household than shown here).

not subject to state hazard mitigation mandates versus $7 in contained counties with state mandates.

Comparing counties across state hazard mitigation mandates (rows) also illustrates the importance of state hazard mitigation mandates. Average losses in contained counties in states without hazard mitigation mandates are $491 per housing unit versus average losses of $306 per housing unit in counties without containment. Where the states mandate attention to hazards the picture is reversed. Contained counties actually have lower losses per housing unit than those without containment, providing strong vindication for the containment and hazard mitigation policies pursued by states such as Florida, Maryland, and Oregon that vigorously champion both containment and hazard mitigation in state planning policy.

Our findings for natural containment mirror those for containment policy, except that both states with and without state hazard mitigation mandates contained counties experienced higher losses than uncontained counties. As shown in the top panel of Table 4, in states with hazard mitigation mandates, losses per housing unit are considerably higher in counties with an above average degree of natural containment (72%) than in counties with a below average degree of containment. In counties subject to state hazard mitigation

TABLE 3. Joint Effects of Urban Containment programs and State Hazard Mitigation Planning Mandates on Insured Losses (2000 dollars) to Residential and Commercial Property in Natural Disasters, January 1, 1994–December 31, 2000[a]

a. Residential property losses per housing unit (average for sample: $292)

Local hazard mitigation mandated by state	Mean losses per housing unit[b] by containment of urban growth*	
	Containment program exists	Containment does not exist
No	$491 ($n$ = 34)	$306 ($n$ = 81)
Yes	$95 ($n$ = 34)	$190 ($n$ = 11)

*p = .001 (one tailed, difference of means test; p = .000 for square root transformation to adjust for skewed distribution of losses)

[a]Sample consists of metropolitan counties with containment programs established 1990 and earlier and a random comparison sample of metropolitan counties without containment programs. Counties that did not experience losses in a natural disaster between January 1, 1994 and December 31, 2000 are not included in the analysis.

[b]Calculated by dividing total insured losses by the total number of housing units in a county. Since all housing units are included rather than just those that carried insurance for property losses, the losses per insured housing unit shown are smaller than those per housing unit carrying insurance (insurance companies experience higher losses per insured household than shown here).

b. Commercial property losses per capita (average for sample $28)

Local hazard mitigation mandated by state	Mean losses by containment of urban growth*	
	Containment exists	Containment does not exist
No	$41 ($n$ = 34)	$28 ($n$ = 81)
Yes	$ 7 (n = 34)	$52 ($n$ = 11)

*p = .03 (one tailed, difference of means test; p = .003 for square root transformation to adjust for skewed distribution of losses)

[a]Sample consists of metropolitan counties with containment programs established 1990 and earlier and a random comparison sample of metropolitan counties without containment programs. Counties that did not experience losses in a natural disaster between January 1, 1994 and December 31, 2000 are not included in the analysis.

mandates, losses are 40% higher in the counties with a higher degree of natural containment. The results for losses to commercial property shown in the bottom panel of Table 4 are similar, with losses per capita notably higher in counties with a high degree of natural containment. As with residential losses, counties in states with hazard mitigation mandates suffered much lower commercial losses per capita, in both areas with a high degree of natural containment and also areas with a low degree of natural containment.

To this point, our analyses do not control for other factors that can affect the magnitude of losses in natural disasters. Multiple OLS regression provides a way to isolate the effects of public policies such as containment and state

TABLE 4. Joint Effects of Natural Containment of Urban Growth and State Hazard Mitigation Planning Mandates on Insured Losses (2000 Dollars) to Residential and Commercial Property in Natural Disasters, January 1, 1994–December 31, 2000[a]

a. Residential property losses per housing unit (average for sample: $293)

Local hazard mitigation mandated by state	Mean losses per housing unit[b] by containment of urban growth*	
	High natural containment[d]	Low natural containment[c]
No	$479 ($n$ = 42)	$278 ($n$ = 64)
Yes	$123 ($n$ = 31)	$88 ($n$ = 8)

*p = .001 (one tailed, difference of means test; p = .000 for square root transformation to adjust for skewed distribution of losses)

[a]Sample consists of metropolitan counties with containment programs established 1990 and earlier and a random comparison sample of metropolitan counties without containment programs. Counties that did not experience losses in a natural disaster between January 1, 1994, and December 31, 2000, are not included in the analysis.

[b]Calculated by dividing total insured losses by the total number of housing units in a county. Since all housing units are included rather than just those that carried insurance for property losses, the losses per insured housing unit shown are smaller than those per housing unit carrying insurance (i.e., insurance companies experience higher losses per insured household than shown here).

[c]Low natural containment includes counties with natural containment below the median level for the sample; high natural containment includes counties with natural containment at or above the median level for the sample.

b. Commercial property losses per capita (average for sample $28)

Local hazard mitigation mandated by state	Mean losses by containment of urban growth*	
	High natural containment[b]	Low natural containment[c]
No	$51 (n = 42)	$19 (n = 64)
Yes	$22 (n = 31)	$6 (n = 8)

*p = .03 (one tailed, difference of means test; p = .003 for square root transformation to adjust for skewed distribution of losses)

[a]Sample consists of metropolitan counties with containment programs established 1990 and earlier and a random comparison sample of metropolitan counties without containment programs. Counties that did not experience losses in a natural disaster between January 1, 1994 and December 31, 2000 are not included in the analysis.

[b]Low natural containment includes counties with natural containment below the median level for the sample; high natural containment includes counties with natural containment at or above the median level for the sample.

TABLE 5. Multivariate Analysis of Urban Containment and Insured Losses (2000 Dollars) to Residential and Commercial Property in Natural Disasters, U.S. Counties, January 1, 1994–December 31, 2000

Variable	Standardized regression coefficients	
	Losses to residential property[a]	**Losses to commercial property**[a]
Containment		
Containment program adopted 1990 or earlier	.07	.03
Degree of natural containment	.15**	.24***
State planning policy		
State mandated local comprehensive planning	−.14*	−.08
State mandated hazard element in plans	−.19**	−.20***
Socioeconomic factors		
Median household income, 1992	.10*	−.08
Total number of housing units, 1990	.51***	——
Value of manufacturing shipments, 1992	——	25**
Number of retail establishments, 1992	——	.23**
Model statistics		
Adjusted R^2	.33	.28
F-value	12.94	10.41
Significance	.000	.000
Number of cases	145	145

* p = .10 ** p = .05 *** p = .01 (one-tailed test)
[a]Total losses with square root transformation to adjust for skewed distributions.

planning mandates while simultaneously taking into account other factors that can affect losses in disasters. The results of these analyses are summarized in Table 5, which shows that containment programs do not have a statistically significant effect on losses, while state planning mandates have negative and statistically significant effects. These findings parallel the results reported above. That is, containment policy has a very moderate effect in magnifying losses while state hazard mitigation mandates reduce losses.

The regression results show that natural containment has a much stronger (and statistically significant) effect in increasing losses in disasters than legislated containment policy. This is not unexpected, for two reasons. First, we would expect that places with high degrees of natural containment (versus high degrees of policy containment) to face higher risks of loss when containment is caused by hazardous conditions, such as lake or ocean shorelines susceptible to hurricane-driven storm surges or steep mountain slopes susceptible to landslides. Second, natural containment by wetlands, rivers, lakes, ocean shoreline, and mountains has been present, where it exists, since urbanization began in naturally contained counties. In contrast and as noted earlier, legislated containment programs are for the most part of relatively recent origin. Over a longer period of time, we would expect to see stronger effects of containment, although probably not as strong as those found for natural containment.

The effects of the other control variables are what we would expect. Counties with more housing units and wealthier people experience more losses to residential property than counties with fewer housing units and poorer people. The reasons may be that wealthier people are better able to afford and purchase insurance, more likely to live in more expensive housing, and possibly more likely to choose housing locations near hazardous areas to gain exclusive enjoyment of views, privacy, and related amenities. In the case of losses to commercial property, variables representing the magnitude of retail and manufacturing property at risk are associated with losses, while household income has little effect.

Some Policy Implications

When the path of urban expansion is blocked by natural features or legislatively by growth boundaries put in place to combat urban sprawl, pressures to develop land exposed to natural hazards can increase. This inevitably leads to higher property damages in natural disasters than would have otherwise occurred. Our findings indicate that the tendency for urban containment to increase vulnerability to natural disasters can be limited (and even reversed) if states enact policies that require local governments to prepare comprehensive plans and attend to hazard mitigation in these plans and in related growth management efforts. Thus, cities such as New Orleans that have limited opportunities for urban expansion outside of hazardous areas and cities with smart growth programs designed to control urban sprawl need not suffer extraordinary property losses in disasters. Smart, safe growth is possible, but only if states simultaneously adopt policies to combat sprawl and reduce vulnerability to losses from natural hazards. States such as Florida, Maryland, and Oregon have been path breakers in this regard and can serve as models for other states that want to be proactive in dealing with urban sprawl and natural hazards.

Prior to Hurricane Katrina, the federal government paid little attention to requirements for attention to natural hazards in local government comprehensive plans. Its hazard mitigation efforts focus primarily on measures to facilitate development in hazardous areas (such as building elevation requirements of the National Flood Insurance Program and flood control programs of the Corps of Engineers) and measures to reduce the adverse consequences to households and businesses when this development is destroyed in disasters (such as flood insurance, disaster relief, and subsidized loans and tax deductions for reconstruction). Incentives for local government hazard mitigation planning are limited and focus narrowly on hazard mitigation, primarily to unwise developments at risk, rather than on planning for and managing the location, as well as the character, of urban development and redevelopment.

At the time of this writing, however, legislation is pending in Congress to help local governments plan effectively for land exposed to various hazards. The Safe Communities Act of 2005 (HR 3524) was introduced in the House of Representatives on July 28, 2005, just a month before Hurricane Katrina struck the Gulf Coast. The safe communities bill authorizes grants of up to $1.25 million per jurisdiction to help states update their comprehensive planning statutes and to help localities to assess their vulnerability to hazards, prepare comprehensive plans, integrate hazards considerations into comprehensive plans and transportation plans, and to update building codes and zoning and other land use regulations so that they give adequate attention to hazard mitigation. If passed, this legislation should go far in realizing the promise of comprehensive plans to counter the potential for natural containment and smart growth containment policies to exacerbate exposure to losses in disasters.

Financial support for this research was provided by a grant from the National Science Foundation (Research Grant CMS-0100012), for which the authors are grateful. We are also indebted to the Institute for Business and Home Safety, which provided data on claims paid by insurance companies for losses in natural disasters and data on state planning and hazard mitigation laws. Our data on natural containment were provided by Professor Laura Steinberg of the Department of Civil and Environmental Engineering at Tulane University; Dade County wetland and flood hazard data were developed by Professor Samuel Brody of the Texas A&M Environmental Planning & Sustainability Research Unit. We wish to also acknowledge the assistance with this research provided by Anna Davis and Mary Margaret Shaw of the University of North Carolina. Of course, the findings reported here are not

necessarily endorsed by the National Science Foundation or those who provided assistance with the research.

Notes

1. There are many other examples. The 1978 comprehensive plan for Boulder, Colorado, also implemented a three-tiered, phased development system, in this case reinforced by a publicly owned greenbelt (Freilich 1999). Based on state enabling legislation enacted in 1976, Minneapolis-St. Paul established a regional urban service boundary in 1980 (Orfield 1997). Since 1980, urban containment policies have been encouraged or mandated by the states of Florida, Maryland, New Jersey, and Washington (Weitz 1999), and have been adopted by cities in over 100 metropolitan regions (Nelson and Dawkins 2004).

2. Our research design uses OLS regression analysis to control for other factors that can affect the magnitude of losses from natural disasters. These factors include the size of the building stock that could be damaged and a measure of income as a proxy for the value of the building stock. Data to measure the magnitude of the housing stock, number of retail establishments, industrial activity, and median household income come from *USA Counties 1998*, a publication of the U.S. Department of Commerce Economics and Statistics Administration, U.S. Census Bureau.

Before proceeding to the research findings, several limitations of the data should be noted. First, our data on losses in disasters are very narrow, since they are limited to claims payments for damage to buildings. They do not include uninsured property losses, losses to public infrastructure, losses from business interruptions, and losses to residential property from flooding or earthquakes. We assume that our insured loss data reflect other types of losses, but we do not have data to verify that assumption. Second, we found it impossible to measure and control for the severity of the hazards experienced by the samples of counties with varying degrees of containment, since records on rainfall and other hazards are not available for every county in the United States. We do not view this as a serious limitation, because in a companion study to this in which we looked at coastal flood losses and controlled for the frequency of flood events, we found that the effects of state planning requirements were similar to those we report here (see Burby 2006). Third, although every effort to be exhaustive has been made in identifying places with urban containment programs, there is some possibility that some containment programs have been missed so that the sample of places without containment may have a few places that, in fact, have containment programs of one sort or another. Also, the containment programs studied vary considerably in stringency, which should affect their impacts on land markets and development pressures in hazardous areas. For example, the programs vary in the amount of land included within growth boundaries, but it was beyond the resources available for this study to physically measure the detailed characteristics of each program. Finally, half the containment programs we studied were adopted between 1980 and 1990, so that not much time had elapsed for them to affect development patterns that could have contributed to losses experienced in disasters between 1994 and 2000. The various limitations of our containment data make it more difficult to detect the effects of containment programs on exposure to hazards and losses in natural disasters. Thus, to the extent we find such effects, readers can have some confidence that the effects are real; to the extent we do not find effects, however, one explanation (in addition to a real lack of effect) could be the crude nature of our measures and the need for more time for the effects of containment to manifest themselves.

3. Notable hurricanes causing catastrophic losses in New Orleans include storms in 1915 (25,000 buildings flooded), 1947, 1965 (Hurricane Betsy), 1969 (Hurricane Camille), 1995 (unnamed rainstorm flooded 20,000 homes), and 2005 (Hurricane Katrina); severe hurricanes striking Miami include the storms of 1926 (which killed 373 and literally destroyed the entire city), 1981 (tropical storm Dennis flooded the entire area), 1992 (Hurricane Andrew), 1999 (Hurricane Irene), and 2005 (Hurricanes Katrina and Wilma) (data from Hurricane City 2006a, b).