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Integrating Hazard Mitigation into New Urban and Conventional Developments

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Abstract

The twentieth century model of the sprawling metropolis has fostered a massive build up of highly vulnerable development. New Urbanism has emerged to counter many of the societal ills of sprawl, but there is growing concern about placing this compact urban form in harm's way. Using 33 matched pairs of New Urban and conventional low-density developments we examine how well New Urban developments located in hazardous areas incorporate hazard mitigation techniques. Findings indicate that New Urban developments are compounding the growing risk to hazards by potentially adding higher density development than in the past. We recommend changes in New Urban model codes, and public policy that places more emphasis on mitigation through comprehensive planning.

Keywords: *hazards; mitigation; land use planning; New Urbanism*

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Metropolitan areas throughout the country are increasingly exposed to disasters as development continues unabated in hazardous areas. The twentieth-century model of the sprawling American metropolis has fostered a massive buildup of highly vulnerable development (Burby 2006). Data on the buildup and subsequent disaster losses are abundant. Average annual economic losses from flood losses alone exceed $6 billion in the United States (United States Geological Survey [USGS] 2006), and losses have been rising relative to increases in population and gross national product (Cutter 2001). In the late summer of 2005, the remarkable flooding brought by Hurricane Katrina, which caused more than $200 billion in losses, constituted the costliest natural disaster in U.S. history (USGS 2006).

New Urbanism has emerged to counter the adverse outcomes of conventional low-density sprawl (Talen 2005). This pattern of development is designed to create compact, mixed-use urban forms to foster social communities by enhancing civic engagement and interactions between public and private spaces as well as to increase pedestrian movement. New Urban developments require considerably less land than conventional developments to accommodate an equivalent number of housing units as in conventional development in return for more opportunities to avoid the hazardous portion of a development site (National Research Council 2006, 59–61) and protect environmentally sensitive areas (Berke et al. 2003; Pollard 2001). From its inception in 1986 until 2003, New Urban developments have rapidly expanded throughout the nation, with 647 projects completed, under construction, or planned, which includes 559,836 dwelling units and 1.56 million residents (Song, Berke, and Stevens 2006).

Despite the increasing attractiveness of New Urban design, there is concern about placing compact urban forms in harm's way. New Urban developments have the potential to further compound the growing risk to hazards by adding higher-density development than in the past. High-density developments place more people, residential and commercial buildings, and infrastructure at risk than conventional low-density development on an equivalent land unit exposed to hazards. New Urbanism can pose a greater risk to people and property than low-density sprawl if hazards are not anticipated and hazard mitigation is not promoted.[1] The question is whether the promise of New Urbanism has translated into more disaster-resilient urban development.

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This article first presents the major technical and political challenges that may prevent building mitigation into New Urban development projects. Next, we present a conceptual framework of how New Urban design is linked to the goals of disaster resiliency and how local government project permit review practices influence use of mitigation in New Urban projects compared to conventional low-density projects. The conceptual framework is then used to comparatively evaluate thirty-three matched pairs of New Urban developments and a control group of conventional low-density developments located in floodplains throughout the United States. Finally, implications of our findings for planning practice and future research are presented.

▶ New Urbanism and the Local Government Paradox

Compared to conventional low-density development, the New Urban concept includes density, mixed-use, and pedestrian design features that create more opportunity to incorporate hazard mitigation practices (we discuss these features later). Yet two obstacles pose serious challenges that may prevent incorporation of mitigation practices into New Urban development projects. One obstacle is the lack of attention that New Urban development codes give to hazard mitigation. While the widely publicized model codes support the basic goals of community character, sense of place, and pedestrian movement, land use and design standards that support natural hazards mitigation are not specified (Calthorpe 1993; Congress of New Urbanism [CNU] 2002; Duany Plater-Zyberk & Company 2001).

Earlier versions of the *SmartCode* produced by Duany Plater-Zyberk & Company (e.g., 2001) reflect these concerns. The code offers the most comprehensive set of guidelines produced to date for creating New Urban developments. Detailed development standards are adapted to six zones along a transect system extending from urban core to rural preserves. Tables of detailed design standards for structures, vehicular lanes, civic space, and streetscapes, are provided for each zone. However, natural hazards are not considered. A generic list of sensitive areas to be protected (e.g., open waters, wetlands, wildlife habitats, and riparian corridors) is provided for rural zones, but no attention is given to hazards in urban and rural zones.

A second obstacle raised by planning scholar Raymond Burby (2006) is the local government paradox that arises when local governments fail to adopt mitigation practices even though disaster losses are primarily local. Mileti (1999, 66) found that only a small proportion of total disaster losses in the United States are covered by federal disaster relief and that most losses are not insured, as they are "borne by victims." Since the losses are primarily local, we would expect mitigation would be a high priority for local officials. The paradox is that few local governments are willing to reduce natural hazards by managing development. While significant loss could be avoided through sound planning and development requirements, the existence of this pattern of community behavior is well documented (Berke and Beatley 1992; Brody 2003b; Burby and French 1985; Dalton and Burby 1994; Murphy 1958).

Political reasons that explain the local government paradox include low priority of hazards on local action agendas relative to other issues (e.g., unemployment, crime, housing, and education); costs of mitigation are not visible like roads and schools, and costs are short term, but benefits are not likely to occur during the terms of elected officials (Mileti 1999). Economic reasons center on federal disaster policies that create disincentives for local governments (and individuals) to act. In a penetrating assessment of federal disaster policy, Burby et al. (1999) observed that federal incentives have encouraged localities to take risks they will not have to pay. Incentives include but are not limited to Federal Emergency Management Agency (FEMA) postdisaster assistance that covers 75 percent of costs for rebuilding public infrastructure, subsidized beach nourishment programs, subsidized National Flood Insurance Program (NFIP) flood insurance for residences, and homeowner tax credits that cover residences in hazardous locations. If local governments believe that the federal government will meet their needs to minimize risk and recover from every disaster, they have less incentive to spend limited resources on mitigation.

An example of post-Hurricane Katrina decision making in the eleven cities and 120-mile coastal region of Mississippi illustrates the promise and pitfalls of New Urbanism. Use of the Mississippi case is relevant to our study of New Urban and conventional development, given similarities in application of federal mitigation policies and population growth trends.[2] The extent of the devastation in Mississippi was staggering with a 28-foot storm surge, 120-mph winds, and an estimated 62,000 homes severely damaged or destroyed.[3] Coastal cities such as Bay St. Louis, Pass Christian, and Waveland were nearly obliterated. Six weeks after Hurricane Katrina struck in August 2005, the CNU—the lead membership organization that promotes New Urbanism—helped initiate the Mississippi Renewal Forum (Mississippi Governor's Commission on Recovery, Rebuilding, and Renewal 2005). This collaborative initiative assembled over 200 community leaders and professionals to formulate New Urban design options to guide the rebuilding of devastated places. The summary document produced by this initiative sets forth a bold vision for the future, indicating that the Mississippi coast "must not only recover but it must do so renewed as a better place than it ever has been" (CNU 2005, 3). Core goals related to New Urbanism include "the restoration of the pedestrian character of beachfront Highway 90 which had become a brutal [auto-oriented] highway, . . . development that must support the new transit stations, [and] . . . recovering the viability of the old commercial main streets" (CNU 2005, 3).

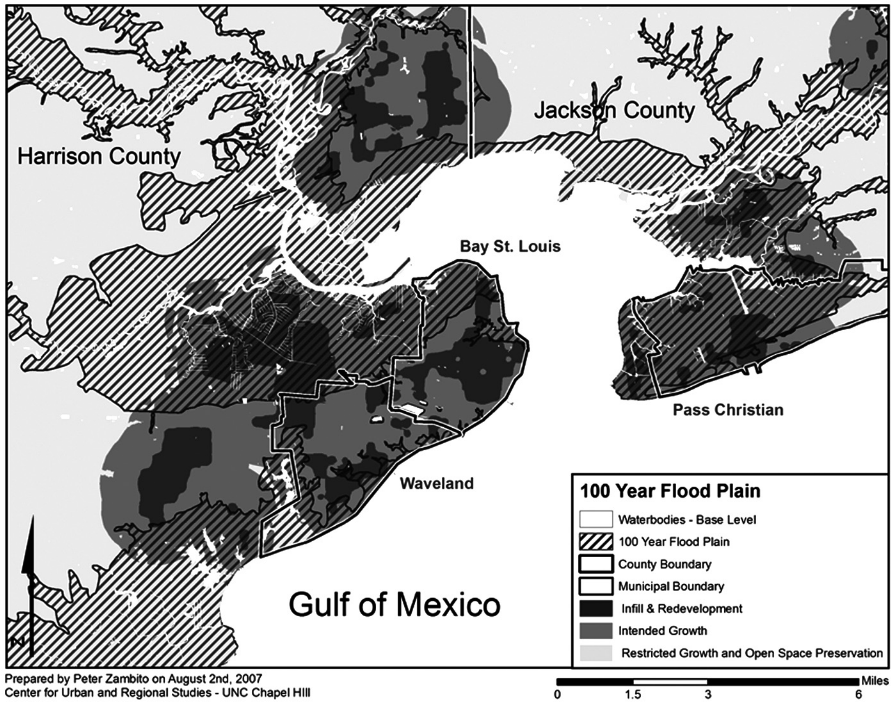

Figure 1. *Proposed New Urban growth sectors and 100-year floodplain.*
Source: Criterion, Inc. (2005), Federal Emergency Management Agency (2007a), and Zambito (2007).

However, the application of the New Urban concept to guide rebuilding after Hurricane Katrina raises concern about the vast potential buildup of New Urban developments in hazardous locations. A transect map prepared as part of the CNU regional visioning and planning initiative reveals the concern (Criterion, Inc. 2005). Six New Urban "growth sectors" were designated along the Mississippi coastal region: preserved open space, reserved open space, restricted growth, controlled growth, intended growth, and infill and redevelopment growth.[4] The sectors were delineated based on proximity to natural resources, preexisting streets and land uses, and local preferences. Using geographic information system (GIS) operations, we overlaid the transect map with the NFIP 100-year Flood Insurance Rate Map (FIRM) and the Hurricane Katrina surge penetration map to reveal the potential risk. As illustrated in Figures 1 and 2, many of the three most intense growth sectors—intended growth and infill and redevelopment—are in the 100-year flood zone and Katrina surge zones.

Although development inside the 100-year flood zone is required to meet minimum flood elevation and structural strengthening requirements of NFIP, these standards combined with federal subsidies justify development in hazardous areas under the local government paradox. This benefit has come at a cost of vastly increased exposure to catastrophic losses from disasters that meet the minimum standards (Burby et al. 1999), as in the case of pre-Katrina exposure compared to potentially greater post-Katrina exposure under the New Urban development pattern.

At issue is whether the communities on the Mississippi coast and those in similar situations throughout the nation can overcome the local government paradox by taking natural hazards more seriously and requiring that new development and public infrastructure be located and designed so as to reduce hazard risks. New Urban site design features offer new opportunities to integrate land use and site design standards beyond the minimum NFIP building elevation and structural strengthening requirements. Will local governments take advantage of the opportunities? Will they adopt standards that maximize avoidance of hazardous portions of a site and protect ecological functions of sensitive areas that provide mitigation services (e.g., wetlands and sand dunes)? If local governments have lax mitigation standards and/or lack staff capacity and commitment to implement plans and regulations, then developers of New Urban projects are likely to avoid incorporating mitigation practices (Berke 1998; Burby, May, and Paterson 1998; May and Deyle 1998). Reluctance to promote mitigation may lead to placing more people, buildings, and infrastructure in harm's way than in the past. The price for inaction will also mean that local people and businesses will increasingly bear most of the ever-mounting losses (Mileti 1999). If local governments adopt site-scale mitigation

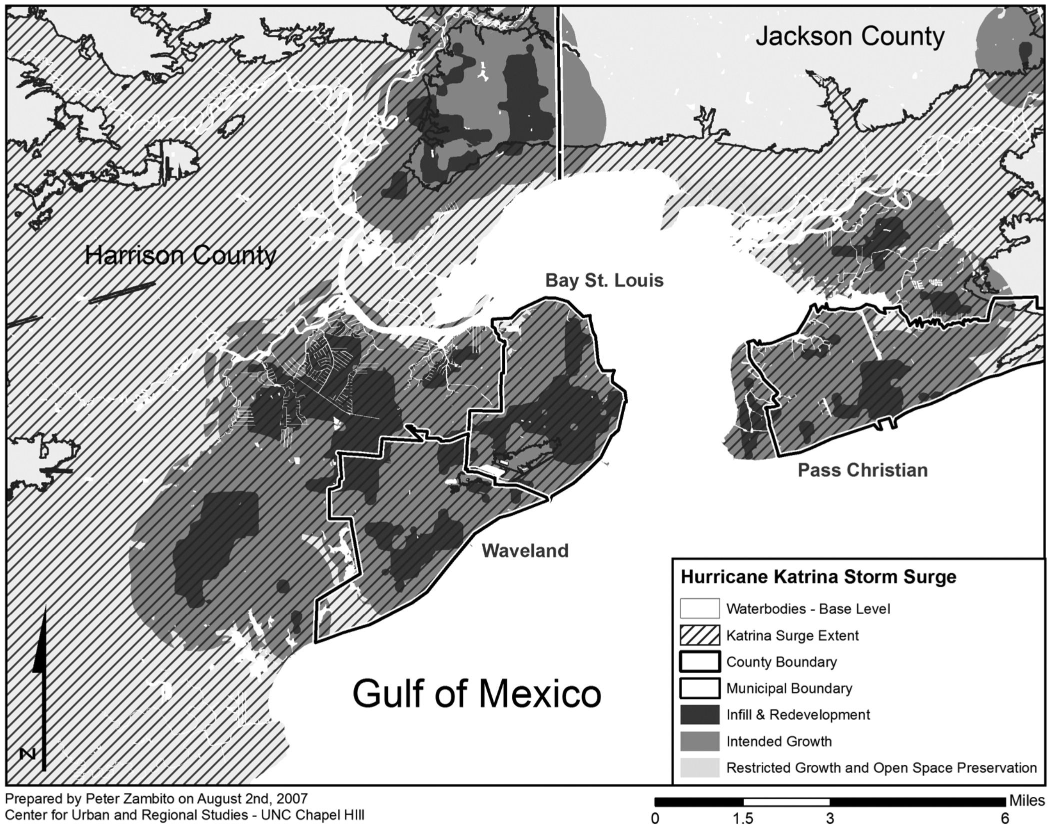

Figure 2. *Proposed New Urban growth sectors and extent of Hurricane Katrina surge.*
Source: Criterion, Inc. (2005) and Federal Emergency Management Agency (2007b).

requirements that extend beyond minimum federal building standards that stress hazard area avoidance, then the promise of New Urbanism could be translated into at least equally (or more) disaster-resilient communities relative to conventional low-density development.

► Conceptual Framework

We draw on three sets of factors that serve as a conceptual basis for a comparative evaluation of New Urban and conventional developments. One set includes various classes of hazard mitigation techniques. The next two sets focus on factors that are posited to influence use of these techniques in developments: (1) New Urban (versus conventional) design features that relate to the goals of natural hazard mitigation and (2) the strength of the local government development review process that can bring about mitigation.

Hazard Mitigation Techniques

We focus on flood hazards to gauge how well New Urban and conventional development projects integrate mitigation techniques. These techniques include a broad range of approaches. We draw on prior conceptualizations of mitigation that specify four categories of techniques (FEMA 2002; Godschalk et al. 1999):

- *Environmentally sensitive area protection* involves preventing development in floodplains and protecting flood mitigation services provided by floodplain ecosystems, upland wetlands, and natural drainage systems. Examples include wetland protection, soil and contour conservation, preservation of natural contours, minimization of fill in the floodplain, and maintenance of floodplain vegetation.
- *Stormwater best management practices* (BMPs) are used to store runoff that reduces on-site and downstream flooding as well as filtrates pollutants in runoff and infiltrate runoff to groundwater. Examples include constructed wetlands, detention ponds, and erosion control devices that prevent sediment buildup, which reduces channel size and capacity to convey floodwaters.
- *Stream channel modifications* are used to clear, enlarge, and stabilize stream channels in or near the development site to facilitate conveyance of stormwater off the site as quickly as possible. On-site flooding is mitigated, but downstream impacts are increased. Examples include structural stabilization of stream banks, clearance of debris in streams, and excavation to deepen and widen stream channels.
- *Structural protection* involves techniques to reduce structural vulnerability to floods. Examples include raising the elevation of buildings and infrastructure, structural strengthening, and building levees and flood walls.

We assume that a wider range of techniques is more effective at reducing hazard risks than a narrower range. This assumption has been made in previous studies. For example, Burby et al. (1997, 121–2) assumed that "more-effective hazard mitigation will occur when governments use more, and more varied, techniques and strategies for reducing potential losses from natural hazards." Berke et al. (2006, 590) make a similar assumption regarding stormwater mitigation techniques, reasoning that "the greater the number of techniques that are employed, the more complete and effective the mitigation strategy would be for a proposed project."

New Urban Design Features

Three design features serve as a common conceptual basis to compare the effects of New Urban with conventional developments: high versus low net density, auto-oriented versus pedestrian-oriented design, and mixed land uses versus single uses. These features have been used in comparative analyses of the effects of New Urban design on watershed protection (Berke et al. 2003), transportation (Crane 1996), and sense of place (Brown and Cropper 2001). We now discuss the hypothesized effects of each design feature on use of flood mitigation techniques for New Urban developments compared to conventional developments.

Net density. New Urban design standards require higher net density than that of conventional developments. Net density is the number of dwelling units per acre in residential use, while gross density includes the land area plus associated streets, alleys, and undeveloped open spaces (Berke, Godschalk, and Kaiser 2006; Gordon and Vipond 2005). Calthorpe (1993), for example, indicates that seven dwelling units per acre is a minimum net density for New Urban developments, compared to four dwelling units or less per acre for conventional developments.

Higher net densities than those of conventional developments are expected to create more opportunities for using nonstructural mitigation techniques. By permitting higher net densities, smaller lots accommodate an equivalent number of housing units as in a conventional development in return for open space within the New Urban development site and/or surrounding area. High net density provides more opportunities for creating common open spaces to locate BMPs, avoiding development in environmentally sensitive areas, and reducing reliance on structural protection techniques, given more room to steer clear of hazardous areas. It also reduces pressure to build on hazardous parts of a development site that would require structural protection. However, higher net density increases the likelihood of using stream channel modification techniques (e.g., widen and deepen, stabilize, and clear debris) since compact development patterns concentrate stormwater runoff rather than spreading runoff across the landscape. While these modifications induce conveyance of on-site runoff and reduce on-site flooding, they increase runoff volume and velocity, which causes stream channel scouring and erosion, destruction of stream ecology, and increased downstream flooding (FEMA 2002).

Pedestrian orientation. New Urban design deemphasizes dependency on automobiles, which may benefit flood mitigation and ecological protection. Compared to conventional development designs that use wide, straight streets to facilitate traffic flow, New Urban design includes narrow streets in grids that spread out and calm traffic. Narrow streets require less paved surface area and offer more room for sensitive area protection and BMPs. More room for open spaces and BMPs is also provided by on-street parking. While this New Urban design feature slows the flow of traffic and civilizes streets by creating a buffer between moving cars and the sidewalk, it also reduces demand for spaces in parking lots and large driveways. Narrow streets and on-street parking also reduce need for structural protection since these pedestrian design features require less space on a given site and thus offer more opportunities to avoid hazard areas. Greenways are another key feature of New Urban designs that provide pedestrian and bikeway connections among residential, commercial, and civic areas, while also offering opportunities for protecting sensitive areas and installing BMPs.

Pedestrian-oriented design may also encourage use of stream channel modifications. Narrow streets and on-street parking reduce the footprint of the New Urban development projects, which leads to more concentrated urban stormwater runoff and the need for rapid conveyance of runoff.

Mixed use. By mixing land uses, New Urban design presents an alternative to conventional developments that segregate uses and separate homes from schools, shopping and jobs, rich from poor, and owner from renter (Calthorpe and Fulton 2001; Duany, Plater-Zyberk, and Speck 2000). The criticism of conventional design includes loss of social interaction among people of different incomes, ethnicities, and household structures and declines in attachment of place and air quality due to auto dependence (Talen 1999).

Mixed uses reduce the footprint of paved areas needed for automobiles, which creates more opportunity for sensitive area protection and BMPs and less need to use structural protection controls. Placement of businesses and civic uses next to residential uses increases pedestrian accessibility, which relieves pressures for parking (Cervero and Kockelman 1997; Khattak and Rodriguez 2005; Saelens, Sallis, and Frank 2003). Demand for parking can further be reduced by locating land uses with different peak-hour parking times near each other (e.g., movie theaters next to daytime offices), which allows joint use of the same parking spaces (City of Olympia 1994). Mixing complementary uses also generates multipurpose trips wherein a single parking space can serve several trip purposes, thus decreasing demand for spaces and offering more room for sensitive area protection and BMPs, creating more opportunity to avoid on-site floodplain development, and reducing the need for structural protection. Furthermore, because this design feature encourages compactness in urban forms, it may induce greater use of stream channel modifications due to higher concentrations of runoff.

Development Review Process

While New Urban site design features offer more opportunities for nonstructural hazard mitigation than conventional development, developers are unlikely to adopt and implement these mitigation techniques unless local governments have the capacity and commitment to bring about mitigation (Berke 1998; Burby, May, and Paterson 1998; May and Deyle 1998). Prior research indicates that in addition to New Urban site design, several key activities used by local planners and their communities during the development permit review process can bring about mitigation in development projects. These activities include application of development management practices, public participation, and technical assistance.

Development management practices. Local government development management practices can reduce losses from flood hazards by influencing the location, density, type, amount, and design of development. There are various types of practices that are designed to shape urban form, reduce development impacts, and avoid (or limit) development in open spaces that include hazard areas, including regulations, incentives, critical public facilities policies, land and property acquisition, BMP standards, taxation and fiscal policies, and building code standards (Olshansky and Kartez 1998).[5] Except structural building standards, we expect that a greater number of development management practices are applicable to New Urban projects and that there is a greater chance that these practices complement and simultaneously advance mitigation goals. Because New Urban design creates more common open spaces, there is more opportunity to apply development management practices that limit or avoid floodplain development, protect sensitive areas that offer flood mitigation benefits, and use stormwater BMPs. However, we expect that development management practices associated with building standards for structural protection will be used less frequently for New Urban developments than conventional developments, given the likelihood that New Urban developments do better in avoiding flood-prone areas.

Public participation. Public participation can influence the level of citizen review and input into development review process (Brody, Godschalk, and Burby 2003; Burby 2003). Because developments such as New Urban projects have higher densities than conventional developments, it is often believed by the public that they generate greater adverse impacts (e.g., more traffic congestion, water quality degradation, and stormwater runoff) at the neighborhood scale (Burby 2003, 34; Shutkin 2001), even though they are widely acclaimed to create significant communitywide and regional benefits (Calthorpe and Fulton 2001; Duany, Plater-Zyberk, and Speck 2000). New Urban developments are thus more likely to be viewed as a NIMBY (not in my back yard) that generates neighborhood opposition. Given the heightened public scrutiny that is likely to be associated with New Urbanism, there is greater potential to integrate a wide spectrum of mitigation techniques for traffic congestion, noise abatement, and water quality protection. The heightened attention is expected to translate to greater scrutiny of hazard vulnerability and use of hazard mitigation techniques.

Technical assistance. During the project review process, planning staffs offer technical assistance to build knowledge and commitment among developers so they will be more capable and cooperative in carrying out the intentions of local development requirements (Burby, May, and Paterson 1998). Technical assistance means explaining policies and rules, clarifying issues to be addressed, providing information to applicants, and conveying advice. This assistance has a potentially important influence on bringing about mitigation in development projects.

Because New Urban developments frequently draw stronger public reaction than conventional developments and generate greater neighborhood-scale impacts (but not communitywide), we expect that planning staffs give more attention to New Urban developments. Moreover, because New Urban developments create a more complex development pattern, they are likely to require more technical assistance since they mix rather than segregate land uses, raise densities and associated impacts, and institute pedestrian-oriented streetscapes instead of well-established auto-oriented conventional development standards. Greater technical assistance brings about more scrutiny of development impacts and identification of a wider range of solutions for reducing impacts. To some extent, these solutions can be applied to hazard mitigation.

► Research Design, Data Collection, and Analysis

To examine hazard mitigation techniques and local government project permit review practices applied to New Urban and conventional developments, we developed a national sample of matched pairs of both types of developments. The initial task was to identify New Urban developments located in hazard-prone areas. We focus on flood hazards since floods are the most common and widespread of all natural disasters to which local governments must react (FEMA 2007b). Moreover, digitized maps that detect the presence of hazards at the development project site scale are widely available for flooding but not for other types of natural hazards.[6]

To determine the number of the New Urban developments that are exposed to flood risk, the following procedure was used. Through use of the *New Urban News*, an initial list of 646 New Urban developments that were completed, under construction, or in planning stage was identified in December 2003. Projects identified by the *New Urban News* had to be fifteen acres or more and include mixed uses and housing types, interconnected street networks, a town center, formal civic spaces and squares, residential areas, and pedestrian-oriented design. From this initial list, 328 projects were in the planning or groundbreaking stage and were eliminated since those projects involve a large degree of uncertainty.

Street addresses and boundaries of development sites were then used to geocode each of the remaining 318 New Urban developments. Digital versions of FIRMs for areas that correspond to the geocoded addresses of the New Urban developments were acquired from FEMA.[7] Digital FIRMs show boundaries of flood zones and Base Flood Elevations (BFEs) for the 100-year flood. The BFE is the regulatory requirement for the elevation or floodproofing of structures that takes place in the flood zone. If a community adopts and enforces at least minimum federal floodplain development standards to reduce future flood risks to new construction in flood hazard areas, the NFIP will make flood insurance available within the community as a financial protection against flood losses. Community participation in the NFIP is voluntary, but some states require NFIP participation as part of their floodplain management program. All communities in our sample participate in NFIP.

Based on the geocoding procedure, 263 of the 318 New Urban developments could be delineated. Floodplain boundaries were then intersected with the boundaries of the geocoded projects. Results indicate that 96 New Urban developments (or 36.5 percent) had floodplains inside the development site. The interested reader is referred to Song, Berke, and Stevens (2009, in press) for further details on the research methods developed for the GIS overlay procedure.

Next, a telephone survey was conducted with the lead planning staff member charged with the permit review administration to identify which of the remaining 55 developments that could not be geocoded contained floodplains. Findings from the survey indicated that 18 (or 32.7 percent) of these New Urban developments had floodplains. Thus, through the GIS overlay procedure and telephone interviewing, 114 New Urban developments were determined to be exposed to flood hazards (or 35.8 percent of the original 318 New Urban developments throughout the United States that are under construction or completed).

The next task involved development of a control group of conventional developments. Telephone interviews were conducted with the lead local government planning staff member charged with permit reviews for each of the 114 New Urban developments in each local jurisdiction. Each of these planners was asked to identify a conventional development that was most comparable of all conventional developments in his or her community to the New Urban development based on several criteria, including percentage of floodplain exposure of the entire site, size in acres, and number of housing units. We also matched in terms of location (greenfield, infill, and redevelopment)[8] and whether the project site sustained flood damages during the prior ten years. Moreover, because construction of almost all New Urban developments began during the mid-1980s, all conventional developments had to be completed by 1985 or later.

Planners identified matching conventional projects in their jurisdictions for 45 of the 114 New Urban developments that were located in the floodplain. All 45 pairs of New Urban and conventional developments were then surveyed between summer 2005 and spring 2006. A survey questionnaire using a pretested protocol was administered with the key local planning staff member for each pair of developments.[9] The protocol consisted of two sets of questions for each matched pair. One set was designed to determine whether a given development incorporated hazard mitigation techniques, including protection of floodplains and other environmentally sensitive open spaces, BMPs that retain and infiltrate stormwater, stream channel modifications, and structural protection measures. A second set was designed to identify activities pursued by local governments during the development review process for each development in the matched pair, including application of development management practices, public participation in project reviews, and technical assistance for project applicants.

For some questions, staff from other local agencies (e.g., public works and environmental services) were interviewed if the planner indicated that these staff were more knowledgeable and better able to respond accurately. Questionnaires were completed for thirty-three of the forty-five pairs of development projects (73.3 percent response rate).[10] Table 1 lists the names and locations of the New Urban developments included in the sample.

Paired-samples t-test for means across matched pairs of New Urban and conventional developments revealed no significant differences ($p < .10$ for t-tests) for the site selection criteria across the two groups of developments for percentage of floodplain exposure of entire site,[11] size in acres, and number of housing units (see Table 2).[12] These results thus allow us to be more confident about the effects of the type of development (New Urban versus conventional) on the use of hazard mitigation techniques and activities undertaken during the development review process.

Table 1.
Development projects by state and location.

State	*New Urban Development Name*	*Conventional Development Name*
Arizona	Civano (Tucson)	Wilmot Farms/Black Hawk Ranch
Florida	Cagan Crossings (Clermont)	Royal Highlands
	Carillon Town Center (St. Petersburg)	Brighton Bay
	Lakeside Village/Lakes of Windermere (Windermere)	Hunter's Creek
	Village of Bridgewater (Windermere)	Hunter's Creek
	Northlake Park at Lake Nona (Orlando)	Vista Lakes
	Pembroke Neighborhood/Cobblestone (Pembroke Pines)	Towngate
	Post Harbour Place (Tampa Bay)	Grand Hamptons
	Summerville (Homestead)	Christian's Subdivision
Georgia	Smyrna Town Center (Smyrna)	Parkview Village
Maryland	Clarksburg Town Center (Clarksburg)	Kingsview Village
	Sunset Island (Ocean City)	Harbourside at Heron Harbour Isle
	WaterView (Essex)	Walnut Point
Michigan	Cherry Hill Village (Canton)	Central Park Planned Development
North Carolina	Ayersley (Charlotte)	Cato
	Carpenter Village (Cary)	Preston Village and Preston Village North
	Meadowmont (Chapel Hill)	Parkside
	Morrison Plantation (Mooresville)	Cherry Grove
	Southern Village (Chapel Hill)	The Oaks
	Spring Brook Meadows (High Point)	Legacy at Sandy Ridge
Oregon	Fairview Village (Fairview)	Fairview Lake Estate
	Twin Creeks (Central Point)	Jackson Creek Estate
Pennsylvania	Lantern Hill (Doylestown)	Annex
	Weatherstone (West Vincent Township)	Stone Croft
South Carolina	Baxter (Fort Mill)	Mill Creek Falls
	I'On (Mount Pleasant)	Seaside Farms
Tennessee	Westhaven (Franklin)	Fieldstone Farms
Texas	Craig Ranch (McKinney)	Custer West
	Highland Park (Pflugerville)	Lakeside
	Plum Creek (Kyle)	Steeplechase
	Turtle Creek Village (Round Rock)	Ryan's Crossing
Virginia	Prince William County Center (Woodbridge)	Westmarket
Wisconsin	Smith's Crossing (Sun Prairie)	Windham Hills

Table 2.
Means for matched pairs (n = 32).

	Mean Values[a]	
Development Site Feature	*New Urban*	*Conventional*
Percentage of development site located in floodplain	24.7	26.3
Size of development site in acres	579.2	625.7
Number of dwelling units	1,376	1,326

a. Paired-samples t-values not significantly different at $p < .05$

▶ Hazard Mitigation Techniques Used by New Urban versus Conventional Developments

Efforts to integrate mitigation techniques into site designs of developments have a major influence on the vulnerability of people and property. Table 3 illustrates comparisons of the mean scores of the New Urban and conventional development sites for four categories of hazard mitigation techniques, including protection of environmentally sensitive areas that offer flood hazard mitigation services, BMPs for stormwater retention, stream channel modification, and structural protection. For each category, an index was calculated by summing the number of techniques employed by a given development (see Table A-1 in appendix for details of the technique categories).

Findings indicate that the performance of New Urban compared to conventional developments for three categories of techniques was unexpected. Mean scores for three subcategories of environmentally sensitive areas indicate that New Urban developments are not more effective than conventional developments in protecting environmentally sensitive areas—wetlands, floodplains, and soil and natural drainage contours—that offer mitigation benefits. Mean scores for use of stormwater BMPs were also not significantly different between New Urban and conventional developments. The lack of difference in performance in use of sensitive area

Table 3.
Mean number of hazard mitigation techniques used (n = 32).

	Mean No. of Techniques[a]	
Category of Techniques	*New Urban*	*Conventional*
Environmentally sensitive area protection		
Wetland protection (max = 3)	2.25	2.31
Floodplain protection (max = 3)	2.13	2.19
Soil and contour preservation (max = 4)	1.56	1.59
Stormwater BMPs (max = 5)	2.91	2.53
Stream channel modification (max = 3)	1.06	0.75*
Structural protection[a] (max = 5)	1.56	1.16*

Note: BMP = best management practice.
a. Paired-samples *t*-value that is significantly different at *$p < .05$

Table 4.
Overall means of actions taken during development review process (n = 32).

	Mean Values[a]	
Category of Actions	*New Urban*	*Conventional*
Development management practices adopted		
Nonstructural development management practices (max = 26)	12.09	10.56*
Building standards[b] (max = 2)	1.16	1.13
Public participation		
Groups active in reviewing development projects (max = 10)	3.38	2.13**
Techniques used for public involvement (max = 10)	3.72	2.19***
Technical services provided to applicants (max = 6)	3.28	2.81***

a.Paired-samples *t*-value that is significantly different at *$p < .10$, **$p < .05$, and ***$p < .01$
b.Since all surveyed local governments participate in the National Flood Insurance Program and meet minimum requirements, we expected limited variation in frequency of use of building standards. To detect strength of local effort in development management, we included two practices that exceed minimum requirements (see Table A-2 in appendix).

protection techniques and BMPs was unexpected since the New Urban design concept was hypothesized to provide more common open space to protect sensitive areas and locate BMPs. Furthermore, New Urban developments unexpectedly used significantly more structural protection techniques than conventional developments. This finding was also surprising since New Urban forms were expected to offer more opportunities to avoid floodplain development and thus reduce the need to use structural protection techniques. As noted, the benefits of greater reliance on structural protection come at a cost of increased exposure to catastrophic losses from disasters that exceed minimum structural design standards (Burby et al. 1999).

Finally, as expected, stream channel modifications were more extensively used by New Urban developments since compact urban forms are likely to generate more concentrated on-site runoff than conventional developments. As noted, while these techniques have a positive impact by mitigating on-site flooding, they can cause negative environmental impacts, including downstream flooding and degradation of aquatic ecology.

In sum, these results reveal that New Urban developments are not taking advantage of the New Urban site design features that allow for greater avoidance of the floodplain when compared to conventional site design. Compared to conventional developments, New Urban developments rely more on structural protection rather than avoidance of floodplains, protection of environmentally sensitive areas, and installation of BMPs. The buildup of New Urban developments in the floodplain appears to be a result of the local government paradox. An examination of the local development review process for the matched pairs of developments yields insight into this weak performance.

Development Review Process

Our examination of the local development review process for matched pairs of New Urban and conventional developments focuses on several categories of activities:

- Two categories of development management practices: nonstructural, aimed at limiting or avoiding development in hazardous areas, protecting sensitive areas that create ecosystem services for mitigation, and installing stormwater BMPs; and structural, aimed at building standards.
- Two categories of public participation: number of groups that participated and number of techniques used to encourage participation.
- Technical assistance to development permit applicants, including, for example, one-on-one technical assistance during plan reviews, redevelopment conferences, workshops to explain code provisions, and newsletters.

Table 4 shows comparisons for New Urban and conventional developments of mean scores for each category. An index was calculated by summing the number of items that apply for a given development by category (see Table A-2 in the appendix for items under these categories).[13]

As expected, New Urban developments are subjected to more public scrutiny than conventional developments during the development review process. Table 4 indicates that on average the level of attention was significantly higher for four of the five categories of development review activities (nonstructural development management practices, groups that participated, techniques used to encourage participation, technical services). The significantly greater mean number of nonstructural development management practices applied to New Urban sites suggests that more attention is given to shaping site designs and defining desirable urban forms, but this attention has not translated into greater use of nonstructural hazard mitigation practices that avoid hazard areas and other environmentally sensitive areas and use of BMPs.

The significantly higher mean number of interest groups involved in the development review process for New Urbanism indicates that higher-density developments associated with environmental, social, and fiscal impacts that New Urban developments generate lead to a stronger public reaction. Stronger involvement may also be due, in part, to the significantly greater number of participation techniques such as charrettes, citizen advisory committees, and open meetings that local planning staffs offer during the review process for New Urban developments. The significantly higher level of technical assistance services given by local planning staffs to applicants of New Urban development projects can also have an important influence in bringing about site designs that are acceptable to the public and consistent with local plans and development requirements. Apparently, the heightened public attention and technical assistance has not led to greater use of nonstructural hazard mitigation practices.

Finally, the only development review activity that was not significantly greater for New Urban development is the mean number of building standards that exceed minimum NFIP requirements adopted by local governments. Yet New Urban developments rely more on structural protection techniques than conventional low-density developments (see Table 3).

▶ Conclusions and Recommendations

While the New Urbanism concept has experienced success in capturing the attention of a wide audience and is emerging as a viable alternative to the dominant conventional pattern of urban development (sprawl), our findings indicate that New Urban developments have underperformed in hazard mitigation compared to conventional developments. Our research suggests that the distinction between New Urban and conventional developments does not make a difference in advancing nonstructural hazard mitigation techniques that prevent development of environmentally sensitive areas, including areas exposed to flood hazards, as well as require BMPs that mitigate downstream flooding and adverse watershed impacts. The failure to capitalize on the potential benefits of New Urban design is also revealed by the finding that New Urban developments rely more on structural protection techniques for mitigation of development that takes place in floodplains. Finally, as expected, New Urban developments more frequently use stream channel modification to handle more concentrated runoff.

Our examination of the development review process reveals inconsistent but not unexpected findings. Compared to conventional low-density developments, local governments give more attention to New Urban developments in applying land use regulatory and incentive techniques, public participation initiatives, and technical assistance. However, the heightened scrutiny has not translated into better mitigation performance by New Urban developments in use of nonstructural mitigation techniques and stormwater BMPs.

The reluctance of local officials and the public to anticipate future risks supports the local government paradox concept (Burby 2006). The political and economic costs of local government inaction are greatly discounted because federal subsidies encourage localities to take risks. This results in millions of households and businesses occupying unsafe structures in highly hazardous locations and not spending limited resources on mitigation. The threat posed by New Urbanism creates even more danger, given the higher densities promoted by this form of development compared to conventional developments.

Recommendations for Building Mitigation into New Urban Designs

These findings suggest the need for more attention toward nonstructural hazard mitigation to counter the building of high-density New Urban developments in flood-prone areas. We do not expect the federal government to make significant changes in reducing the financial incentives for coastal development. Our focus is on actions that can be taken by state and local governments and practitioners of New Urbanism to overcome the local government paradox by stimulating commitment to mitigation.

Local governments should take a stronger role in hazard mitigation by paying greater attention to proactive planning and management of New Urban developments. A high-quality plan draws attention to issues such as hazard mitigation that are often ignored, enhances communication and understanding, and provides clear guidance to implementation decisions (Berke et al. 2006). More nonstructural hazard mitigation techniques are likely to be adopted, and losses from flooding are likely to be lower in communities that prepare and implement comprehensive plans for urban development (Burby 2006).

States should adopt legislation that mandates local governments to prepare and implement comprehensive plans and require mitigation to be an element of these plans. As of 2002, only seven states require local governments to include a hazard mitigation element in local plans (Schawb 2002). Mandates lead to better-quality plans that support hazard mitigation and improve prospects for implementation (Berke et al. 1996; Brody 2003a; Dalton and Burby 1994). Better planning for hazard mitigation will foster involvement of a wider array of stakeholders that give attention to hazards, increase use of vulnerability data to better inform the process, and enhance consideration of a wider range of mitigation alternatives in the location and design of New Urban developments.

State and local government officials and planning practitioners should be aware of recent additions to the *SmartCode* (Duany Plater-Zyberk & Company 2009) that includes hazard mitigation standards. The new standards take advantage of the unique design features of New Urbanism (e.g., high net densities, pedestrian-oriented streets, and mixed land uses). The new standards also prioritize the protection of environmentally sensitive areas, given their critical mitigation services. Natural hazard researchers have increasingly supported a comprehensive approach to flood management that moves beyond traditional structural protection approaches and relies on environmentally sensitive natural systems (e.g., wetlands, riparian buffers, sand dunes, and mangroves) to manage and store floodwaters (Association of State Floodplain Managers 2007). Reliance on natural systems for mitigation requires that they be protected, which New Urban design is in concept better able to do than conventional designs.

Finally, planning practitioners and researchers should carefully evaluate New Urban developments as they are completed. The proliferation of New Urban developments offers living laboratories of new ideas on how best to integrate hazard mitigation and environmental protection strategies into urban form. They also provide test beds to deal with emerging hazards such as sea level rise and more intense weather events (hurricanes, floods) linked to global climate change. Planners should take a strong role in informing public policy debates and educating the public, developers, and policy makers about how best to advance more sustainable and disaster-resilient communities.

Appendix

Table A-1.
Categories of hazard mitigation techniques.

Technique Category	*Techniques*	*Mean*	*Standard Deviation*	*Range*
Wetland protection (3 items)	1. Minimize fill in wetlands. 2. Minimize grading in wetlands. 3. Maintain wetland vegetation buffers.	NU = 2.25 CON = 2.31	NU = 1.22 CON = 1.12	NU = 0–3 CON = 0–3
Floodplain protection (3 items)	1. Minimize fill in floodplain. 2. Minimize grading in floodplain. 3. Maintain floodplain vegetation buffers.	NU = 2.13 CON = 2.19	NU = 1.13 CON = 1.20	NU = 0–3 CON = 0–3
Soil and contour preservation (4 items)	1. Protect topsoil during construction. 2. Preserve natural drainage systems. 3. Restore natural contours on site after construction. 4. Reforestation to stabilize landslide-prone slopes.	NU = 1.56 CON = 1.59	NU = 1.22 CON = 1.10	NU = 0–4 CON = 0–3
Stormwater BMPs (5 items)	1. Excavate ponds to provide flood storage. 2. Construct wetlands. 3. Use detention/retention basins. 4. Provide compensatory flood storage. 5. Use erosion/sediment control devices.	NU = 2.91 CON = 2.53	NU = 1.30 CON = 1.32	NU = 1–5 CON = 0–5
Stream channel modification (3 items)	1. Deepen, widen, and/or line streams. 2. Stabilize banks. 3. Clear debris and/or obstructions in streams.	NU = 1.06 CON = 0.75	NU = 1.08 CON = 0.88	NU = 0–3 CON = 0–3
Structural protection (5 items)	1. Raise elevation of buildings. 2. Add fill to raise elevation of roads. 3. Additional structural strengthening for buildings. 4. Build flood control dams on streams. 5. Build flood walls and/or levees along streams.	NU = 1.56 CON = 1.16	NU = 1.19 CON = 1.08	NU = 0–4 CON = 0–3

Note: BMP = best management practice; NU = New Urban; CON = conventional.

Table A-2.
Categories of development management practices.

Practice Category	*Practices*	*Mean*	*Standard Deviation*	*Range*
Development management: structural building standards (2 items)	1. Mandatory flood proofing of nonresidential structures in floodplains 2. Require additional freeboard beyond elevation required by National Flood Insurance Program.	NU = 1.16 CON = 1.13	NU = 0.81 CON = 0.75	NU = 0–2 CON = 0–2
Development management: nonstructural BMPs (3 items)	1. Require compensatory flood storage for floodwaters displaced by development. 2. Require on-site stormwater retention. 3. Require environmental impact statements.	NU = 1.75 CON = 1.69	NU = 0.88 CON = 1.06	NU = 0–3 CON = 0–3
Development regulations (12 items)	1. Prohibition of all development in floodways. 2. Prohibition of residential development in floodplains. 3. Allow planned unit developments. 4. Allow cluster development, density transfers, and/or density bonuses. 5. Performance zoning. 6. Low-density zoning in floodplain areas. 7. Require river, stream, floodway, wetland, and/or floodplain buffers. 8. Require greenways. 9. Require setbacks. 10. Adopt traditional neighborhood development ordinance. 11. Use overlay districts for floodplain areas. 12. Require dedication and/or preservation of open space.	NU = 7.47 CON = 6.41	NU = 1.65 CON = 1.88	NU = 3–12 CON = 2–12
Development incentives (2 items)	1. Expedited review process. 2. Density bonuses.	NU = 0.50 CON = 0.19	NU = 0.67 CON = 0.40	NU = 0–2 CON = 0–1
Critical and public facilities (2 items)	1. Prohibition on extending water and sewer to serve development in floodplain areas. 2. Government policy not to locate public facilities in floodplain areas.	NU = 0.56 CON = 0.59	NU = 0.76 CON = 0.76	NU = 0–2 CON = 0–2
Land and property acquisition (5 items)	1. Transferable development rights. 2. Land acquisition program to acquire floodplain areas. 3. Development rights acquisition program. 4. Land bank program for floodplain areas. 5. Accept dedication of conservation easements.	NU = 1.47 CON = 1.34	NU = 1.05 1CON = 1.07	NU = 0–4 CON = 0–3
Taxation and fiscal policies (2 items)	1. Merit-based point system to determine the size of bond the developer must put up for the project. 2. Reduced taxation on undeveloped land to maintain open space.	NU = 0.34 CON = 0.34	NU = 0.55 CON = 0.55	NU = 0–2 CON = 0–2
Public participation: Involved groups (9 items)	1. Businesses or business groups. 2. Development groups. 3. Neighborhood groups. 4. Media. 5. Environmental groups. 6. Special district representatives. 7. Affordable housing groups. 8. Agriculture and/or forest industry groups. 9. Professional groups.	NU = 3.38 CON = 2.13	NU = 2.47 CON = 1.90	NU = 0–9 CON = 0–6
Public participation: Techniques used to encourage public involvement (10 items)	1. Formal public hearings. 2. Visioning charrettes and/or workshops for goal setting, strategies, or designs. 3. Community forums. 4. Citizen advisory committee. 5. Subcommittee(s) and/or workshop(s). 6. Interviews with key stakeholder(s). 7. Household survey(s). 8. Web site(s). 9. Telephone hotline(s). 10. Open meeting(s) where citizens talk to planning staff.	NU = 3.72 CON = 2.19	NU = 2.45 CON = 1.82	NU = 0–9 CON = 0–7
Technical assistance (6 items)	1. One-on-one technical assistance during plan reviews. 2. Predevelopment conference. 3. Checklist of items to be included on site plan. 4. Workshops to explain code provisions. 5. News letters/bulletins. 6. Audio/video tapes.	NU = 3.27 CON = 2.82	NU = 0.80 CON = 0.88	NU = 0–5 CON = 0–4

Note: BMP = best management practice; NU = New Urban; CON = conventional.

▶ Notes

1. A similar argument has been made in the area of watershed protection. While higher densities have been found to create less impact on watersheds at the regional scale, they potentially generate more adverse impacts to watersheds at the site scale (Moglen and Kim 2007; Stone and Bullen 2006). Thus, anticipation and mitigation of these impacts are critical.

2. A similarity in the Mississippi local jurisdictions and our sample of local jurisdictions with thirty-three matched pairs of New Urban and conventional developments is that both are subject to the same federal mitigation policies that offer financial incentives that support development in flood hazard areas. Another similarity is that populations were growing in local jurisdictions that contained our sample of thirty-three matched pairs of New Urban and conventional developments (29.9 percent

during ten years prior to construction of New Urban projects) and the eleven municipalities and three counties along the Mississippi coast prior to Hurricane Katrina (about 10–18 percent population growth rates during the 1990–2000 census period; for a review of Mississippi development trends and post-Katrina plans, see Evans-Cowley and Gough [2007]). Predisaster trends have been shown to be maintained and often accelerated after a disaster (National Research Council 2006). Prior studies indicate that such population growth has a positive impact on local government mitigation efforts (see, e.g., Berke et al. 2006; Brody 2003a, 2003b). A difference between the Mississippi case and our study sample is that New Urban Design (NUD) is proposed during the postdisaster recovery period rather than the predisaster period. During the postdisaster period, a "window of opportunity" phenomenon almost always occurs in which public interest peaks after a focusing event such as a disaster (see, e.g., Prater and Lindell 2000). Thus, following Hurricane Katrina, we would expect more support for integrating mitigation, including hazard avoidance practices, into rebuilding plans compared to predisaster periods. However, as noted, the obstacles posed by the local government paradox and absence of mitigation provisions in New Urban codes may explain why local postdisaster recovery plans in Mississippi do not take advantage of windows of opportunity by incorporating mitigation in the form of hazard avoidance.

3. Federal Emergency Management Agency (FEMA) (2006).

4. TransectMap software developed under the auspices of the Congress of New Urbanism was used to classify lands that are most suitable for New Urban developments (Criterion, Inc. 2005). Spatial data used for the classification included preexisting land use, street and infrastructure locations, and natural resources (e.g., wetlands, slopes, soils, and hazards). TransectMap used these data to delineate the Mississippi coastal region into six classes of growth sectors that were tailored to local conditions and preferences

5. We do not offer a hypothesis on the effects of development management on use of stream modification techniques because development management practices that specify use of these techniques were not included in our survey of matched pairs of developments.

6. Although earthquake and landslide hazard data can be identified through the United States Geological Survey (USGS), these data have been prepared with a degree of detail for viewing at a scale of 1:7,500,000 and 1:2,000,000, respectively. These data are intended primarily for display and for regional and national analysis rather than for more detailed analysis in specific areas. Acquisition of earthquake and landslide data at higher levels of accuracy appropriate for our proposed detailed analysis would require time and funds well beyond the resource limitations of this project. However, floodplain maps at the USGS 1:24,000 scale can be readily obtained from FEMA's Map Service Center. This level of accuracy accommodates our purposes that involve identification of matched pairs of New Urban and conventional low-density developments that are subject to flood risks.

7. We acquired the most accurate maps available in our effort to developed matched pairs of development projects. We acquired geographic information system (GIS) shapefiles of all available county Q3 digital flood maps from the FEMA HAZUS99 data CDs. These county Q3 floodplain data were appended using GIS to create statewide data sets. Where available, we also accessed more recent Digital Flood Insurance Rate Map (DFIRM) data for selected counties, which are available online via FEMA's hazard maps digital map/data server. Finally, we acquired "FIRMettes," PDF excerpts of scanned paper FIRMs, from the FEMA Flood Map Store for selected projects located in counties without digital flood data available.

8. Greenfield is defined as an open-space site located adjacent to or outside an existing urban development boundary. Infill is an open-space or previously developed site that was redeveloped as a New Urban development and is located within an existing urban development boundary. Redevelopment is an underdeveloped space in a developed zone.

9. The pretest was carried out for New Urban developments in which we were unable to identify a matched conventional development and that was located in the FIRM-designated floodplain.

10. Reasons for nonresponse from the local government planning staffs were because respondents were too busy. In one case, the respondent was in a jurisdiction that was heavily damaged by Hurricane Katrina and thus did not have the time to respond.

11. While the percentage of floodplain exposure of an entire site could be estimated by our respondents, it was not possible to determine the percentage of actual development on a site. Because most New Urban projects in our sample were still under construction and subject to change in spatial layout, it was difficult for our respondents to estimate percentage of development in floodplains. Moreover, FIRMs available to local jurisdictions are considered by most respondents to be too inaccurate to permit such estimates.

12. We used the paired sample *t*-tests because we selected each pair (New Urban and conventional) based on similarity of the theoretically relevant criteria (percentage of floodplain exposure of entire site, sizes in acres, number of housing units). We tested this similarity and found no statistically significant differences (see Table 3).

13. Similar to hazard mitigation techniques, we assume that a wider range of techniques for development management practices, public participation, and technical assistance is better than a narrower range.

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