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DEVELOPMENT MANAGEMENT AS MEANS OF MITIGATING THE IMPACTS OF COASTAL STORMS

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Development Management As Means of Mitigating the Impacts of Coastal Storms

Timothy Beatley and David J. Brower

Hurricanes and Urban Growth

Hurricanes and coastal storms represent substantial threats to life and property. Brinkman (1975) reports that between 1925 and 1970, over 5,000 lives were lost and $7.5 billion property damages occurred in U.S. hurricanes. The Wiggins Company has estimated that the annual combined costs of wind and surge damages may reach $5 billion (in 1978 dollars) by the year 2000 (Wiggins 1979). Recent hurricane episodes support these estimates, and suggest that, if anything, they are conservative. In 1979, Hurricane Frederick, for example, wreaked some $1.7 billion in property damages to the coasts of Alabama, Mississippi, and Florida (U.S. Army Corps of Engineers 1981).

A number of collective adjustments to mitigate the impacts of coastal storms are available. Several approaches have become popular: the federal flood insurance program; the construction (typically with federal funding) of structures, such as seawalls and groins, which reinforce the coastal environment; the use of building codes and construction standards which encourage or require that structures be better able to withstand storm forces; and the provision of post-disaster assistance, usually by federal and state governments.

We would argue that development management is a more cost-effective and efficacious method of reducing long-term storm hazards. "Development management" is defined as a system of programs and policies designed to influence the location, density, timing and/or type of development occurring in a community (see Brower et al. 1984; Godschalk, Brower et al. 1979). Six categories or types of development management measures are discussed in this paper: 1) planning; 2) development regulation; 3) land acquisition; 4) taxation, and other fiscal incentives; 5) capital facility and public investment policy; and 6) information dissemination. These techniques can all be used to reorient or redirect urban development away from the most hazardous locations. It should be noted that in the short term development management approaches may not be helpful in built-up coastal communities like Miami Beach, where high risk areas have already been completely built-out. However, in the longer term, even in built-out communities development management can be used to direct redevelopment and reconstruction as a part of the natural urban evolution or should a hurricane occur. (See McElyea, Brower, and Godschalk 1982.)

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Findings from a recent survey of hurricane prone localities in 18 Gulf and Atlantic Coast states and Hawaii indicate the extent to which development management and other mitigative programs are currently in use and the extent to which they are perceived as being effective at reducing storm hazards. The results of this questionnaire are presented in detail in the sections below. This survey was administered during the summer of 1984, and was sent to all Gulf and Atlantic coast communities containing V-zones (high hazard wave zones) designated under the National Flood Insurance Program. Surveys were mailed to 636 communities. Responses were received from 420, for a response rate of approximately 67 percent (see Beatley, Brower, Godschalk, and Rohe 1985). Responses to the questionnaire indicate heavy usage of measures which structurally alter and reinforce the coastal environment, (e.g. sea walls, revetments) and construction standards.

The survey results also indicate that many localities are managing development in ways which serve to reduce coastal storm hazards. The survey instrument provided respondents with a list of 21 development management techniques and asked that they indicate those currently in use in their jurisdiction and to rate, on a five-point scale, the degree to which each of these measures was effective at reducing storm hazards. What follows is a brief description of six different categories of development management techniques, an evaluation of their potential use in mitigating coastal storm hazards, and information concerning the extent to which these techniques are currently in use in hurricane-prone localities.

A. Land Use Planning

Land Use Plans can provide a rational basis for land use decisions. A community's land use plan serves as the guiding framework and formulation for orienting growth and development, by identifying community goals and objectives, development scenarios, and various strategies and means for their achievement. Typically such plans provide a community-wide picture of desirable patterns of development and growth and appropriate activities and uses to be permitted in particular sectors. Usually more general and less specific than zoning ordinance, a local land use plan may establish, for instance, that high hazard areas in the community should be reserved for recreational uses, or for low density development. The plan may designate these hazard areas and then provide a set of policies and standards for controlling development in them. Local plans may result in the reduction of storm hazards in their overall effect, or they may contain specific hurricane and storm hazard mitigation components. The Development Plan for Sanibel Island, Florida, for example, explicitly considers, indeed contains as a central feature, the reduction of hurricane and storm hazards.

The survey indicated that many coastal localities have land use plans, but considerably fewer plans which deal specifically or exclusively with hurricane and coastal storm hazards. (See Table 1.)

Table 1: Planning Measures

	Frequency	Percent	Average Effectiveness Rating*
1. Comprehensive/land use plan	352	83.8	2.94
2. Evacuation plan	278	66.2	3.54
3. Capital Improvements Program	222	52.1	2.55
4. Recovery/reconstruction plan or policies	88	21.0	2.99
5. Hurricane/storm component of comprehensive plan	81	19.3	3.34

N=420

*on a five-point scale

Under North Carolina's Coastal Area Management Act, coastal localities are now required to develop hurricane hazard mitigation components for their land use plans. In the relatively brief period in which this requirement has been in effect, some 15 coastal localities have developed such plans with the assistance of planning grants provided by the state. In its mitigation component, the Town of Nags Head, for instance, has delineated general mitigation goals and specific mitigation policies which will serve to guide future development decisions in ways which will reduce these hazards. (See Town of Nags Head 1984.) The CAMA regulations require that these plans consider and include the following:

> (i) a local damage classification scheme consistent with those of federal and state assistance agencies.
>
> (ii) the establishment of local damage assessment teams . . .
>
> (iii) consideration of the establishment of a "recovery task force" to oversee the reconstruction process and any policy issues which might arise after a storm disaster.
>
> (iv) the establishment of guidelines for post-disaster repair and reconstruction, including but not limited to:
>
> (a) timing and completion of damage assessments;
>
> (b) the timing and imposition of temporary development moratoria; and
>
> (c) the development standards to which repairs and reconstruction shall conform.

(v) the establishment of a schedule for staging and permitting repairs and reconstruction according to established priorities assigned to the restoration of essential services, minor repairs, major repairs and new development.

(vi) the determination of which local agency is to implement the policies and procedures contained in the post-disaster plan.

(vii) establishment of policies concerning the repair and possible relocation of public utilities and facilities. (Sec. 203 (9) (6)).

Reconstruction plans can serve, on the one hand, as general guidelines for making decisions about redevelopment following a storm or, on the other hand, may constitute very detailed instructions about which uses and site-specific areas and parcels will be permitted to be rebuilt and in what ways. The North Carolina reconstruction plans which have been developed thus far focus largely on the decisionmaking process following a storm, and the necessary institutions and components of that process. The plans, to a lesser extent, provide specific policies and information about where redevelopment should be permitted or not permitted, and under what conditions and requirements. (See Beatley 1985.)

B. Development Regulation

The most widely used development management tools are those which regulate the location, amount, density, and type of development in coastal localities. Basic types include zoning and subdivision ordinances, and variations of these standard regulations. Conventional zoning ordinances may be used to control the type (e.g., residential, commercial, recreational), intensity (e.g., bulk, height, floor area ratio, setback provisions), and density of development which occurs in high hazard areas. Examples of reductions in densities along high hazard shorelines are not difficult to find. Several localities along the highly vulnerable South Shore of Long Island, New York, have reduced permissible densities. (Long Island Regional Planning Board 1984.) Hollywood, Florida, in an effort to protect a relatively undeveloped segment of its shoreline, and to keep the area's population within existing evacuation capacity, severely downzoned this area from high density hotel and multi-family uses to single-family detached residences. In its recent hurricane hazard mitigation and post-disaster reconstruction plan, the Town of Emerald Isle, North Carolina, cites its efforts to reduce storm hazards by keeping densities down. (See Town of Emerald Isle, N.C. 1984.) The Town of Sullivan's Island, S.C., permits single-family detached units on 1/2 acre lots, keeping the extent of property at-risk on that island low. The hurricane hazard mitigation and reconstruction plan for Onslow County, North Carolina, recommends that future densities be lowered considerably in West Onslow Beach (Topsail Island), to facilitate evacuation. While it recommends a reduction in overall density for the area, it recommends more extensive reductions where the hurricane hazard is greatest. The mitigation and reconstruction plan fo for the Town of Nags Head proposes rezoning portions of its beachfront in order to prevent the future location of high density uses.

A relatively common and effective approach under this category is the requirement that new construction be setback a certain distance from the ocean's edge. These requirements can be found both at the state and local levels. In North Carolina, for instance, new multi-family structures locating in Ocean Erodible Zones (oceanfront areas) must be setback a distance of 60 times the average annual rate of erosion for that particular stretch of coast. Numerous individual coastal localities have adopted setback requirements (see Kusler 1982). Glynn County, GA, for instance, has enacted restrictions which vary depending upon the nature of the coastline (i.e., whether or not an active dune sequence exists). Sullivan's Island, S.C., has what amounts to a setback provision through the delineation of a recreation and conservation district in which development is prohibited. The reduction of damages from hurricanes and storm flooding is specifically cited in each of these ordinances as a major reason for the setbacks.

Subdivision ordinances govern the conversion of raw land into developed uses, and the type and extent of improvements made in this conversion. Subdivision regulations can control the density, configuration and layout of development. They operate in ways similar to zoning to control the amount and density of development on a particular site. The requirement of a minimum lot size can reduce the amount of new development exposed to storm hazards. Site plan review and other requirements of subdivision approval can provide the opportunity to orient the location of development sites in ways which minimize storm risks. For instance, subdivision provisions may require that new single family dwellings on lots in hazard areas be sited in ways which maximize distance from high hazard oceanfront areas.

Subdivision approval might be made contingent upon mitigative actions, such as the protection of dunes, wetlands and natural vegetation. For instance, subdivision and site plan provisions may require that structures locate a sufficient distance from protective dunes. Builders may also be required to "cluster" structures on the safest portions of a parcel, to minimize exposure to storm hazards (e.g., see Whyte 1968 for a general description of the clustering concept, and Urban Regional Research 1982, for an application to hazard reduction). In Gulf Shores, Alabama, developers are encouraged to cluster the development of new structures on the landward side of the highway, placing recreational and parking facilities on the waterside. A potentially effective strategy is to require or encourage clustering of structures on safer sites, or portions of parcels, during reconstruction. This is a primary strategy proposed for Long Island communities by the Long Island Regional Planning Board (see LIRPB 1984).

A promising alternative is to protect the option of moving a structure back from the ocean by requiring lots which are sufficiently deep for this purpose. Such areas could be considered analogous to the "repair" areas often required for septic tank use. If necessary, a structure could be moved to the landward portion of the lot, in a safer location. Concomitant with this approach would be the prohibition of immovable structures in such areas. The State of New York has established just such a system for highly eroding areas of Long Island, though it is yet to be implemented.

As we have already noted, many of these techniques may be appropriate to impose following a hurricane or severe storm. A moratorium on reconstruction is one technique which can give a locality more time to determine how it wishes to redevelop, and actions it can take which will minimize the impacts of the next storm.

Table 2 presents the survey findings concerning the use of selected development management tools. The vast majority of respondents had enacted zoning and subdivision regulations, though the extent to which these measures actually reduce storm hazards is unclear. A shoreline setback was in place in about half of the responding communities. Dune protection and special hazard area ordinances were also in use by a number of localities.

Table 2: Development Regulation

	Frequency	Percent	Average Effectiveness Rating*
1. Zoning ordinance	368	87.6	3.15
2. Subdivision ordinance	359	85.5	3.06
3. Shoreline setback	225	53.6	3.59
4. Dune protection	159	37.9	3.68
5. Special hazard area ordinance	109	26.0	3.85

N=420

*on a five-point scale

C. Land and Property Acquisition

An effective approach to reducing coastal storm damage is to prevent the development of hazardous lands through their public acquisition. Several types of land acquisition are possible. Fee-simple acquisition involves obtaining the full "bundle of rights" associated with a parcel of land. Undeveloped lands could then be maintained for open space, or other public recreational uses, for instance. (See Field Associates 1981; Kusler 1979.)

The use of fee simple acquisition poses a number of practical questions. The most significant perhaps for most coastal localities have to do with cost and how such acquisitions are to be financed. Fee-simple acquisition in coastal areas experiencing moderate or high levels of market demand will tend to be very expensive--prohibitively expensive for many communities. The purchase of already-improved land (i.e., land with homes and facilities) will be even more expensive, although damaged properties purchased in the aftermath of a storm may

reduce these expenses substantially. Where "preemption" or "right of first refusal" is legally possible this can lead to a more efficient and manageable acquisition program. Such a mechanism would essentially permit the locality to insert itself in the place of a property-buyer in any local land transaction. This would, then, allow a local government to oversee all land transactions and to expend its limited funds in acquiring only those lands which are truly threatened by development (i.e., are in fact in the process of being sold for development uses). Another approach to cost-reduction is re-selling fee-simple acquisitions, with certain deed restrictions limiting future development in hazardous areas. Proceeds from these sales could then be used, on a revolving fund basis, to fund additional acquisitions.

A locality may also be able to more efficiently use its available acquisition funds by coordinating its acquisition decisions with private organizations, such as the Nature Conservancy and the Trust for Public Land, that are actively involved in land acquisition. These organizations are often in a better position to engage in extensive acquisition than are single jurisdictions. Although their acquisition decisions are typically based on non-hazard objectives, a community may be able to influence these private purchase decisions, for instance by sharing the costs of their acquisition, or in some way facilitating them.

An alternative to fee-simple acquisition is the purchase less-than-fee simple interests in land, in which public purchases have only the right to develop the land. Under this arrangement, a jurisdiction would pay the landowner the fair market value of this right in exchange for agreeing to leave the land in an undeveloped state for some specified period of time, or in perpetuity. This is usually accomplished through a restrictive covenant which runs with the deed. While a leading reason for preferring development rights acquisition over fee-simple acquisition is that public expense will be less, this will still be very expensive. In areas where market demand is high, the purchasing of a development right will constitute the major portion of the parcel's fair market value (Coughlin and Plaut 1978). Because of this fact, this approach may be no more financially feasible than fee-simple acquisition.

Also included in this category of development management measures are relocation programs. Relocation can take at least two forms: 1) relocation of structure to another site, and 2) relocation of the contents of a structure while demolishing or putting to a new use the remaining structure(s) (see Johnson 1978). Relocation of the structure to a hazard-free or less hazardous site, while physically possible, may be economically infeasible. This will depend on the type of structure involved, and the distance over which it must be moved. Relocation of families and their belongings to new housing outside the hazard or high-hazard area may generally be a more feasible approach. This is particularly true following extensive storm damage, where demolition of damaged properties (rather than extensive reconstruction) involves fewer opportunity costs. The recent efforts in the Town of BayTown, Texas, to purchase properties in the Brownwood subdivision--an area devastated by Hurricane Alicia--are illustrative of the technique. Through the use of federal monies, some 300 destroyed or heavily damaged single family homes have been acquired. (See U.S. FEMA, September 1983; December 1983).

As Table 3 indicates, almost one-third of the respondents were using (or had used) fee-simple acquisition of hazard area parcels. Considerably fewer responding communities had less-than-fee simple acquisition programs, and almost no communities were currently using relocation.

Table 3: Public Acquisition

	Frequency	Percent	Average Effectiveness Rating*
1. Acquisition of undeveloped land in hazardous areas (e.g., for open space) (V60)	121	28.8	3.61
2. Acquisition of development rights or scenic easements (V61)	58	13.8	2.88
3. Acquisition of damages building in hazardous areas (V62)	14	3.3	3.54
4. Building relocation program (moving structures) (V63)	9	2.1	3.33

N=420

*on a five point scale

D. Taxation, and Other Fiscal Incentives

Development management may also include attempts to indirectly influence patterns of development and growth through the use of taxation and other fiscal incentives. The use of differential assessment is one such measure, and is based on the theory that by reducing the property tax burden on undeveloped parcels of land, this will decrease the holding costs associated with these lands and in turn will prolong the time to which they are devoted to non-intensive or undeveloped uses. Almost every state now has a provision for some form of differential assessment (Coughlin and Keene 1981; Keene et al. 1976). The uses which are typically eligible for such reductions are farm and forestland, open space and recreational uses. These are uses which do occur in coastal high hazard areas, and which could in turn reduce the amount of property and people exposed to the storm threat.

While differential taxation is widely used its effectiveness at retaining land in undeveloped uses is generally found to be low where the market price of land is high (e.g., Keene et al. 1976; Coughlin et al. 1977, 1981). Consequently, differential assessment is likely to be most successful in circumstances (perhaps specific locations in the

jurisdiction) where development pressures are slight-to-moderate, and where landowners are actively interested in maintaining the present undeveloped use of the land. This suggests that differential assessment will not be an appropriate tool for managing development in ocean-front and barrier island areas where market demand is extremely great and alternative non-intensive uses less available. Differential assessment will tend to be a more appropriate tool for discouraging development in bay and riverine areas subject to hurricane and storm forces.

Differential assessment will also be a more effective tool at reducing development of hazardous sites when used in collaboration with other approaches, such as the regulation of new development, the fee-simple purchase of land, and the transfer of development rights. For instance, reducing the permissible development density in a hazard location together with preferential assessment may reduce opportunity costs to the landowner enough to reduce actual conversion of hazard lands to developed uses.

Another set of fiscal approaches includes the use of special assessments and impact fees. Building in, and inhabiting, high hazard areas often involves substantially greater public costs than in similar less-hazardous sites. These costs are seen when a hurricane or coastal storm strikes, or even threatens, a locality. There are, for instance, public costs of evacuation, search and rescue, temporary housing, the reconstruction of public facilities such as roads, utilities, water and sewer lines, and so on. One public policy approach is to acknowledge that such additional public expenses will exist as a result of permitting this development to occur and to attempt to assess those who will ultimately benefit from these expenditures. This can be accomplished through several means.

One approach is to attempt to tie more closely benefits received and costs incurred through the use of special benefit assessments. A common example is a special assessment charged to property owners benefiting from the public installation of curbs and gutters, or the improvement of roads, drainage, and sewer and water services. Such assessments are typically tied to a geographically-delineated district in which property owners are generally determined to receive a distinct and substantial benefit in excess of the general benefits received by the public at-large (Hagman and Misczynski 1978). Applying this concept to storm hazard management, a locality would thus be required to delineate an area in which "special storm services" are provided, and in which residents would be subject to the special assessment.

A variation on this theme is the impact fee. Here the levy may be designed to recoup and mitigate the overall "impacts" of a project or development on the community at-large--impacts that may extend beyond the immediate environs and requirements of a project or development (see Hagman and Misczynski 1978; Stroud 1978). For instance, while a special assessment may be levied to cover the immediate costs associated with the floodproofing of sewer and water service, an impact fee might assess broader and perhaps more diffuse consequences, less clearly related to services or benefits received directly by a specific site or development.

Rather, it is less an issue of direct and visible benefits received, so much as the negative impacts on the locality created by the developer or landowner which must be mitigated. For example, the jurisdiction might levy an impact fee according to the extent to which a new project further reduces the overall ability of the locality to evacuate in the event of a hurricane. While it may not be designed to cover the costs of a specific improvement or set of improvements by which the particular development will benefit in a unique and special way, it is designed to require the developer (and presumably future residents who purchase these properties) to compensate the public for the costs of these consequences.

One potentially effective incentive to reducing the amount of property-at-risk is to permit the transfer of development rights (TDR) from a high storm hazard zone to a non-hazard or "safe" zone in another part of the jurisdiction (see generally Carmichael 1974; Costonis 1973; Rose 1975). Such a system could either be voluntary or mandatory. Under the latter, a locality would simply zone the storm hazard area so that fewer units of development are allowed (or prohibit new development entirely), and the owner of land within this zone would then be permitted to transfer all or some of this unused development density to parcels in designated safe areas, or to sell these on the open market to others who own land in areas designated for development. The locality would then permit increased levels of development in the safe zone as a result of possessing extra development rights; thus a natural market for the transfer of these rights is created. A voluntary approach would simply present this transfer as an additional option for the landowner--a way of maintaining the land in its undeveloped use if the landowner wishes. The landowner in this case would still have the option of developing his land, or selling it for development purposes.

A large-scale TDR program requires extensive information and knowledge about local market conditions and land development trends, and this can represent a major limitation. How large, for example, should the receiving zone be (by how much should the locality raise permissible densities?) to ensure an adequate demand for development rights? How readily will landowners in sending zones sell their development rights and when? One reasonable approach to these empirical limitations is to develop a modest TDR program, at least initially, with relatively small receiving and sending zones which can be monitored closely over time.

The transfer of development rights can also be viewed as a form of compensation when restrictions are placed on development in storm hazard areas. For instance, although an oceanfront landowner may be prevented from developing his land (i.e., it is now zoned for open space or recreational uses), he may be able to realize a portion of this development potential by transferring (or selling to those who will transfer) his allocated development rights to areas of the jurisdiction less susceptible to storm hazards. Viewing TDR primarily as a form of compensation raises several questions: key among them is the extent of compensation deemed to be desirable or equitable. At what point will the market value of a development right be unacceptably low as a form of compensation? If full or substantial compensation is a goal, this may require a more active role for government in the development rights market, say, by entering the market to buy rights at times when demand is low.

Survey findings suggest that taxation and other incentives are not extensively used by coastal localities in reducing coastal storm hazards. About 20 percent of the responding localities did indicate that they were using some type of development transfer measures, and about 10 percent were using below market taxation. Almost no respondents were using impact taxes or special assessments.

Table 4: Taxation, Financial and Other Incentives

	Frequency	Percent	Average Effectiveness Rating*
1. Transfer of development potential from hazardous to non-hazardous sites (e.g., clustering, planned unit development) (V59)	89	21.2	3.44
2. Reduced or below market taxation for open space and non-intensive uses of hazard areas (V57)	45	10.7	3.02
3. Impact tax or special assessment to cover the additional public costs of building in hazard zone (V58)	8	1.9	3.75

N=420

*on a five-point scale

E. Capital Facilities Policy

Coastal development--its type, location, density and timing--is highly influenced by capital facilities such as roads, and sewer and water services. Such public investments have been aptly called the "growth shapers." In this section we will briefly review the potential role to be played by the location, type and timing of capital facilities in reducing local storm hazards. Issues relating to the financing of these facilities have been discussed in a general way in the taxation and financial incentives section above. The use of particular pricing policies may also significantly affect patterns of development, but this strategy is not discussed here (see Downing 1975).

Two primary dimensions to capital facilities emerge which have implications for local storm hazard mitigation: one is geographical (where capital facilities are placed), and the other temporal (when these are placed there) (see Nugent 1976). With respect to the first dimension, a locality can develop an explicit set of capital facilities

extension policies designed to avoid high hazard areas, thus reducing the amount of development and property which is placed at risk, and reducing the potential threats to personal safety.

Redirecting capital facilities, and thus the development which accompanies them, into "safer" areas of the locality can be facilitated through several means. One is the clear delineation of an urban service area or district, in which the jurisdiction agrees to provide certain facilities and services. This district would also likely entail a temporal dimension, for example including sufficient land to accommodate further growth, under certain assumptions about evacuation capacity and public facilities. Such a practice has several advantages. It provides a long-term perspective on growth and development, and permits developers, residents and the locality generally, to visualize where and when such facilities will become available in the future (and in turn where they cannot be expected). This, in effect, modifies long-term expectations about where future development will and will not be acceptable to the community. Development pressures may tend to shift naturally as a result of this public designation, as developers, landowners and others realize that certain facilities will not become available outside of these designated areas. The provision and availability of facilities may determine the amount of overall development that can take place in a locality, and suspicions of "no growth" objectives are often held. Designation of a service area in "safer" parts of the locality, and a good faith effort to satisfy growth demands here, will tend to enhance the political and legal acceptability of such an approach.

In perhaps more intermediate terms, the locality needs a policy instrument by which to systematically identify, finance and sequence specific capital improvements. This is typically the function of a capital improvements program (CIP). Ideally, the CIP follows closely designated service boundaries, as well as the comprehensive plan, zoning and other regulatory and planning provisions. The CIP provides a specific framework for making short-term (i.e., each year) decisions about which improvements to make and where. Avoidance of storm hazard areas can be incorporated into this instrument and decision framework, as a specific CIP policy.

A close connection between the designation of service areas and the capital improvement program, and the overall planning process in a jurisdiction (including the local comprehensive plan), is essential. Such a close link will tend to enhance their effectiveness in advancing overall local objectives, and their legal fortitude. From a practical standpoint, the concept of guiding growth through capital facilities should be closely linked to the objective of reducing the public costs of such facilities and the extent of public investment at risk in high storm hazard areas. The latter is, by itself, a legitimate argument for denying facility extension. This is a facility-related reason which is likely to enhance the legal standing of hazard-sensitive capital facilities extension policy (Nugent 1976).

Opportunities may exist after a storm has occurred to implement these capital facilities objectives. It may be possible, if facilities are sufficiently damaged, that facilities such as public roads and

sewers can be rebuilt in areas which are less susceptible to damage from the next storm. Even if such facilities are not relocated, they may be repaired and reconstructed in ways which make them stronger or less susceptible to storm forces. Roads and sewers can be elevated, for instance, and sewer and water lines can be floodproofed.

It may be possible that such facilities can be reconstructed in ways that not only reduce the possibility of their own damage but which reduce other storm-related hazards. As before, the presence of certain public facilities will influence development patterns. If certain facility repairs are not permitted to occur after a storm has hit, this may preclude or discourage the private redevelopment of this area. This technique was used subtly in the Baytown, Texas, case. The option of selling-out and leaving the Brownwood Subdivision was made much more attractive to homeowners because they were uncertain that sewers and roads would be restored and maintained. As a further example, placing power and telephone lines underground after the storm will ensure safer evacuation when the next storm threatens.

A similar approach might be taken to the rebuilding or reconstruction of damaged public buildings such as town halls and fire stations. If sufficiently damaged, it may be logical to move these structures to safer sites in the locality. After Hurricane Camille, for instance, the Pass Christian Town Hall was rebuilt on higher ground, and consequently much more protected from future storm damages than it would have been if rebuilt in the same location. When structures are not relocated, it may be possible to repair or rebuild them in ways that reduce their susceptibility to future storm damages (e.g., through elevation). It may be desirable, as well, to rebuild these structures in ways which permit their usage as storm shelters.

Two types of capital facility policy were asked about on the questionnaire: the location of public buildings to reduce public investments at risk, and the location of capital facilities to direct private development away from hazard areas. Considerable use of each is indicated, although more use of the former strategy than the latter. (See Table 5.)

Table 5: Capital Facilities Policy

	Frequency	Percent	Average Effectiveness Rating*
1. Location of public structures and buildings (e.g., hospitals, schools) to reduce extent of risk to public investments (V56)	193	46.0	3.66

Table 5: Capital Facilities Policy (continued)

	Frequency	Percent	Average Effectiveness Rating*
2. Localities of capital facilities to reduce or discourage development in high hazard areas (V55)	131	31.2	3.41

N=420

*on a five-point scale

F. Information Dissemination

Classical economic theory supposes that the more informed consumers are, the more rational and allocatively-efficient their market decisions will be. This implies an additional set of mitigation strategies which aim primarily at supplementing and enlightening individual market decisions regarding the hurricane and storm threat. Several approaches can be taken in this vein.

The first approach is to seek mechanisms and processes which facilitate the effective informing of potential consumers of homes and other buildings of the actual risks associated with their location (e.g., in a high hazard district). This can be done in several ways. It might be required that real estate agents and those selling homes inform prospective buyers about the potential dangers from storm forces. Exactly this approach was proposed in Texas, but was not enacted due to opposition from real estate and development interests (e.g., Texas Coastal and Marine Council 1981). This approach has been used in California in an attempt to inform prospective homebuyers of the risks of living near earthquake fault lines (see Palm 1981). Under the Alquist-Priolo Special Studies Zone Act a real estate agent or individual selling property must disclose to the prospective buyer the fact that the property lies in a special studies zone (earthquake fault zone). A recent study (Palm 1981) indicates, however, that such a requirement has had little measurable effect on the market behavior of housing consumers. Among the problems identified are the tendency for homeowners to place a low priority on the earthquake threat, the issuance of the disclosure in the latter stages of a home purchase, a downplaying of the importance of the earthquake hazard zones, and a disclosure vehicle (e.g., a line that simply says "in Alquist-Priolo zone") that conveys little or no real information about the earthquake risk. As Palm observes, "At present, real estate agents are disclosing at the least sensitive time in the sales transaction, and are using methods which convey the least amount of information about special studies zones." (p. 102).

Consequently, if a similar disclosure approach is to be applied to hurricane and storm hazards in an effective way it must learn from the California experience. Namely, the disclosure must be provided early

in the sales transaction, preferably during the initial agent-purchaser meeting, and this disclosure must convey real and accurate information about the location and nature of the hazard. Not only should the disclosure form or process be "labeled" in a meaningful way (e.g., the home is in a "storm hazard zone" as opposed to an ambiguous "special studies zone") it must provide a full description of the nature of storm related risks. Strong resistance from the real estate industry in coastal areas can be expected, and efforts to convince them of the utility of such a process, may be essential to its success. More "passive" types of hazard disclosure might also be used. Included in this category would be requirements that hazard zone designations be recorded on deeds and subdivision plats, and public signs be erected indicating the boundaries of storm hazard areas (and perhaps the location of past storm damages).

Another approach is to attempt to reduce storm hazards by increasing information on the "supply side." This might take the form of construction practice seminars for coastal builders and developers, introducing both conventional and innovative approaches both to building and designing structures, as well as siting and planning the orientation of buildings in vulnerable locations. This approach was proposed as a primary mitigation strategy following Hurricane Alicia in 1983 (see U.S. FEMA 1983). The success of such a strategy, however, depends essentially on the integrity of builders and developers, and those who are conscious of storm threats are probably already planning their projects accordingly. Perhaps the most significant impediment to this type of private sector mitigation is that real estate development is a competitive industry in coastal regions and the incurring of substantial mitigation costs by one developer may place him or her at a competitive disadvantage. This is a major reason, for example, why building codes, subdivision restrictions, zoning ordinances, and other jurisdiction-wide requirements are to be preferred--they set general rules for all developers to adhere to, and in this sense create a common set of expectations which do not require one developer to be placed at a competitive disadvantage.

The survey results indicate that approximately one-quarter of the responding localities had in place some type of hazard disclosure requirement, which only 15 percent had been using construction practice seminars. (See Table 6.)

Table 6: Information Dissemination

	Frequency	Percent	Average Effectiveness Rating*
1. Hazard disclosure requirements in real estate transactions (V64)	107	25.5	2.92

Table 6: Information Dissemination (continued)

	Frequency	Percent	Average Effectiveness Rating*
2. Construction practice seminars for builders (V65)	65	15.5	3.22

N=420

*on a five-point scale

Conclusions

This article has briefly described a number of development management techniques which could be used to reduce storm hazards. It is important to understand that localities must select appropriate measures, according to unique local needs and objectives, and consistent with political, economic and other local constraints. We have argued that controlling and managing development in hazard zone localities represents a potentially effective, efficient and viable approach to mitigating storm hazards, as well as responding to numerous other social goals, and should be given equal consideration alongside structural measures.

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