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Rebuilding the North Carolina Coast after Hurricane Fran: Did Public Regulations Matter?

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The 320-mile oceanfront shoreline of North Carolina, one of the nation's premier vacation destinations, is frequently struck by landfalling hurricanes and extratropical winter storms. In 1996, Hurricane Fran, two months after Hurricane Bertha, inflicted an estimated \$7 billion in public and private damage, including 40,000 homes destroyed, 115,000 buildings damaged, and 25 lives lost. Post-storm rebuilding of the North Carolina coastal zone is governed by a complex array of federal, state, and local laws, of which the keystone is the state Coastal Area Management Act (CAMA). This act, as augmented by the National Flood Insurance Program and the federal Coastal Barrier Resources Act, seeks to reduce vulnerability to future coastal hazards through postdisaster adjustments in the horizontal and vertical placement of structures, among other measures. This article reviews experience in rebuilding the North Carolina oceanfront after the 1996 hurricanes to discern the influence, if any, of these laws. The research is based on review of postdisaster assessments, interviews with key personnel, news media reports, and direct observation. We found widespread compliance with vertical elevation and building codes but rather uneven application of minimum setbacks under CAMA, especially where vegetation was removed. Oceanfront structures are being built more strongly to resist wave and wind forces but are vulnerable to ongoing erosion, resulting in beach and dune scour, and possible stranding of structures below the mean high water line. Experience with temporary replacement of dunes and the shore road at North Topsail Beach

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indicates that political pressure may overwhelm the intent of Congress to limit repetitive loss costs for infrastructure, especially in areas designated under the Coastal Barrier Resources Act.

Keywords coast, hazard, hurricane, law

"Do you realize the risk that people take every day when they invest in the stock market? People every day take much more risk than buying property on a beautiful beach."

—John Starling, real estate developer
North Topsail Beach, NC
The News and Observer (Raleigh, NC)
December 21, 1989

"The thing that bothers me the most is the way we've lost the beach. It's right up to those cottages."

—Governor James B. Hunt, Jr.
The News and Observer (Raleigh, NC)
September 7, 1996

Introduction

A dramatic 320-mile chain of coastal barriers lines the coast of North Carolina from Currituck Banks near the Virginia line to Sunset Beach at the South Carolina border (Pilkey et al., 1980) (Figure 1). The Outer Banks—the northerly half of this chain—forms a narrow arc of beaches and maritime forest sheltering Currituck, Albemarle, and Pamlico Sounds and the mainland from the Atlantic Ocean. Cape Hatteras and Cape Lookout are the seaward extremities of the Banks, each the focal point of a national seashore. Offshore of the Outer Banks lies Diamond Shoals, the "Graveyard of the Atlantic," where hundreds of shipwrecks lie just beneath the waves. Southwesterly of the Banks, the lower North Carolina coast is lined with additional barriers and mainland beaches, each of storied history and distinctive landform: Bogue Banks, Topsail Island, Figure Eight Island, Wrightsville, Carolina, Kure, Holden, and Sunset Beaches. The barrier shoreline is shaped and pierced by inlets, some ephemeral and others artificially stabilized, including: Oregon, Hatteras, Ocracoke, Drum, Beaufort, Bogue, New River, Masonboro, Carolina Beach, and the mouth of the Cape Fear River (Dolan & Lins, 1986).

About one-third of the North Carolina oceanfront is in public ownership. The other two-thirds in private ownership has experienced widespread residential and commercial development over the past three decades wherever road access is available. Behind the coastal barriers, North Carolina's sounds are lined by some 4,400 miles of shoreline, much of it also in the process of development. The fishing camps and barren beaches of the 1930s gave way to summer cottages and small motels in the 1950s and 1960s, which in turn have yielded to pseudo-urban clusters of subdivisions, malls, and condos. Even in areas earlier avoided as too hazardous, such as North Topsail Island and Shell Island (Wrightsville Beach), high-rise structures have mushroomed along the oceanfront.

Coastal Hazards

Developed or not, the low-lying barrier beaches of North Carolina continually shift in response to wind, tide, storms, sea level, and human interventions. Remaining dune fields are subject to overwash during storms, and beaches oscillate in width and slope

damaged over 100 homes at Topsail Island, North Carolina, washed out the shore road and sewer line, and removed virtually all dunes and beach there (Stallman, 1996, p. 23).

Most of the North Carolina coast is subject to long- and short-term erosion. The Cape Hatteras Lighthouse, the world-renowned symbol of coastal North Carolina, was built 1,500 feet from the water in 1870, but by the 1990s was at the water's edge. In 1999, the 208-foot tower and associated buildings were physically moved about 2,000 feet landward to save them from the encroaching sea, as a National Research Council (1988) report had recommended a decade earlier. Rapidly shifting inlets also reflect the dynamism of the barrier shore. New Topsail Inlet just north of Wilmington decreased in width from 2,500 feet to roughly 1,200 feet between the 1920s and 1970s while shifting southward about a half-mile (Stallman, 1996, pp. 9–10).

Studies of coastal shoreline change indicate that over a 50-year period, more than half of North Carolina's oceanfront exhibited average annual erosion rates of two feet or more (National Research Council, 1990, p. 104). A 1988 state study estimated that of the 237 miles of ocean shoreline surveyed, approximately 70% was eroding, of which about 30 miles appeared to be receding at rates exceeding six feet per year (McCullough, 1988). North Carolina has received more direct hurricane strikes than any other Atlantic coast state except Florida (Godschalk, Brower, & Beatley, 1989). As of the late 1980s, nearly 5,000 buildings were within the estimated reach of erosion over the next 60 years, with about 770 of those threatened within the next 10 years (Association of State Floodplain Managers, 1988).

The North Carolina Coastal Area Management Act

In 1974, North Carolina adopted its Coastal Area Management Act (CAMA)¹ to reduce storm and erosion damage and to protect the biotic and recreational amenities of its coastal areas. The act involved two major approaches to reducing coastal hazards: (1) state designation and regulation of Areas of Environmental Concern (AECs) and (2) mandatory local planning in North Carolina's 20 coastal counties. CAMA established a 15-member Coastal Resources Commission (CRC) with the authority to formulate and oversee the regulation of coastal policy.² The Division of Coastal Management (DCM) administers the act and provides staff for the CRC.

AECs

The CRC designates Areas of Environmental Concern (AECs) of four basic types: (1) estuaries; (2) ocean hazard areas; (3) public water supplies; and (4) natural and cultural resource areas.³ A state CAMA permit is required for "major developments within AECs, namely those which (1) require approval from the state or federal government, (2) involve drilling, (3) occupy more than 20 acres of land or water, or (4) involve a structure with a ground area of more than 60,000 square feet. Other projects ("minor development") require a local permit issued in conformity with CAMA standards. Both types of permit decisions may be appealed to the CRC. Within ocean hazard areas, new construction and improvements that increase a structure's value by 50% or more ("substantial improvements") must satisfy wind resistance, elevation, and pile requirements based on FEMA standards and the state building code (Owens, 1984).

The CRC has long prohibited "permanent erosion control structures . . . [including] bulkheads, seawalls, revetments, jetties, groins, and breakwaters."⁴ This ban on coastal "armoring" was upheld judicially in a case involving the Shell Island Resort, a high-rise condominium and hotel on the northern tip of Wrightsville Beach (Figure 2). The structure was built in the early 1980s with the stipulation by the builders that the site was



Figure 2.

known to be hazardous and no sea walls would be permitted. Subsequently, the inlet separating Wrightsville Beach from Figure Eight Island has shifted southward, threatening to undermine the entire complex. The CRC initially opposed a variance to the state's no-armoring policy, but after the inlet moved closer to the building during Hurricane Fran, the commission reversed itself and approved the construction by the resort of a "temporary" revetment of two-ton sand bags (Richissin, 1996). (The resort also received an SBA disaster loan of \$1.5 million to repair damage caused by Fran.) After the CRC

rejected Shell Island's request to build a permanent sea wall, the homeowners association sued the state in 1998, claiming that the denial amounted to a taking of their property without compensation in violation of the 5th Amendment to the U.S. Constitution.⁵ In July 1999, the North Carolina Court of Appeals unanimously upheld the state ban on seawalls.⁶

Oceanfront Setbacks

Under CAMA, the CRC sets minimum setbacks for new development within ocean hazard areas based on average annual erosion rates, natural site features, and the nature of the proposed development. Setbacks are measured landward from the first line of stable natural vegetation or, in its absence, an approximation thereof based on aerial photographs or ground surveys.⁷ Preexisting lots that are not deep enough to meet the erosion setback requirements may be developed subject to construction standards, the 60-foot minimum setback requirement, and dune setback provisions.

Oceanfront setbacks are based on both long-term shoreline fluctuations and dramatic, short-term coastal changes. Long-term erosion rates were estimated from aerial photography taken between 1937 and 1986. Fluctuations for the entire North Carolina shoreline have now been mapped at 50-meter transect intervals. The state strives to update these data every five years.

County and Local Coastal Plans

CAMA required North Carolina's 20 coastal counties to prepare land use plans under the guidance of the state Coastal Resource Commission and encouraged municipal governments to do so as well.⁸ Such plans must address population and land use trends, resource protection, resource production and management, economic and community development, public participation, and storm hazard planning. Concerning the latter, plans should include: (1) hazard maps and narrative descriptions of hazardous areas; (2) an inventory and analysis of existing structures and land uses in hazard areas; (3) descriptions of the risks and severity of damage and an estimate of monetary losses that might be sustained in hazard areas; and (4) hazard mitigation policies for public and private facilities in all hazard areas.

By 1989, all of the counties and 90 municipalities had adopted local plans (Godschalk, Brower, & Beatley, 1989). However, according to the North Carolina Coastal Federation (Miller, 1998), "more of these plans are paper exercises that mean nothing to local governments." On September 25, 1998, the state CRC for the first time rejected a local plan for not following CRC's land use guidelines. A study of barrier island community compliance with storm mitigation policies in land use plans found that most local governments do not meet the guidelines required by the North Carolina Administrative Code (Baldwin, 2000). The study also found that the DCM and the CRC, with responsibility for plan development oversight and plan approval, respectively, placed no emphasis on mitigation in the local plans, in spite of the communities' rapid development and their vulnerability to coastal storms.

Federal Programs Affecting Coastal Development in North Carolina

The National Flood Insurance Program

All communities on North Carolina barrier islands participate in the National Flood Insurance Program (NFIP) (Federal Emergency Management Agency, 1997). As estab-

lished by Congress in 1968, the NFIP involves three major interrelated activities, namely to: (1) map inland and coastal flood hazard areas throughout the nation; (2) establish minimum land use and building standards to guide community regulation of development and redevelopment in such areas; and (3) offer affordable flood insurance to property owners within communities that adopt and enforce such standards (Platt et al., 1992, pp. 26–27). Land use management in floodplains was intended to be a central focus of the NFIP, along with actuarial insurance rates for new construction, as stated by George Bernstein, the first Flood Insurance Administrator, in Congressional testimony in 1973:

It is the combination of effective land use controls and full actuarial based rates for new construction that makes the national flood insurance program an insurance program rather than a reckless and unjustifiable giveaway program that could impose an enormous burden on the vast majority of taxpayers without giving them anything in return. (U.S. Congress 1973)

The 1973 Flood Disaster Act⁹ added “flood-related” coastal erosion as an insurable hazard under the NFIP: “(c) The term ‘flood’ shall also include the collapse or subsidence of land along the shore of a lake or other body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels. . . .”¹⁰ The act also reaffirmed that land use planning would be prerequisite to federal flood insurance and disaster assistance:

The purpose of this act . . . is to: (3) require states or local communities, as a condition of future federal financial assistance to participate in the flood insurance program and to adopt adequate flood plain ordinances with effective enforcement provisions consistent with federal standards to reduce or avoid future flood losses. . . .¹¹

Special limits on development are required within “coastal high hazard zones” (V-zones) as mapped by FEMA along open ocean coasts and some bay and Great Lakes shorelines. A coastal high hazard is defined as “an area of special flood hazard extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high velocity wave action from storms or seismic sources.”¹² They are based on a computer simulation of the reach of a three-foot breaking wave during a 100-year flood. Despite the imposing term “coastal high hazard area,” FEMA allows new construction in V-zones as far seaward as “the reach of mean high tide,” as long as the structure is elevated and does not encroach on dunes or mangrove swamps.¹³

But oddly, erosion hazard areas are omitted from NFIP maps even when such data have been published by states like North Carolina. Erosion is not reflected in NFIP land use standards or in rating of flood insurance premiums.¹⁴ The NFIP has nudged recent shoreline development upward but not landward. Structures built or substantially improved in communities where the NFIP is in effect must be elevated to or above the specified 100-year flood elevation (plus wave heights) or else insurance premiums will be prohibitive and a building permit may be denied by the local government. Elevation, however, does nothing to retard erosion: retreating shorelines will simply continue to move toward and beneath the elevated structure until collapse eventually occurs. Of course, once utilities, septic fields, and safe access and egress are disrupted, a structure becomes legally uninhabitable. If not demolished or moved, it may persist as a derelict hulk towering over the surf zone, obstructing public use of the beach. A recent study conducted pursuant to the Flood Insurance Reform Act of 1994 (Sec. 577) reported that over the next 60 years, erosion may claim one out of four houses within 500 feet of the U.S. shoreline (H. John Heinz III Center, 2000). The report urged FEMA to reflect erosion hazards in NFIP maps and insurance rates.

Coastal Barrier Resources Act

After a spate of hurricanes in the late 1970s, Congress was persuaded that flood insurance and other federal benefits actually encourage development on coastal barriers. The Coastal Barrier Resources Act of 1982 (CBRA)¹⁵ prohibited new flood insurance coverage, shoreline and access projects, and other federal development incentives within a series of undeveloped, unprotected barriers designated as the Coastal Barrier Resource System (CBRS). The system initially included nearly 200 segments of coastal barriers identified by the U.S. Department of the Interior. The system was enlarged in 1990 to include 560 units involving 1.3 million acres and 1,200 shoreline miles (Beatley, Brower, & Schwab, 1994, p. 90). CBRA units may still be developed privately without federal benefits. In other coastal areas not covered by the CBRA, federal flood insurance and other benefits remain in effect.

Federal Disaster Assistance

Under a long succession of disaster relief acts dating back to 1950, the nation has committed tens of billions of dollars to relief and recovery from natural disasters. The Stafford Disaster Relief and Emergency Assistance Act ("Stafford Act")¹⁶ and its predecessors provided that federal disaster assistance is: (1) limited as to the scope of federal assistance to be supplied; (2) contingent upon a presidential disaster declaration; and (3) limited as to amounts of federal funding to be allocated to disaster relief (Platt, 1999). But these limitations have been eased over time as declarations have become more plentiful and generous. During the 1990s, FEMA spent more than \$25.4 billion on declared disasters and emergencies compared with \$3.9 billion during the 1980s.¹⁷ The 1999 hurricane season produced 17 disaster declarations, surpassing a record set in 1985. Hurricane Floyd that year alone spawned 13 presidential declarations for states extending from Florida to Maine (Maiolo et al., 2001).

The Stafford Act (Sec. 409) requires that states or local governments receiving disaster assistance: "shall agree that the natural hazards in the areas in which the proceeds of the grants or loans are to be used shall be evaluated and appropriate action shall be taken to mitigate such hazards, including safe land-use and construction practices. . . ."¹⁸ However, researchers at the University of North Carolina have found that this provision is a dead letter in terms of eliciting significant mitigation actions and that "Section 409 reports" are routinely prepared solely to qualify for (more) federal assistance (Kaiser & Goebel, 1999; Godschalk et al., 1999).

The foregoing has summarized state and federal provisions that affect rebuilding after a coastal disaster in North Carolina. The remainder of this article explores the question as to whether these elaborate state and federal rules have made any difference in North Carolina's recovery from Hurricane Fran.

Hurricane Fran and the North Carolina Coast

From 1996 to 1999, six hurricanes struck North Carolina (Bertha, Fran, Bonnie, Dennis, Floyd, and Irene). Since a previous cluster in 1954–1955, only one damaging hurricane had hit the state (Donna in 1960). During the relatively calm period of 1955–1996, a building boom occurred along the coast, setting the stage for the onslaught of the late 1990s.

Hurricane Bertha struck North Carolina near Wilmington on July 12, 1996, with sustained winds over 105 miles per hour (mph) and drenching rains. Bertha battered buildings, downed trees, eroded beaches, toppled mobile homes, damaged fishing piers,

and left about 160,000 homes and businesses without power. Two people died, at least 127 homes were destroyed, and over 650 structures suffered major damage. According to an account in *The New York Times*:

Pounding surf gouged through high dunes protecting the beaches leaving many homes teetering closer to the water's edge and in a few cases, toppling houses into the sea. On Topsail Island . . . the authorities estimated that 40 houses were severely damaged. . . . In some places, the surf had eaten away up to 50 feet of beach. (Janofsky, 1996)

This was the state of the North Carolina coast when Fran arrived two months later on September 5 as a low Category 3 hurricane. Maximum sustained winds were approximately 115 mph with a minimum central pressure of 954 millibars. Fran generated storm surges of up to 12 feet along the southern barrier islands of North Carolina extending from Cape Fear near Wilmington to Bogue Banks. The storm moved inland at about 10 mph, delivering up to 12 inches of rain in some areas and with gale force winds measuring up to 69 mph at the Raleigh-Durham Airport. Coastal and inland flooding, wind damage, and falling trees ravaged eastern North Carolina except for the Outer Banks, which escaped serious harm.

Hurricane Fran was estimated to be a \$7 billion disaster, including governmental, insured, and uninsured losses—one of the costliest hurricanes in U.S. history.¹⁹ The indirect costs upon social communities, businesses, and the environment would drive that total even higher. In North Carolina, the following were estimated levels of damage or losses due to Fran²⁰:

- 25 lives lost,
- over 40,000 homes destroyed at a total cost of \$2.24 billion,
- over 115,000 structures damaged in five coastal counties,
- 891 businesses damaged at a total cost of \$50 million,
- 8+ million cubic yards of debris removed at a cost of \$200 million,
- \$2 billion in crop and timber losses,
- 150 miles of coast damaged,
- \$1+ billion in damages to public facilities,
- power outages affecting 1.8 million people,
- six ocean piers destroyed,
- 4,000–5,000 recreational and fishing boats destroyed or damaged.

With the shore already weakened by Bertha, Hurricane Fran caused more property damage in North Carolina than any other hurricane prior to Floyd in 1999. Coastal damage affected close to 90% of oceanfront homes along the 100-mile stretch of barrier islands from the Cape Fear River to Bogue Banks.²¹ The worst coastal damage was experienced at Topsail Island, a 26-mile heavily developed barrier (discussed below). Erosion under oceanfront houses there averaged 4–6 feet of vertical loss of sand (Federal Emergency Management Agency, 1997).

On the day that Fran struck, North Carolina Governor James B. Hunt Jr. requested a presidential major disaster declaration for the state (see quotation at beginning of this article). The declaration was granted the following day by President Clinton, authorizing 100% federal funding for the first 72 hours and a 75% federal share thereafter. In December, the federal share was increased to 90% upon petition from the state claiming that total disaster-related expenses from Fran exceeded \$64 per capita.²² A total of 58 counties in central and coastal North Carolina were included in the declaration and were eligible for federal disaster benefits. Federal costs within the state relating to Fran eventually amounted to nearly \$850 million (Table 1).

Table 1
Federal outlays: Hurricane Fran, North Carolina, through August 26, 1997

Source	Applicants	Amount
FEMA Individual Assistance (IA)		
Disaster Housing Payments	25,188	\$39.3 million
Individual and Family Grants	10,911	\$23.3 million
Unemployment Payments	1,527	\$0.6 million
FEMA Public Assistance (PA)	4,088 projects	\$211.6 million
FEMA Hazard Mitigation Grants	7 communities	\$23.4 million
FEMA transfers to other agencies (incl. Army Corps of Engineers)		\$211 million
SBA disaster loans	5,673	\$108.6 million
National Flood Insurance payments	6,610	\$126.9 million
U.S. Department of Agriculture Emergency Conservation Program		\$14.7 million
NRCS		\$25.1 million
U.S. Department of Transportation		\$17.7 million
U.S. Department of Housing and Urban Development*		\$35.7 million
Total Federal Outlays (approx.)		\$837.9 million

*Lowe's Storm98 Hurricane Central Web Site (August 19, 1997).

Source: Federal Emergency Management Agency Website (May 9, 1998).

Exploring Mitigation: Post-Fran Advisory Reports

In the aftermath of Bertha and Fran, several studies sought to identify opportunities to reduce future vulnerability to hurricanes in North Carolina. The principal postdisaster assessments are summarized below.

1. A *Disaster Recovery Task Force* was established by Governor Hunt on October 10, 1996 to recommend disaster recovery actions for the state. Among the 84 recommendations in its report²³ of February 14, 1997, the task force proposed that the state
 - require full disclosure and "hazard notification" to persons acquiring property on barrier islands;
 - restrict state subsidies and support of development in designated high hazard areas on barrier islands;
 - review Flood Insurance Rate Maps (FIRMs) and urge FEMA to update coastal FIRMs;
 - provide funding for mapping or provide incentives to local governments to undertake mapping;
 - evaluate the effectiveness of hazard mitigation rules and designated ocean hazard areas;
 - evaluate local land use plans for mitigation and disaster recovery;
 - retain sand in place for use on the beaches while removing debris from barrier islands.
2. *The Godschalk Report* (Godschalk, 1998) addressed four interlocking issues of coastal hazard mitigation, namely, how to (1) *define* coastal hazard areas, (2) *notify* the public about hazards, (3) *limit* public subsidies for development in hazard areas, and (4) *acquire* threatened property in hazard areas for public purposes. It called for improved delineation of coastal hazard zones using a combination of (a) NFIP V-zones, (b) North Carolina CAMA areas of critical concern (AECs), and (c) hurricane hazard areas mapped by the Army Corps of Engineers. It urged the adoption of a state law to require sellers to inform buyers of the hazard risk pertaining to specific coastal properties, however they are defined. And it advised the state to withhold state expenditures that undermine the federal Coastal Barrier Resources System.
3. The North Carolina Division of Emergency Management and FEMA, pursuant to the Stafford Act (Section 409), jointly released a *Mitigation Strategy Report* (State of North

Carolina, 1997) five months after the disaster. The report was intended to serve as a blueprint for hazard mitigation projects to be cost-shared by FEMA and the state at a ratio of 75/25 with potential joint funding totaling \$100 million. Its four primary concerns were:

- principal dwellings: acquisition, relocation, demolition, or elevation of chronically flooded properties;
- critical public facilities: relocation, retrofitting, or floodproofing of water and other public facilities;
- business recovery: floodproofing, windproofing, and relocation; and
- storm water drainage improvements.

In addition to statewide recommendations, the *Mitigation Strategy Report* called for coastal storm surge modeling studies as a basis for a revision of FEMA's flood hazard maps to "encourage more stringent building codes, subdivision ordinances, and improved land use practices." The report also urged that the state require the implementation of local plans as well as consistency between those plans and local zoning and subdivision regulations. It also urged that better public information be provided by the state and realtors concerning limitations on federal flood insurance within Coastal Barrier Resources Act units.

4. FEMA deployed a Building Performance Assessment Team (BPAT) to coastal North Carolina to assess damage to structures caused by Fran. In the worst affected areas, its report documented a loss of sand under structures of 4–7 feet due to erosion and scour (FEMA, 1997). Over 100 structures were found to have collapsed due to inadequate depth of pilings, particularly those built before state embedment depths were increased in 1986. Also several hundred decks and porches were found to have collapsed as a result of insufficient foundation and piling support. In general, it found that structures inland from the oceanfront which were built to NFIP and state specifications survived relatively intact.

Each of the four reports summarized above appeared several months after Hurricane Fran. Their potential usefulness as guides to public policy revisions was therefore diminished; i.e., the "window of opportunity" for the adoption of new legislation had passed. The FIRMs for affected coastal areas were revised by FEMA based on post-Fran ground and aerial measurements. However, the state has not acted on recommendations concerning mandatory disclosure of hazards to buyers or elimination of state subsidies within CBRA units.

The FEMA BPAT report suggested ways to strengthen structures to withstand hurricanes, but the unstated implicit message is that those inland from the oceanfront fared much better. In general, improvement of building durability on a disappearing beachfront may be compared with redesigning the *Titanic's* deck chairs to float.

Rebuilding on the North Carolina Barriers

Three days after Fran, the *Wilmington Morning Star* (1996) reported that "Fran destroyed an estimated 90% of the structures [at North Topsail Beach]" and the Governor was weighing a ban on rebuilding there. This ban was not implemented, but residents were prohibited from returning to their properties for a month. Rebuilding was fueled by a massive infusion of federal assistance (excluding flood insurance) amounting to nearly \$115 million for the three coastal counties hit most directly by Fran: Pender, Onslow, and New Hanover (Table 2). One year after Fran, federal disbursements to three barrier islands, Topsail, Wrightsville Beach, and Pleasure Island (including Carolina and Kure Beaches), were estimated at \$10,500 per year-round resident (Whitlock, 1997).

The Road at North Topsail Beach

Between 1982 and 1989, 12 oceanfront condominium, hotel, and townhouse projects involving over 1,400 units were approved by Onslow County for the hazardous northern end of Topsail Island (Olson & Vance, 1989). In 1990, the area incorporated as the

Table 2
Federal disaster assistance allocated to three North Carolina coastal counties
after hurricanes Bertha and Fran (excluding flood insurance payments)

	Housing grants		SBA disaster loans		Public assistance		Total*
	No.	Amt.	No.	Amt.	No.	Amt.	
Pender Co.	1,616	\$2.8 m	429	\$7.2 m	10	\$4.6 m	\$16.5 m
Onslow Co.	2,034	\$3.3 m	473	\$13.0 m	9	\$16.2 m	\$34.7 m
New Hanover Co.	3,006	\$4.1 m	1,015	\$31.0 m	9	\$23.7 m	\$63.0 m
Three counties	6,656	\$10.2 m	1,917	\$51.2 m	28	\$44.5 m	\$114.2 m

*Includes Individual and Family Grants (IFGs) not shown in table.

Source: Federal data reprinted in Godschalk (1998, App. 3H).

town of North Topsail Beach to limit further high-rise development and improve local services. Proposals for further growth appeared, however, drawing a warning from Duke University coastal geologist Orrin H. Pilkey in a letter to the state governor: "It is our opinion that the physical danger to inhabitants on North Topsail Island has reached an unconscionable level. *This may be America's most dangerous barrier island development in terms of human hazards.* It also ranks very high in its potential for property damage."²⁴

The shore road (S.R. 1568) serving North Topsail Beach was overwashed and damaged by both Bertha and Fran. The road had long been contentious and vulnerable. In the 1980s, the state and private developers had relocated the road slightly landward to facilitate construction of high-rise development along the oceanfront. In 1991, the state withdrew the road from the federal highway system in order to avoid the need for federal permits. In 1993, the state asked the Federal Highway Authority to take it back so that it would be eligible for federal repair funds in the event of further damage. At least half the length of the road within North Topsail Beach lies within a CBRA unit designated by Congress in 1982 where no new federal expenditures or new financial assistance is allowable. However, the CBRA exempts from this ban "repairs" of roads that are "essential links in a larger network or system." Under this exception, S.R. 1568 was repaired at a cost of \$200,000 after Bertha and another \$376,000 after Fran, a total of \$576,000, of which the federal share amounted to between 75% and 90%. By contrast, the total cost of road repairs for the other two-thirds of Topsail Island was \$458,000 (Godschalk, 1998, pp. 62-63).

The Emergency Dune

Another infrastructure issue concerned the reconstruction of dunes along Topsail Island which were substantially overwashed by Bertha and Fran. Whereas dune damage at Wrightsville Beach and Carolina Beach was eligible for restoration by the Army Corps of Engineers under their ongoing projects at those sites, Topsail Island does not have an approved Corps nourishment project. Its dunes have long fluctuated in height and width according to storm activity, sand supply, and local beach scraping with bulldozers.

The presidential disaster declarations for Bertha and Fran extended the benefits of the Stafford Act to the three Topsail Island communities. FEMA is authorized to provide assistance for restoration of beaches and dunes in selected locations after declared coastal disasters. Beach nourishment is authorized under two authorities: (1) "Emer-

gency Facilities” (limited to a five-year level of protection)²⁵ and (2) “Permanent public works—parks, recreational, and other” (limited to “engineered beaches” built to Corps of Engineers specifications).²⁶ Beach nourishment also may potentially be eligible for FEMA hazard mitigation grants (HMGs) if estimated to be cost-effective.²⁷

FEMA beach restoration activities have been modest in number and cost so far, but political pressure can be expected to grow as beaches continue to erode and structures are endangered. FEMA can act much faster than the Army Corps of Engineers, which requires a specific congressional authorization and extended period for design and environmental impact assessment. FEMA reimburses for 75% of project costs (90% for Fran) versus 65% or less under Corps programs. Also, FEMA is a less visible political target for opponents of beach nourishment since these efforts are included in the overall process of disaster recovery, which is politically popular in the affected area.

FEMA paid \$4.6 million in Public Assistance (PA) funds to restore a “five-year berm” along 15 miles of Topsail Island in the communities of Surf City and Topsail Beach. Much of the sand for this purpose was pumped into the beach by the Corps of Engineers using material dredged out of the Intracoastal Waterway and the New River Inlet. (Although the Corps had no authorized project to renourish Topsail Island, it provided dredge spoil pursuant to an opinion of its legal department.)²⁸ Other sand was trucked back to the beach from overwash areas on the island. Still more was scraped up from the beach face by bulldozers. The result was a low (4–5 foot) sand ridge of various grain size and color along the landward edge of the beach just in front of the building line (Figure 3).

FEMA, however, drew the line at funding beach nourishment within the CBRA portion of North Topsail Beach, where the most severe damage had occurred on Topsail Island. A low berm was temporarily established there through state, local, and private beach scraping.

The “five-year berm” provided little or no protection: most homes were elevated well above the five-year storm elevation. A Fish and Wildlife biologist described the project as “a useless, feel-good project” (Whitlock, 1997). A representative of the Corps



Figure 3.

of Engineers in Wilmington declared: "From an engineering perspective, [the emergency dunes] have very little protective value. The experience I have with them is that they generally don't last, even with grass on them" (Whitlock, 1997). These assessments proved accurate: at least half of the post-Fran emergency dune was washed away by Hurricane Bonnie in 1998 (Figure 4).²⁹

Rebuilding Residential Property

The state Disaster Recovery Task Force estimated that 115,000 structures were damaged or destroyed in the five North Carolina coastal counties struck by Bertha and Fran. Due to the enormity of the damage, precise structure-by-structure data on rebuilding practices are unavailable. There is no reliable community or state database that encompasses: the rebuilding of coastal areas in North Carolina.³⁰ In general, the rebuilding process was haphazard and subject to differing definitions and objectives of local, state, and federal authorities.

The state Coastal Area Management Act delegates many key actions to local and county governments. The rebuilding or repair of a damaged structure requires a CAMA "minor permit" which "shall be obtained from the appropriate city or county."³¹ A further local determination that is critical to the rebuilding process is whether a structure is "substantially damaged." This concept is fundamental to both the state CAMA and the federal NFIP. Structures so declared may only be rebuilt in compliance with all current federal, state, and local regulations pertaining to siting and construction. Thus a "substantially damaged" structure must conform to current minimum elevation and setback regulations in effect at the time of rebuilding (even if adopted after the disaster event). However, a structure not found to be substantially damaged is "grandfathered" and may be rebuilt with the predisaster elevation, position, and footprint (unless the lot itself has been washed away) (Figure 5).



Figure 4.



Figure 5.

“Substantial damage” is defined somewhat differently under the federal NFIP and the North Carolina CAMA. The former defines the term as “damage of any origin sustained by a structure whereby the cost of restoring the structure to its before-damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred.”³² The state also uses the standard of damage exceeding 50% of predisaster value as the threshold for compliance with all current land use and building requirements.³³ But, as administered by local building officials, determinations of “substantial damage” after Fran varied widely from one jurisdiction to another. According to staff of the state Coastal Management Division: “Some counties and towns used tax valuations to estimate pre-storm values; others used replacement costs; and still others used market value. We quickly realized that these differences would make it difficult for us to apply coastal management rules evenly throughout the coastal counties with storm damage” (Pate & Davis, 1997).

Even more problematic, North Carolina and FEMA weighed different factors in determining the degree of damage to a structure:

FEMA is concerned with the costs of restoring a structure to its pre-storm conditions, including interior work. At the Division of Coastal Management, we are concerned with the costs of returning the structure to compliance with state building codes and safety standards. Had we adopted FEMA’s repair estimates, hundreds of additional structures would have required rebuilding permits—and many of those would not have been allowed back. (Pate & Davis, 1997)

The problem of coordination between the state and FEMA led to the development of a software program using local information on building costs and standardized methods for damage assessment to serve the needs of both programs (Pate & Davis, 1997). But the delivery of this software to local jurisdictions came so late in the rebuilding process that it was little used.³⁴ By the time it became available several months after

Fran, local building inspectors had made hundreds of judgments regarding whether individual structures were "substantially damaged." While there is no precise accounting as to how many buildings were so designated, coastal engineer Spencer Rogers estimated the total at about 200 structures.³⁵

Where substantial damage was found, rebuilding required compliance with federal elevation and V-zone regulations under the National Flood Insurance Program (whether or not a structure actually was covered by flood insurance), as well as with state erosion setbacks under CAMA. A coastal disaster like Fran often renders obsolete the zone boundaries and elevations designated in predisaster FIRMs. In part, this is because FIRMs do not reflect the effects of short- and long-term erosion. Indeed, many coastal FIRMs are chronically inaccurate due to the continuous process of shoreline change. Fran devastated the dune line of Topsail Island and nearby coastal areas. It also scoured several feet of sand from beaches, of which part was deposited landward of the beach through the process of wave overwash and part was drawn seaward and along the shore.

As part of its new emphasis on hazard mitigation, FEMA undertook to remap coastal areas affected by Hurricane Fran. Within a few days after the storm, a team of coastal engineers from Dewberry and Davis, Inc., under contract with FEMA developed a new set of shoreline positions and elevations using satellite-based GPS and GIS technology. Based on this new data, a new set of coastal FIRMs was developed that raised minimum base flood elevations (BFEs) and expanded the landward extent of the V-zone on Topsail Island, in some cases all the way to the landward side of the island.

The technical ability to update FIRMs, however, had leaped ahead of the legal process for map revisions. Under a procedure established in the 1970s, FEMA regulations prescribe a lengthy period of comment, publication, and revision of local ordinances, altogether lasting as long as a full year.³⁶ Clearly, this would have been too protracted to influence the rebuilding process after Fran. However, mitigation staff from FEMA's Region IV office in Atlanta presented the maps to the coastal communities to enlist their voluntary compliance with them, pending formal adoption. Despite some rancorous meetings, several coastal communities agreed to use the new elevations and V-zones in issuing permits for rebuilding substantially damaged structures. The exact number of buildings rebuilt under the new maps is unknown.

Substantially damaged structures were also subject to state erosion setbacks under CAMA. Once again, the enforcement of state rules was a local function, with technical assistance provided by the state. A major problem was that the baseline from which setbacks were measured was the first line of stable, natural vegetation, and Fran had erased all vegetation from many areas of the shoreline. Working with local governments, the state devised a method to estimate where the vegetation line would be expected to reappear. Under a temporary rule of the state Coastal Commission, the Division of Coastal Management measured the extent of recession in the vegetation line, where still visible, due to Fran with respect to where it stood in a set of aerial photographs taken just after Bertha. By subtracting the distance the line receded from its pre-Fran location (ranging from 5 to 70 feet), the state established lines from which to measure setbacks in areas where no vegetation remained (Pate & Davis, 1997, p. 125).

Field measurement of the setback from the reference line (either actual vegetation or the state's estimated line) is largely a local determination, as with the other elements of the rebuilding process discussed above. Also, there is evidently some uncertainty about exactly what comprises the seaward edge of a structure. Decks, pools, and other appurtenant features are observed to encroach into the setback area in certain cases. But conversely, some lots have been declared unbuildable for failure to contain enough space landward of the CAMA setback.

Conclusion: Did Public Regulations Matter?

The results of the post-Fran rebuilding process in North Carolina are mixed, a product of conflicting public policy signals. The shoreline at Topsail Island, in particular, is a mosaic of public and private decisions, some clearly denying the existence of continued hurricane hazards, and others leaning in the direction of reduced vulnerability. This was in fact a reflection of inconsistency among federal and state policies affecting the coast, some of which encourage development while others attempt to promote hazard mitigation. While this study could not conduct a house-by-house survey of the rebuilding process, some broad conclusions are possible.

First, the Coastal Barrier Resources Act (CBRA) designation of part of North Topsail Island failed to deter intense development there. While the act prohibits federal flood insurance and other federal inducements to growth on designated coastal barriers, it does not prohibit private construction in such areas. In this case, a *de facto* alliance between the state, Onslow County, and the private developers led to the relocation of the shore road (S. R. 1568) and the construction of several high-rise structures between the new road and the ocean. In so doing, the warnings of coastal geologist Orrin Pilkey and the North Carolina Coastal Federation were brushed aside. There were also charges that realty agencies failed to warn condominium buyers of the coastal hazard and the nonavailability of federal flood insurance, and that insurance agents improperly sold some NFIP policies to cover units within the CBRA area. (These policies, however, were not honored by the Federal Insurance Administration after the 1996 hurricanes.) The rebuilding of the shore road after both Bertha and Fran was funded in part by the federal government under a loophole in the CBRA for repairs to roads that are "essential links in a larger network or system." FEMA, however, declined to fund the construction of an emergency dune within the CBRA unit. The Godschalk Report urged North Carolina to enact legislation to prohibit state subsidies for construction within CBRA units and to require disclosure of coastal hazards. Neither of these proposals have been acted upon to date.

Second, FEMA's *elevation* requirements were apparently enforced by state and local authorities for new or substantially damaged structures. Oceanfront structures on Topsail Island are, by and large, elevated on heavy pilings, with the space below the first floor evidently limited to parking, access, and storage in accordance with NFIP regulations. FEMA was able to persuade some coastal communities to adopt new post-Fran elevations voluntarily. The FEMA Building Performance Assessment Team disclosed numerous technical problems with embedment depth, cross-bracing, and concrete slabs, some of which dated back to a change in state regulations in 1986. On the whole, post-1986 buildings performed quite well, except on the oceanfront where many were undermined by erosion and scour amounting to 5–7 feet in vertical depth. It would appear that the marginal cost of complying with elevation and building code requirements has been capitalized into the private value of structures that run to several hundred thousand dollars apiece on the oceanfront, with commensurately high rental values. The BPAT report, however, did not address the wisdom of rebuilding, no matter how durably, on land that is vanishing into the ocean. FEMA's V-zone regulations do not involve any setback along eroding shorelines. *Despite repetitive claims, federal flood insurance remains available to substantially damaged structures at the water's edge* (other than in a CBRA unit).

Third, *setbacks* for new and substantially damaged structures in North Carolina are governed by the state Coastal Area Management Act (CAMA). There are an unknown but significant number of lots that cannot be rebuilt due to both CAMA setbacks and other requirements such as septic regulations and street setbacks. However, the state sought to avoid banning any rebuilding where Fran had removed all vegetation (the

reference feature for setbacks prescribed by CAMA). The state approved an emergency procedure to extrapolate the "vegetation line" to cover such denuded areas. Some would argue that this procedure circumvented the intent of CAMA: If there is no vegetation remaining, there should be no rebuilding. But the state decided to depart from a literal reading of CAMA in the interest of allowing as many structures to be rebuilt as possible, while giving lip service to the setback requirement. One may assume that vegetation will revive naturally or through human intervention, provided the dune-beach system remains stable for long enough to allow that to happen. That, however, is a questionable assumption at Topsail Island, where much of the post-Fran emergency dune was washed away by Hurricane Bonnie in August 1998.

Fourth, the CAMA prohibition against *armoring* the shore has been notably effective (and has been upheld judicially in the Shell Island decision). By and large, North Carolina has avoided the trap of building seawalls, groins, revetments, and other structures that hinder public use of beaches and often exacerbate erosion losses. However, the 30- and 60-year setbacks, which have been intended to forestall the need for armoring, may have been based on erosion rates that are too low. According to the North Carolina Coastal Federation, "30-year setbacks have been more like 15–20 year grace periods. The day of reckoning is now here, and the continued existence of the ban on armoring is by no means certain."³⁷

Although North Carolina has one of the leading state coastal management programs in the country, many key decisions affecting the rebuilding of the state's oceanfront are made locally. The zoning of North Topsail by Onslow County for high-rise development in 1979 facilitated the building boom there in the 1980s despite the well-documented hazards affecting the site. After Bertha and Fran, local authorities were responsible for many critical determinations governing the rebuilding process. These included: (1) designation of substantially damaged structures; (2) issuance of "minor permits" under CAMA; (3) enforcement of CAMA minimum setbacks; (4) enforcement of minimum elevation and building code requirements; and (5) issuance of building permits under local land use plans and zoning laws. These functions were conducted under extreme pressure of time, media attention, and public sympathy for owners of damaged structures. Also, local actions were taken in the midst of other damage assessments by federal and state authorities and insurance adjusters with resulting confusion of findings and cross-purposes.

Paradoxically, the abundance of federal assistance, including grants, flood insurance, and disaster loans, has been blamed for undercutting the effort of the state, as well as FEMA's own mitigation staff, to promote hazard mitigation. As noted above, federal assistance to the principal barrier islands affected by Bertha and Fran was estimated at \$10,500 per full-time resident of those islands (Whitlock, 1997). Local coastal communities were spared difficult choices by having at least 90% of their public costs assumed by FEMA. Owners of oceanfront property were similarly encouraged to rebuild by the availability of low-interest SBA disaster loans and continuing eligibility for affordable flood insurance. A year after Fran, the *Raleigh News & Observer* (Nov. 11, 1997) editorialized:

In the Wake of Hurricane Fran, North Carolina's coastal communities and residents mined taxpayer accounts to rebuild in fragile areas. Such generosity encourages overdevelopment, at great expense. . . . The allocation of hundreds of millions in taxpayer dollars has led the federal government to undermine what state officials have been trying to do for decades—discourage development in coastal areas that are vulnerable not just to hurricanes but to heavy storms of any kind.

Ten months later, after the near-miss by Hurricane Bonnie, the same newspaper published the following reprise:

When a natural disaster strikes, government does, indeed, have a reasonable responsibility to help people rebuild their homes, their businesses, and their lives. . . . But those are not open-ended obligations. Extending insurance in the face of irresponsible placement of property, building infrastructure that storms are bound to wash away, and encouraging any policy that continues a cycle of predictable damage and guaranteed repair—all that sounds like the recipe for chronic disaster. (*News & Observer*, Sept. 3, 1998)

Notes

1. North Carolina General Statute 113A-100 et seq. The early development of the North Carolina Coastal Program was discussed in Owens (1985) and National Research Council (1990).
2. NC Laws, Ch. 113A, Sec. 104.
3. NC Rules T15A, Subchapter 7H.
4. *Ibid.*
5. Todd Miller, Executive Director, NC Coastal Federation, personal communication, Sept. 28, 1998.
6. *Raleigh News and Observer*, "Court rules against resort on sea walls," July 19, 1999. See: *Shell Island Homeowners Assn. v. Tomlinson* 517 S.E.2d 401 and 517 S.E.2d 406 (NC App. 1999).
7. Alison Davis, NC Division of Coastal Management, personal communication, June 15, 1998. New structures smaller than 5,000 square feet and containing fewer than five residential units must be constructed the farthest landward of (1) a distance equal to 30 times the long-term annual erosion rate, (2) the crest of the primary dune (the first dune with an elevation equal to the 100-year storm level plus six feet), (3) the landward toe of the frontal dune (the first dune with substantial protective value), or (4) 60 feet landward of the vegetation line. Structures larger than 5,000 square feet in total floor area or containing five or more residential units must be set back to the farthest of the following four distances: (1) 60 times the average annual erosion rate; (2) the crest of the primary dunes; (3) the landward toe of the frontal dune; or (4) 120 feet landward of the permanent vegetation line.
8. NC Laws, Ch.113, Sec. 106.
9. P.L. 93-234.
10. 42 USCA, Sec. 4121.
11. 42 USCA, Sec. 4002(b)(3).
12. 44 CFR Sec. 59.1. "Primary frontal dunes" are defined as "a continuous or nearly continuous mound of ridge of sand with relatively steep seaward and landward slopes immediately landward and adjacent to the beach and subject to erosion and overtopping from high tides and waves during major coastal storms." Moreover, dunes are designated as landward limits of V zones only where the dune cross-section above the 100 year stillwater elevation and seaward of the dune crest exceeds 540 square feet. V-zones have long been delineated on flood insurance rate maps (FIRMs) based on computer simulation of the reach of a three-foot breaking wave during a 100-year storm event.
13. 44 CFR Sec. 60.3(e). Additional provisions for V-zones prohibit "manmade alteration of sand dunes . . . which would increase potential flood damage" and the enclosure of space below elevated structures with non-breakaway walls or for purposes other than parking, access, or storage. Mapped V-zones typically are fairly narrow and are bordered on the landward side by A zones with lower elevations and less restriction of solid wall enclosure of space below base flood elevation.
14. The 1994 National Flood Insurance Reform Act (PL 103-325, Sec. 577) directed the Federal Emergency Management Agency (FEMA) to study the impacts of coastal erosion. The act, however, failed to impose any limits on flood insurance in areas of critical erosion hazards as recommended by the National Research Council (1990) and adopted by the House of Representatives in 1991 (HR 1246). See: Platt, 1999. Ch. 6.
15. P.L. 97-348; 16 USCA 3501-10.
16. P.L. 100-707; 42 USCA Secs. 5121 et seq.
17. FEMA website: www.fema.gov/library, Nov. 2, 2000.

18. P.L. 100-707, Sec. 409.
19. Lowe's Storm98 Hurricane Central Web Site (August 17, 1997).
20. North Carolina Disaster Recovery Task Force. *Draft Goals and Action Team Reports*, November 1996. Raleigh, NC: Office of the Lieutenant Governor (mimeo); "Recommendations for Action" (Feb. 14, 1997) Raleigh, NC: Office of the Lieutenant Governor (mimeo).
21. NC Disaster Recovery Task Force, Coastal Action Team Report, November 26, 1996.
22. NC Disaster Recovery Task Force. "Recommendations for Action" (Feb. 14, 1997). The source of the \$64 per capita standard is unknown.
23. North Carolina Disaster Recovery Task Force. *Draft Goals and Action Team Reports*, November 1996. Raleigh, NC: Office of the Lieutenant Governor (mimeo).
24. Letter from O. H. Pilkey, Jr. to North Carolina Governor James Martin dated June 27, 1990 (emphasis added). Pilkey reaffirmed this opinion after Hurricane Bonnie grazed Topsail Island in 1998 (*The New York Times*, August 31, 1998, p. 8).
25. 44 CFR 206.225.
26. 44 CFR 206.226.
27. 44 CFR 206.434.
28. Testimony of Martin Lancaster, Assistant Secretary of the Army for Civil Works, to Subcommittee on Clear Air, Wetlands, Private Property, and Nuclear Safety of the U.S. Senate Committee on Environment and Public Works (104th Cong., 2nd Sess.), October 2, 1996. Washington, DC, U.S. Government Printing Office, p 11.
29. Todd Miller, NC Coastal Federation, personal communication, September 28, 1998.
30. Alison Davis, NC Division of Coastal Management, personal communication, June 15, 1998.
31. NC CAMA, Sec. 113A-118(b).
32. 44 CFR Sec. 59.2. "Substantial damage" is included in "substantial improvement" which is subject to applicable elevation and other building regulations under 44 CFR Sec. 60.3.
33. NC CAMA Regs., Subch. 7J.
34. Janet Russell, NC Division of Coastal Management, personal communication, June 17, 1998.
35. Spencer Rogers, NC Sea Grant Program, personal communication, January 15, 1997.
36. 44 CFR Part 67.
37. Todd Miller. NC Coastal Federation, personal communication, September 28, 1998.

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