EMERGENCY MANAGEMENT

PREPAREDNESS

Powicki, Christopher R. 1990. The calm before the storm: a hurricane preparedness plan. *Operations Forum* (March):24-29.

> A comprehensive emergency preparedness plan at the Plum Island Wastewater Treatment Plant at Charleston Harbor minimized damages and allowed operations to resume soon after Hugo devastated the area. This article clearly summarizes the steps taken by the plant's managers and personnel from the first hurricane watch to the critique of their performance a month after the storm passed. An interesting description of the state's procedure for testing water for contamination after Hugo is included.

United Nations 1991. Hugo: a case study. *UN Chronicle* 28(2):50-51.

> The cyclical nature of hurricanes, volcanic eruptions, and other natural disasters in the Caribbean, coupled with the relative isolation of the various islands, has made it essential for planners to view disaster preparedness there as part of economic development and environmental assessment. The Pan Caribbean Disaster Prevention and Preparedness Project, managed by the United Nations Disaster Relief Organization, has worked to help develop local capabilities to prepare for disasters. This article highlights the Project's successes in the aftermath of Hugo.

Forecasting and Warning

McKinney, Stan M. 1991. Preparations for the storm. Pp. 8-10 in Benjamin L. Sill and Peter R. Sparks, eds., *Hurricane Hugo One Year Later, Proceedings of a Symposium and Public Forum.* New York: American Society of Civil Engineers.

> This short article, compiled by the Division of Public Safety Programs of the South Carolina Governor's Office, lists chronologically the steps taken by the State Emergency Preparedness Division as Hugo approached the mainland. The emphasis is on use of the forecasts and computer models, the process of deciding whether and when to order evacuation of certain areas, and mobilizing the various local emergency response units.

Sparks, Peter R. 1990. Wind speeds in the Carolinas during Hurricane Hugo. *The Wind Engineer* 4(2):1,8.

The experience in Hugo is a clear example of the problem of recording and reporting wind data in the United States. In South Carolina there was an area of over 7,000 square miles in which the winds were almost certainly gusting to over 100 mph but within which there was not one reporting station. Many official anemometers throughout the Hugo impact area were improperly sited, either in height above the ground or in relation to adjacent objects, such as buildings or forests. These deficiencies posed significant problems to forecasters of the National Weather Service who were attempting to obtain information during the storm. A properly located and calibrated grid of anemometers, adhering to an already-established international format, would greatly assist both the meteorologist and the wind engineer.

U.S. Department of Commerce 1990. *Hurricane Hugo, September 10–22, 1989: Natural Disaster Survey Report*. Silver Spring, Md.: National Oceanic and Atmospheric Administration, National Weather Service. 71 pp.

Compiled by a post-disaster survey team, this report chronicles the storm's course, presents pertinent meteorological information, summarizes preparedness actions and National Weather Service (NWS) warning services, evaluates the interpretation and dissemination of NWS information, and discusses public response to the storm and the benefits of NWS services. Findings and recommendations include 1) a comprehensive evacuation study has not been undertaken for Puerto Rico and the Virgin Islands; 2) in its advisories, the National Hurricane Center did not sufficiently emphasize the impacts that inland high winds might have for the Carolinas; 3) construction of future NWS offices in hurricane-prone areas should have hardened hurricane-proof areas that can preserve foodstuffs, provide temporary sleeping quarters, and include minimal personal hygiene facilities; 4) the public continues to receive most of its warning information from the media; and 5) in both the Caribbean and the Carolinas, emergency managers coordinated frequently with their local NWS offices.

Evacuation

Baker, Earl J. 1990. *Evacuation Decision Making and Public Response in Hurricane Hugo in South Carolina*. QR#9. Boulder, Colo.: University of Colorado, Natural Hazards Research and Applications Information Center. 16 pp. $2.00.

The effective evacuation of South Carolina's residents during Hurricane Hugo can be attributed to up-to-date weather information and timely decisions by public officials. This paper evaluates various evacuation study tools (surge maps, clearance times, and decision aids); public response to evacuation; and evacuation rates, timings, and destinations. Inundation maps and evacuation clearance time calculations produced in pre-storm studies proved useful and generally accurate. It is noted that, in many areas, evacuation was not as complete as is widely believed.

Federal Emergency Management Agency and the U.S. Army Corps of Engineers 1990. *Hurricane Hugo Assessment: Review of Hurricane Evacuation Studies Utilization and Information Dissemination*. Prepared for the U.S. Army Corps of Engineers South Atlantic Division and the Federal Emergency Management Agency Region IV by Post Buckley, Schuh and Jernigan, Inc., Tallahassee, Florida. Copies are available from FEMA Region IV, 1371 Peachtree St., Atlanta, GA 30309, (404) 853-4302.

> Before Hurricane Hugo, comprehensive hurricane evacuation studies—jointly funded by the Federal Emergency Management Agency, the Corps of Engineers, the state governments, the National Weather Service, and the South Carolina Coastal Council—had been completed for North and South Carolina, and a study for Georgia was almost done. This report evaluates whether these studies were being used by local and state officials, whether the data from the studies were reliable, and which study products were the most useful to officials. The report covers hazards, vulnerability data, behavioral characteristics of evacuees, shelters, transportation and clearance time data, evacuation decision making, and public information. Findings suggest that 1) more than half the evacuees from all areas went to the homes of friends or relatives; 2) very few evacuees went to public shelters; 3) roughly a fifth reached their destinations in less than 30 minutes; 4) very few respondents interpreted the evacuation notices as being mandatory; and 5) over 90% of respondents felt that officials had handled the evacuation well.

Sexton, M. C. 1990. Hurricane Hugo: evacuation and repair. Pp. 355-58 in *Compendium of Technical Papers: Institute of Transportation Engineers 60th Annual Meeting*. Washington, D.C.: ITE. 470 pp. Reprints available from author, Wilbur Smith & Associates, Analytical Laboratory, Bankers Trust Tower, P.O. Box 92, Columbia, SC 29201, (803) 738-0580.

> The minimal loss of life in South Carolina during Hurricane Hugo can be attributed to the evacuation before landfall of most of the population at risk. This article analyzes the evacuation process, detailing the density of automobile traffic in the hours preceding the storm; damage to highways, roads, signalling equipment, and signs; and the impacts of power outages on traffic management. Recommendations are given for minimizing the impacts of a future hurricane on local and regional transportation systems.

RESPONSE

Badolato, Edward V. 1990. *Hurricane Hugo: Lessons Learned in Energy Emergency Preparedness*. Clemson, S.C.: Clemson University, Strom Thurmond Institute of Government and Public Affairs. $8.50.

> The report discusses the problems caused when Hugo knocked out electrical power in widespread areas for extended periods, including the effects of the prolonged disruption on community health, safety, commerce, industry, and recovery efforts. The author recommends that emergency planners prepare for the worst; coordinate their responses with federal, state, and industry responders; establish and sustain pre-emergency planning; create an energy emergency preparedness group to work at the state and local levels; familiarize themselves with the role of the military; and better utilize their communications systems.

Berke, Philip, and Dennis Wenger 1991. *Montserrat: Emergency Planning, Response and Recovery Related to Hurricane Hugo*. College Station, Tex.: Texas A&M University, Hazard Reduction Recovery Center. 84 pp.

This is the report of an investigation of the emergency planning, response, and long-term recovery activities carried out by government and nongovernmental organizations as they coped with Hugo's impact on Montserrat. The authors analyzed the island's disaster plans, communication systems, organization, budgetary status, and health care systems to determine what factors contributed to or detracted from effective response and recovery from the hurricane. Specific disaster response activities, such as provision of shelter, damage assessment, distribution of aid, handling of the dead, and emergency medicine are also discussed. Among the recommendations are that the National Disaster Plan be updated based on the Hugo experience, that the roles of government agencies be more clearly spelled out, and that training and public education be enhanced.

Brooks, Jim 1990. Lessons from Hugo: San Juan mayor writes a booklet. *Nation's Cities Weekly* 13(January 15):4.

Although Hugo left San Juan, Puerto Rico, with 4,000 refugees in 32 emergency shelters, not one life was lost. The city's mayor headed the crisis management team, and summarized the lessons he learned, foremost of which was that a written emergency plan cannot anticipate every variable and that common sense and personal leadership are invaluable. Other lessons include that any emergency plan must be tested periodically; onsite quarters should be provided for key employees; the lines of communication and chain of command should be kept clear; communication with the public should be carried out through the mass media; and as recovery begins, key symbolic events, such as summer festivals or the opening of public schools, should be held on schedule.

Drabek, Thomas E. 1991. Microcomputers and disaster responses. *Disasters* 15(2):186–92.

Microcomputers have transformed the operations of many private-sector and governmental organizations. This article surveys the use of microcomputers in the disaster preparedness and response activities of 11 state and local agencies involved in two floods, two hurricanes (including Hugo), a fire and toxic chemical threat, and a nuclear power plant exercise. Specific examples are given of shortcomings in the use of the computers and associated software, in improvisational use of the technology, and in the unexpected impacts the computers had on other aspects of the organization's response. The author concludes that computer technology has improved the ability of the organizations to coordinate the complex systems involved in a disaster, that some agencies were further along in the effective use of their computers than others, and that most agencies have not really come to grips with the subtle ways in which the computer has and will continue to affect their procedures and policies.

Griswold, J. S., T. L. Lightle, and J. G. Lovelady 1990. Hurricane Hugo: effect on state government communications. *IEEE Communications* 28(6):12–17.

> The state of South Carolina is the largest user and fourth-largest provider of telecommunications services in South Carolina, with about 50,000 lines. Although the state system did enable critical communication between Charleston and the capitol in Columbia to be maintained during Hurricane Hugo, there were some deficiencies, including tremendous competition for local and long distance access and loss of power and lack of backup generators in the days soon after the storm. The State Division of Information Resource Management (DIRM) began emergency preparedness activities in the week before Hurricane Hugo, firming up contacts with private companies supporting the network, protecting equipment, and gathering repair supplies. As a result of the storm, the state is developing an emergency disaster recovery communication network that includes several layers of communications, diverse facilities, alternate communications devices, and infrastructure protection to ensure that the network functions during a disaster. South Carolina is also one of the states selected for development and implementation of the National Communications System/Telecommunications Services Priority model plan for emergency restoration of telecommunication services, administered by the National Communications System for the Federal Communications Commission.

Hudak, Mary 1991. Lessons learned by the federal government. Pp. 251–53 in Benjamin L. Sill and Peter R. Sparks, eds., *Hurricane Hugo One Year Later, Proceedings of a Symposium and Public Forum*. New York: American Society of Civil Engineers.

> The scope and intensity of Hugo's impact occasioned many unprecedented situations that had to be resolved by the Federal Emergency Management Agency in its attempts to provide assistance to state and local governments both before and after the storm. The agency learned many "lessons" about its response organization and structure, staffing levels, management of donations, and operational details, among others. This short article details a few of the more generally applicable discoveries.

Jesitus, John 1990. Still standing: South Carolina duo shares hard lessons. *Communications News* 27(April):30.

> The Charleston County, South Carolina, telecommunications manager and assistant manager spent 48 hours preparing for Hugo, and rapidly rounded up additional vital telephone lines and mobile radios in the days after the storm. The county's long-term relationship with Southern Bell and Motorola speeded acquisition of extra phone lines and mobile radios. The local Motorola supplier worked all night to get the mobile radio system up and running, which was crucial to the cleanup effort after the hurricane. Thirty cellular phones and 50 additional pagers were also provided by vendors. The Hugo experience has helped Charleston County plan its new disaster-preparedness facility.

Lindbergh, Charles 1991. Inspection of damaged buildings. Pp. 121–28 in Benjamin L. Sill and Peter R. Sparks, eds., *Hurricane Hugo One Year Later, Proceedings of a Symposium and Public Forum.* New York: American Society of Civil Engineers.

> Volunteer engineers and architects helped expedite South Carolina's recovery from Hugo. They augmented state and local government organizations, assessed damage to public facilities, and provided contingency engineering and construction repair services to municipalities. The paper reviews the initiation, continued development, and utilization of the group, Volunteer Technical Assistance Group (VOLTAG). It concludes by recommending the institutionalization of such groups to assist during future disasters.

Morbidity and Mortality Weekly Report 1990. Surveillance of shelters after Hurricane Hugo—Puerto Rico. *Morbidity and Mortality Weekly Report* 39(3):41–43.

> Even though 10,300 evacuees were housed in 161 temporary public shelters in Puerto Rico from about September 25 to October 3, 1989, surveillance by the Puerto Rico Department of Health detected no serious disease outbreaks or other public health problems in the shelters. Only a few minor health problems were identified. The article describes how the Health Department surveyed the shelters and recommends such action by other public agencies in similar situations.

Moss, Bill 1989. A post-Hugo evaluation. *Public Management* 71(12):15–17.

> When Hurricane Hugo struck the South Carolina coast, the city of Myrtle Beach had just finished revising its disaster preparedness plan. This enabled the local government to respond swiftly and decisively to the disaster. Among other details, the article describes the usefulness of having city employees be prepared to stay at work for up to three days, some communications successes and failures, and some early-recovery problems.

Pan Caribbean Disaster Preparedness and Prevention Project 1989. *Case Report: Hurricane Hugo, September 1989, Caribbean.* Publication no. 89/21. Available from the Office of the United Nations Disaster Relief Coordinator, Palais des Nations, CH-1211, Geneva 10, Switzerland.

> Hugo caused $365 million in damages on Dominica, Montserrat, Antigua/Barbuda, the British Virgin Islands, and St. Kitts/Nevis. Overall coordination of the response and relief operations was provided by the Pan Caribbean Disaster Preparedness and Prevention Project (PCDPPP). This report was prepared by the PCDPPP to inform the international community of the subsequent activities that were undertaken to promote disaster preparedness and to improve the efficiency of future relief operations. Seventy-six comments are offered dealing with hurricane preparedness measures, regional and telecommunications planning, public awareness, training of emergency personnel, the response to Hugo, the coordination of both internal and external responses, and implications for PCDPPP activities. The rest of the document contains the United Nations Disaster Relief Organization information and situation reports.

Piacente, Steve 1989. In the eye of the storm. *Government Executive* 21(12):24-33.

> Federal response to the Hurricane Hugo and Loma Prieta earthquake disasters is described in this feature article, along with criticisms of those efforts levelled by state officials and legislators. Some of the hindrances faced by the Federal Emergency Management Agency and the shortages in funds and personnel that the agency overcame are detailed.

Shields, Bobbie 1991. Lessons learned by local government, Charlotte, North Carolina. Pp. 254-58 in Benjamin L. Sill and Peter R. Sparks, eds., *Hurricane Hugo One Year Later, Proceedings of a Symposium and Public Forum*. New York: American Society of Civil Engineers.

> The City of Charlotte and the Mecklenburg County governments worked cooperatively in the aftermath of Hugo to provide emergency services, response, and recovery assistance. This article summarizes a local official's impressions of the roles played by the local governments, their interaction with their citizens, and the more helpful aspects of the response effort.

Shook, Marie and Don Steger 1989. How to handle a disaster: a study in teamwork. *Public Management* 71(12):10-14.

> The joint Emergency Management Office of Charlotte, North Carolina, and Mecklenburg County, North Carolina, followed its standard all-hazard plan to cope with Hurricane Hugo. Both city and county public health, safety, and other departments cooperated in immediate response activities to help the area respond to the storm. The article describes the various steps taken and cooperative methods used by the EMO personnel.

U.S. House of Representatives 1991. Federal Emergency Management Agency's Response to Natural Disasters. U.S. House of Representatives, Hearings before the Subcommittee on Investigations and Oversight of the Committee on Public Works and Transportation, 101st Congress, 2nd Session, May 1-2, 1990, Washington, D.C. 357 pp.

> About six months after Hurricane Hugo and the Loma Prieta earthquake, hearings were held to evaluate the accomplishments of the Federal Emergency Management Agency (FEMA) in its role as provider and manager of the Federal Disaster Assistance Program. The subcommittee sought answers to the following questions: Was FEMA's response sufficient? Was it proactive in supplying needed information and resources to state and local officials and to disaster victims? What more would have been useful? How well did FEMA coordinate the relief effort among various government agencies and nonprofit ones? Was the military used wisely? Was FEMA's staffing adequate? How well did its system of using paid reservists work? Were they well trained for the jobs they were required to perform? How timely, accurate, and fair were FEMA's assessments of damages and needs, and was relief swift and forthcoming? Testimony and prepared statements from witnesses and four members of Congress, along with reprinted documents, letters, and articles provide insights to FEMA's response to the two natural disasters.

Virginia Department of Emergency Services 1991. Coastal hurricanes pose severe threats to inland jurisdictions. *Update* 1991(September):1.

This brief article recounts the experience of the Director of Public Safety and Civil Defense for Sumter County, South Carolina—a county 100 miles inland that was nevertheless seriously affected by Hugo. Some of the problems included a nine-day power outage, blocked roads, loss of mass communications, broken water mains and sewer lines, and hundreds of injured residents.

Wagar, Linda 1990. Hugo and the earthquake: lessons learned. *State Government News* 33(3):10–14.

Confusion among government agencies at all levels slowed efforts to get South Carolina communities back on their feet after Hugo. This article describes some of the misunderstandings and ad hoc decisions that were made in the wake of the hurricane in attempts by local, state, and federal officials to respond to the crisis. Some comparisons are made to the response to the Loma Prieta earthquake in California.

Wilson, Carol and Ann Lindstrom 1989. Survival of the network. *Telephony* 217(October 23):38.

The telephone system in the Carolinas remained intact and working during the Hurricane Hugo disaster, due mainly to modern electronic switching, fiber optic trunking, and buried cables. About 90-95% of all Southern Bell customers had telephone service throughout the crisis. North Carolina had received $1 billion and South Carolina $781 million worth of telecommunications modernization in recent years.

RECOVERY

BCD Council of Governments 1990. Disaster Analysis and Recovery Tracking System (DARTS): Project Description. Charleston, S.C.: BCD Council of Governments. 32 pp.

The BCD (Berkeley, Charleston, Dorchester) Council of Governments developed a disaster and recovery tracking system to provide local policymakers in stricken communities with maps and data to guide their recovery decisions. This report describes the system, including the methods used to analyze hurricane damage by neighborhood; a regional tracking system for local facilities reconstruction; information needed to plan for economic development, transportation, housing, emergency medical services, and other local government responsibilities; and the planning-oriented land-use and mapping system for the region, which is designed for a microcomputer. BCDCOG is producing community studies for each of the affected areas, damage assessment profiles, and planning practice manuals, as well as documents dealing with other specific aspects of the system, all described in this report.

Beatley, Timothy 1990. *Managing Reconstruction along the South Carolina Coast: Preliminary Observations on the Implementation of the Beachfront Management Act Following Hurricane Hugo*. QR#38. Boulder, Colo.: University of Colorado, Natural Hazards Research and Applications Information Center. 27 pp. $2.75.

> South Carolina's 1988 Beachfront Management Act prohibited rebuilding heavily damaged structures that were close to the ocean—specifically within 20 feet of the natural duneline in the so-called "dead zone." This paper describes the law, examines the mechanisms for managing reconstruction, and relates lessons learned from South Carolina's Hurricane Hugo experience. Although the state Coastal Council was reasonably well prepared to deal with damage assessment, reconstruction permitting, and administrative rulings, many specific issues had not been foreseen and support for the existing law even before the storm was by no means universal. The author recommends that additional research and thinking be done—before the next hurricane—about equitable and feasible mechanisms for moving development back from the ocean in the aftermath of such storms.

Berke, Philip, and Dennis Wenger 1991. *Linking Hurricane Disaster Recovery to Sustainable Development Strategies: Antigua, West Indies*. College Station, Tex.: Texas A&M University, Hazard Reduction Recovery Center. 30 pp.

> This is the report of an investigation of the emergency planning, response, and long-term recovery activities carried out by government and nongovernmental organizations as they coped with Hugo's impact on Antigua. The intent was to develop recommendations for a successful recovery planning program that will make reconstructed localities less vulnerable to future disasters while improving local capability to undertake sustainable development activities. Among the findings are that the Antigua disaster planning program failed completely during Hugo; that the Disaster Relief Committee, which was established outside of existing governmental organizations, was a successful vehicle for assessing damage data and distributing and monitoring housing aid; that, in some instances, recognition of the legitimacy of Antiguan authorities by foreign donor organizations was low; and that most of the housing recovery work was not developmental in nature.

Berke, Philip, and Dennis Wenger 1991. *Linking Hurricane Disaster Recovery to Sustainable Development Strategies: St. Kitts and Nevis, West Indies*. College Station, Tex.: Texas A&M University, Hazard Reduction Recovery Center. 41 pp.

> This is the report of an investigation of the emergency planning, response, and long-term recovery activities carried out by government and nongovernmental organizations that coped with Hugo's impact on St. Kitts and Nevis. The intent was to develop recommendations for a successful recovery planning program that will make reconstructed localities less vulnerable to future disasters while improving local capability to undertake sustainable development activities. Among the findings are that the pre-disaster awareness programs and planning proved very effective; that some organizations used Hugo as an opportunity to initiate development activities not directly related to the disaster; that private insurance companies were able to provide accurate and rapid damage assessments and housing recovery aid; and that many opportunities to make rebuilt homes less vulnerable to hurricanes were missed,

partly because of the lack of adequate building codes and procedures in place before the storm.

Dowd, Millard W., Jr. 1990. Recovery from Hurricane Hugo—Debris Removal and Channel Shoaling. *Shore and Beach* 58(4):53–56.

Debris removal was a major component of the disaster recovery operations after Hurricane Hugo, accounting for about 36% of FEMA's total approved recovery funding. An estimated 15.5 million cubic yards of debris was removed by the combined efforts of municipalities, the military, the Corps of Engineers, and private citizens, at a cost of about $5.90 per cubic yard. It is hypothesized that the absence of shoaling in the navigation channels around Charleston Harbor (as would be expected after a hurricane) is the result of the presence of jetties at the entrance to the Charleston harbor and harbors northward. The funnel-shaped jetties may have allowed higher velocities in storm water exiting the estuaries, enabling the flow to scour channel bottoms and thus remove any shoals.

Kana, Timothy W., F. David Stevens, and Gered Lennon 1990. Beach and dune restoration following Hugo. *Shore and Beach* 58(4):57–63.

After Hugo, the federal government and the state of South Carolina made a commitment to restore the beach/dune system in the most seriously affected areas. The emergency work included beach scraping and dune shaping, beach nourishment, and dune revegetation. For the work at 7 sites (one of which was 65 miles long), $9.8 million was spent and 1.2 million cubic yards of sand were placed on the beach from external sources and accreted shoals. It is anticipated that the recovery of the beaches will continue for more than a year, and that the new dunes will be stabilized by natural accretion.

Katuna, Michael P. 1991. Effects of Hurricane Hugo on the Isle of Palms, South Carolina: from destruction to recovery. *Journal of Coastal Research* SI(8):263–73.

Damage to the Isle of Palms beachfront houses, private development, public facilities, and beach after Hugo was considerable. A significant amount of sand was eroded from the island's beach-dune system. The most noticeable effects were the erosion of the primary dune ridge and the reduction in width and slope of the beach. Most of the sediment removed from the beach and dunes was transported and deposited offshore in ridges or in tidal inlet channels. At the time of the survey, much of the displaced sand was migrating back onshore and naturally replenishing the beach. Beach scraping and revegetation were initially successful in restoring the shoreline.

Rhodes, Perry E. 1990. Federal emergency work on South Carolina beaches following Hurricane Hugo. Pp. 26–35 in Lawrence S. Tait, comp., *Beaches—Lessons of Hurricane Hugo: Proceedings of the Third Annual National Beach Preservation Technology Conference*. Tallahassee, Fla.: Florida Shore & Beach Preservation Association.

> After Hurricane Hugo, the Federal Emergency Management Agency made public assistance grants available for, among other activities, restoration of the beach nourishment project at Myrtle Beach and the construction of a 17.3-mile-long emergency protective berm from the Stono River to the North Carolina border. The Corps of Engineers was contracted to build the emergency berm with eroded sand reclaimed from the surf zone. The paper describes the eligibility of sandy beaches for grants for both permanent and emergency work, and summarizes the eligible areas in South Carolina. The emergency work on South Carolina beaches, which cost about $2.5 million in federal funds, is described.

Rubin, Claire B. 1990. *Report on trip to Charleston County, South Carolina, after Hurricane Hugo*. QR #33. Boulder, Colo.: University of Colorado, Natural Hazards Research and Applications Information Center. 7 pp. $1.50.

> This report analyzes the intergovernmental aspects of recovery from Hurricane Hugo, including intergovernmental relationships; state, county, and city emergency management capabilities; the Federal Emergency Management Agency Section 409 requirements and the mitigation grant option under Section 404; the use of hazard mitigation tools and multihazard mitigation; assistance to the large number (50,000) of displaced persons; political reactions to the disaster; training, education, and preparedness; and coastal zone management. Needs for further research are identified.

Rubin, Claire B., and Roy Popkin 1991. *Disaster Recovery after Hurricane Hugo in South Carolina*. Working Paper #69. Boulder, Colo.: University of Colorado, Natural Hazards Research and Applications Information Center. 91 pp. $4.50.

> This paper explores response and early recovery problems confronting South Carolina's municipal, county, and state governments; the Federal Emergency Management Agency; and the Red Cross after the hurricane. These agencies' organizational and functional problems with preparedness, response, recovery, and mitigation are discussed in detail. In addition, the authors examine how existing educational and training processes have failed to teach local emergency managers to manage disaster recovery efforts. The findings suggest that 1) problems existed in all four phases of emergency management; 2) post-hurricane response problems were both organizational and functional; and 3) serious mitigation planning problems were found with both hurricanes and potential earthquakes. An appendix presents a new explanatory model of recovery that demonstrates the many levels of effort, commitment, and cost connected with recovering from a major natural disaster.

URS Consultants, Inc. 1991. Follow-up Investigation Report: Repair Efforts 9 Months after Hurricane Hugo, Surfside Beach to Folly Island, South Carolina. Volume I, Damage Assessment of Flooded Buildings, and Volume II, Survey Forms. Reports prepared for the Federal Emergency Management Agency by URS Consultants, Inc., Paramus, N.J.. 56 pp.

Nine months after Hugo, many homes along the South Carolina coast were either just beginning to be repaired, had been abandoned, or were awaiting a contractor. This report documents, with numerous photographs, both the progress in repair and rebuilding and the adherence to National Flood Insurance Program building standards and other hazard-resistant design criteria. The report concludes that, in general, most of the coastal construction would fare better today in a storm of Hugo's magnitude than it did during Hugo. Most homeowners were able to see for themselves the value of properly built elevated construction.

Wells, John T., and Jesse McNinch 1991. Beach scraping in North Carolina with special reference to its effectiveness during Hurricane Hugo. *Journal of Coastal Research* SI(8):249-61.

Biweekly surveys of 1-kilometer stretches of scraped and adjacent unscraped beaches at Topsail Beach, North Carolina, for one year after Hugo revealed that 1) the scraped beach had lost 25% less sediment than the unscraped beach, 2) the dune from the unscraped section retreated 1 meter more, and 3) scraping had no obvious impact on the recreational beach because only a small percentage of sediment was removed. Despite higher erosion rates in the scraped section after Hugo, it can be argued that sediment losses would have been even greater during Hugo without scraping.

MITIGATION

Coch, Nicholas K., and Manfred P. Wolff 1991. Effects of Hurricane Hugo storm surge in coastal South Carolina. *Journal of Coastal Research* SI(8):201-26.

Structural damage along the South Carolina shoreline due to Hugo's storm surge was a function of location with respect to the eye, elevation, exposure, foundation types, and bracing. In some lowlying areas groin fields amplified the surge levels. High dunes were the most effective surge barriers. Incorporating what was learned about surge damage into the emergency management programs of coastal states can help decrease the damage and loss of life when another large storm inevitably hits an even more urbanized section of the coast.

Faupel, Charles E., and Susan P. Kelley 1991. Individual and Household Response to Hurricane Hugo. Final report to the National Science Foundation. 128 pp. Single copies are available for $4.00 from Susan Kelley, Department of Behavioral Sciences, Charleston Southern University, P.O. Box 10087, Charleston, SC 29411.

Under a grant from the National Science Foundation, the researchers examined whether participation in disaster education programs enhanced appropriate preparedness activities or reduced the level of stress experienced by disaster victims. It was found that, in general, disaster education is an important factor in appropriate preparedness behavior, particularly household planning, even if the type of disaster for which persons were trained is not the

same as the one that eventually befalls them. However, the earthquake education workshops conducted by Charleston Southern University themselves did not have a significant impact on household planning or adaptive response. Stress levels were found to increase as a result of participation in disaster education programs, but the authors point out that this stress may not be dysfunctional. The report discusses the implications of these findings for hazards education.

Gayes, Paul T. 1991. Post-Hurricane Hugo nearshore side scan sonar survey; Myrtle Beach to Folly Beach, South Carolina. *Journal of Coastal Research* SI(8):95–111.

Hurricane Hugo significantly modified the nearshore system of the northern half of the South Carolina coast. There was massive offshore transport of sand and construction debris. The nearshore response to the storm and post-storm topography varied along the coast and may have been influenced by coastal development. The system's recovery was rapid in water less than 4 meters deep; storm-related structures were reworked and debris was buried. This was aided in several areas by emergency beach renourishment projects. Recovery in deeper water was slower.

Hall, Mary Jo, and Susan D. Halsey 1991. Comparison of overwash penetration from Hurricane Hugo and pre-storm erosion rates for Myrtle Beach and North Myrtle Beach, South Carolina, U.S.A. *Journal of Coastal Research* SI(8):229–35.

A comparison of detailed pre-storm erosion rates with post-hurricane onsite inspection and aerial photographs showed that zones with higher pre-storm erosion rates were also areas of greater overwash penetration during Hugo. Other factors also significantly increased the overwash penetration, namely the presence of low-elevation areas landward of the beach, and large open stretches of pavement such as parking lots and streets perpendicular to the beach. In contrast, where buildings were well back from the beach with fronting dunes, overwash was not significant. Because the locations of overwash are predictable, relatively low-cost hazard mitigation measures can be taken to reduce their occurrence and severity.

Interagency Hazard Mitigation Team, Region IV 1989. Hurricane Hugo: Interagency Hazard Mitigation Team Report. FEMA-843-DR-SC. Atlanta, Ga.: Federal Emergency Management Agency. 39 pp.

Hurricane Hugo affected an estimated 1.8 million people—20 persons died, 264,500 were evacuated, 270,600 were temporarily unemployed, 60,000 were left homeless, and about 54,000 had registered for disaster assistance six weeks after the storm. This report contains recommendations for improved recovery and hazard mitigation that were proposed by a regional Federal Emergency Management Agency mitigation team that investigated the stricken area in the hurricane's aftermath. The report addresses issues that South Carolina should consider in future emergency plan development. It offers a general description of the disaster and the response to it, addressing government and regulatory structures, hurricane preparedness, damage, initial reaction, and long-term reconstruction. It recommends improvements in the use of South Carolina's emergency operations centers, in floodplain and coastal zone management procedures, in emergency communications, and in the

implementation of a mandatory statewide building code that provides structural protection from both hurricane-force winds and earthquakes.

Lennon, Gered 1991. The nature and causes of hurricane-induced ebb scour channels on a developed shoreline. *Journal of Coastal Research* SI(8):237–46.

Of the various types of storm-induced erosion, ebb-scour channels were particularly evident after Hugo on Folly Island, South Carolina. Water flowing in these channels carried vast amounts of debris offshore, wrecked buildings and seawalls, and undermined roads and water lines. A one-mile segment of Folly Island was studied to determine what processes were responsible for the creation of the channels. The study concluded that several factors encourage or inhibit channel formation, including streets laid perpendicular to the shoreline, wind direction, open drainage areas, public access, and existing bodies of water. The author recommends two individual actions to help prevent channel formation in future storms: keeping as much of the beach area as fully vegetated as possible, and maintaining shoreline armoring in as strong a condition as possible. He cautions that this is *not* a recommendation for the use of more and larger seawalls, but only a note that the stronger, already existing ones did seem to deter channel formation.

Lindstrom, Ann 1990. One year later—Hugo changes network approach. *Telephony* 219(September 17):14.

The state of South Carolina has announced the establishment of a private emergency preparedness telecommunications network that will operate only in a disaster like Hurricane Hugo. The network has four tiers and is built around an electronic tandem network that includes seven voice and data switching nodes connected by a DSI backbone and an independent fiber optic ring around the state. Since Hurricane Hugo, all telecommunications companies have increased the percentage of buried cable in their networks. Most of the cleanup costs after Hugo were absorbed by each company's stockholders, including $50 million for Southern Bell and $20.1 million for GTE.

Pilkey, Orrin H., David M. Bush, Rodney Priddy, Kathie Dixon, Amber Taylor, and E. Robert Thieler 1990. *Recovering from Hugo: Preparing for Hilda—Hurricane Damage Mitigation Field Trip Guide from Folly Island, South Carolina to Bogue Banks, North Carolina.* Durham, N.C.: Duke University Program for the Study of Developed Shorelines. 110 pp. Photocopy available for $12.00 from Program for the Study of Developed Shorelines, Department of Geology, Duke University, Box 6729 College Station, Durham, NC 27708, (919) 684–5847.

This guidebook for a three-day automobile trip along the North and South Carolina coast includes a section on basic principles of property damage mitigation, a mile-by-mile itinerary, detailed descriptions of natural and engineered features of the coastline and what happened to them during Hugo, and useful appendixes summarizing pertinent coastal legislation. The objectives of the field trip were to foster a new way of thinking about hurricane recovery, to wit, taking active steps to repair the islands themselves and to enhance the protective characteristics of the natural setting. The authors suggest principles for reducing hurricane

property damage in light of anticipated accelerated rates of sea level rise, increasing barrier island migration, and increases in both frequency and intensity of Atlantic hurricanes.

Platt, Rutherford H., Timothy Beatley, and H. Crane Miller 1991. The folly at Folly Beach and other failings of U.S. coastal erosion policy. *Environment* 33(9):7–9, 25–32.

The concept of relocating a structure back from an eroding shoreline has been widely advocated in the United States but is seldom achieved in practice. Instead, the prevailing response has been either to ignore it or to safeguard coastal development with a variety of "hard" protection structures, which are of varying effectiveness and can have detrimental side effects. Five strategies for responding to coastal erosion have been pursued by the federal government: shoreline protection, direct federal regulation, public ownership, incentives for state planning, and insurance and mitigation of erosion losses. The failure of federal and state policies to cause beachfront development in South Carolina to move landward after Hugo demonstrated the strength of political pressure and the irrelevance to erosion problems of some of the otherwise effective federal policies. The authors make detailed recommendation for changes in federal policy to remedy the situation.

Richardson, Thomas W. 1990. Panel discussion: technological preparedness and response to severe storms. *Shore and Beach* 58(4):75–77.

This article is the report of a panel discussion at a special conference sponsored by the U.S. Army Corps of Engineers, the American Shore and Beach Preservation Association, and Sea Grant, which focussed on recommendations of ways to reduce the potential property damage, physical injury, and death from severe coastal storms like Hurricane Hugo and to improve our ability to cope with the consequences of such storms when they strike. The recommendations include those related to predicting effects of storms, assessing conditions, reducing damages, public education, and interdisciplinary communication.

Sill, Ben L. 1991. Lessons learned from Hurricane Hugo and future mitigation activities. Pp. 286–89 in Benjamin L. Sill and Peter R. Sparks, eds., *Hurricane Hugo One Year Later, Proceedings of a Symposium and Public Forum*. New York: American Society of Civil Engineers.

This paper summarizes the more salient observations made during a symposium held one year after Hugo. In general terms, it gives lessons learned about the kinds of structures damaged during the storm and the kinds of damage that were common, the performance of utility systems, the effectiveness of the evacuation, and the response effort, among other issues. The paper concludes that if all that was known about mitigating hurricane disasters had been properly put into practice, Hugo's damage would have been reduced by several billions of dollars. A summary of two major mitigation projects in North and South Carolina is also presented.

Sill, Ben L., and John S. Fisher 1991. Advisory and mitigation activities in the Carolinas. Pp. 129–32 in Benjamin L. Sill and Peter R. Sparks, eds., *Hurricane Hugo One Year Later, Proceedings of a Symposium and Public Forum*. New York: American Society of Civil Engineers.

> After Hugo it was obvious that the magnitude of the disaster and the recovery time could have been substantially reduced through improved planning, education, engineering, and construction. Several programs in the Carolinas have been launched that are aimed at long-term mitigation of the impacts of hazardous occurrences. This paper outlines several principal efforts, including the South Carolina Multi-Hazard Mitigation Program, the Coastal Hazards Advisory and Mitigation Project, and the University of North Carolina's research and education program under the Center for Disaster Reduction.

Wilson, Susan, Michael Mahoney, and Cynthia Keegan 1990. Post-Hurricane Hugo mitigation issues for reducing flood losses in South Carolina. Pp. 203–206 in Association of State Floodplain Managers, Inc., *Challenges Ahead, Flood Loss Reduction Strategies for the '90s, Proceedings of the Fourteenth Annual Conference*. SP#23. Boulder, Colo.: University of Colorado, Natural Hazards Research and Applications Information Center. $10.00.

> This article identifies a number of short- and long-term mitigation strategies that could be implemented after Hurricane Hugo as part of local, state, or federal floodplain management programs to reduce future losses. They focus on improvements in coastal construction codes, mapping, building repairs, wind design, manufactured housing, using Section 1362, and making additions to the Coastal Barrier Resources System. Although the details of the recommendations are specific to Hurricane Hugo, they can be effectively utilized after virtually any hurricane.

Wood, William L. 1990. Coastal management alternatives for reducing storm impacts at a coast. *Shore and Beach* 58(4):72–74.

> This article is a general discussion of the management alternatives identified in the wake of Hugo for reducing coastal storm impacts, the recommended objectives of such approaches, and the political, economic, and technological hindrances to action. The author recommends further education of the public of the consequences of coastal development and an improved system of gathering oceanographic data during severe storms.

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