

EXECUTIVE SUMMARY

Beginning on October 28 and lasting until November 1, 1991, a succession of meteorological events combined over the northwest Atlantic Ocean resulting in a series of extraordinary ocean waves and swells. Driven and maintained by persistent, near-hurricane force winds, these waves and swells spread to the south and southwest before crashing onto the North American coast and the northern shores of the islands of the western Atlantic. Although New England, closest to the storm, received the hardest blows, widespread destruction was the rule as far south as Cape Hatteras, North Carolina, while scattered damage occurred to southern Florida and the north coast of Puerto Rico.

During the course of its investigation, the NOAA Disaster Survey Team (DST) traveled along the East Coast from North Carolina to Maine. Overall, the Team found that the system established to develop and disseminate coastal flood watches, warnings, and statements worked well. The several NWS offices involved--national, regional, and local--recognized the threat early and did yeoman work in keeping Federal, state, and local emergency officials; the media; and the public informed with clear, concise, and timely products.

The Team feels, however, that there are some problems that need to be addressed. These are discussed in the pages that follow and are summarized in the findings and recommendations section of this report. In general, there are three areas that require the most attention: data availability, guidance inadequacy, and public response.

Data Availability

All NWS warning products must begin with reliable and timely observations. The Team found that there are not enough water level observation sites along the East Coast. Where these sites do exist, there is not adequate real-time access by the forecasters to the data provided. Further, the Team found a disturbing shortage of basic marine weather observations available* Specifically, there are too few Coastal Marine Automated Network (CMAN) units and buoys along the East Coast. Thus, in many cases, the forecasters are not able to adequately monitor existing conditions.

Guidance inadequacy

The various numerical models available provided forecasters with very good guidance on open ocean conditions and on the movements and intensity changes of the weather systems affecting the storm. However, the guidance as to coastal conditions was unreliable and, in at least one case, actually inhibited an early warning issuance.

Current development activities on an extratropical coastal storm surge model and a coastal wave prediction system need to be accentuated.

Public Response

Excellent warnings and statements were disseminated by the NWS to state and local emergency service officials and to the media. In general, the response by these groups of people was excellent. The media forwarded this information to the public in a timely fashion. The emergency service personnel were ready ahead of time to take appropriate actions.

In most cases, however, the public either did not respond or they responded improperly. Many people did not perceive this coastal storm as a threat to them. It is apparent to the Team that a public education campaign is needed to make sure people understand the potential of coastal flooding. Such a campaign needs to include the utilization of the NOAA Weather Radio (NWR). The radio's effectiveness in such places as the Outer Banks of North Carolina highlights its potential as a tool for alerting and informing the public

FINDINGS AND RECOMMENDATIONS

THE EVENT AND ITS IMPACT (CHAPTER 1}

Finding 1:

A coastal flood of unusually long duration and intensity occurred during late October 1991, affecting areas along the entire east coast of the United States and Puerto Rico. This storm caused millions of dollars in damage to beaches and man-made beachfront structures, including the seaside home of President George Bush.

DATA ACQUISITION AND AVAILABILITY (CHAPTER III)

Finding 2:

The availability and continuity of an adequate, reliable, and timely data base (consisting of meteorological observations, sea state conditions, and water level measurements) is vital if NWS offices are to provide accurate and timely coastal flood watches and warnings. This includes those areas behind barrier islands, particularly where large rivers or embayments are involved (e.g., Pamlico Sound) so that adequate warning for seiches and coastal flooding can be given.

Recommendation 2-1:

NWS and National Ocean Service (NOS) should implement a system that will ensure that local NWS offices will have real-time, **24-hour** access to reliable water level measurements especially from **critical** tide gage stations. This should include those stations behind the various oceanic barriers. The availability of these data is vital to NWS offices responsible for issuing coastal flood watches and warnings.

Recommendation 2-2:

The phaseover from the Water Level Telemetry System (WLTS) to Next Generation Water Level Measurement System (NGWLMS) technology must be accomplished only after **all** questions and reservations about the new system have been answered and the operational implementation of the new system has been agreed to by both NWS and NOS.

Recommendation 2-3:

The NWS should install an adequate marine observational network that would fill the gaps in the current arrangement and would provide the minimum coverage necessary for the reconfigured forecast areas in the modernized NWS. This network should include shoreline/shallow water wave height measurements.

Finding 3:

A **water** level value relayed to WSFO Portland, Maine, from a properly operating gage was discounted by forecasters due to past problems with the gage. The coastal flood warning was issued only after electronics technicians verified that the earlier reading was correct, some 3 hours after the threshold value was reached.

Recommendation 3-1:

Water levels should be monitored on a regular basis, either manually or automatically, so that NWS forecasters are aware of possible gage problems and so that water level trends can be observed.

Finding 4:

Marine weather data are not as accessible to NWS forecasters as are land-based data making the use of this information more difficult.

Recommendation 4-1:

The NWS should ensure that marine weather data are integrated into the Automation of Field Operations and Services (AFOS) hourly surface plots for use at local offices having marine responsibility. The Ocean Products Center should seek other ways to bring needed data to the high seas forecasters of the Satellite Marine Section (SMS) at **NMC**.

Recommendation 4-2:

The NWS should explore adapting the marine monitoring (**MARMON**) program, developed at WSFO Cleveland and utilized across the Great Lakes, to assist forecasters in monitoring conditions along the East Coast.

PREPAREDNESS (CHAPTER IV)

Finding 5:

On-station standard operating procedures (SOP) varied widely from one station to another. In some cases, guidance materials were not complete or clear enough for a station's most inexperienced members to carry out their duties with the confidence that they had enough information to make the best decisions possible.

Recommendation 5-1:

All local managers should review their Station Duty Manuals (SDM), checklists, emergency procedures, etc., regarding coastal flooding to ensure they are complete, clear, concise, and up to date.

Finding 6:

Station drills on coastal flooding are not common practice at all offices having such responsibility.

Recommendation 6-1:

Drills should be scheduled at all stations with a frequency that will keep coastal flood procedures fresh in the minds of all watchstanders. Actual coastal flood events could be substituted for a drill.

WARNING SERVICES (CHAPTER V)

Finding 7:

NMC and coastal **WSFOs** and Weather Service Offices (WSO) recognized the potential for a dangerous ocean storm several days before the storm's major impact on the New England and Mid-Atlantic coastlines. Overall, notification of emergency officials and watch/warning lead times were sufficient for effective preparedness -actions yielding a remarkably low loss of life.

Recommendation 7-1:

Appropriate recognition is warranted for individuals and organizations who played pivotal roles in ensuring the effective performance of the warning process.

Finding 8:

Overall, the various atmospheric models performed well. However, statistical output from the NMC Marine Product-East Coast Storm Surge (MRPECS) program was consistently too conservative for this storm and may have inhibited warning effectiveness. Also, forecasters were unfamiliar with its usefulness in forecasting wave conditions during long duration storms.

Recommendation 8-1:

NOAA should be encouraged to complete the development of an extratropical storm surge model.

Recommendation 8-2:

NOAA should finalize development of a replacement for the MRPECS program having sufficient resolution and coupling the NMC deep water wave model to the shallow, coastal areas. Further, NWS should ensure that, once developed, the benefits and utilities of this guidance are made known to field personnel.

Finding 9:

In some cases, the public was drawn to the coast to witness the power of the heavy surf. This created traffic problems that may have obstructed emergency actions.

Recommendation 9-1:

NWS offices, working with local emergency managers, are encouraged to develop wording for use in coastal products designed to discourage spectators from going to the coast during coastal flood and high surf episodes.

COORDINATION AND DISSEMINATION (CHAPTER VI)

Finding 10:

Although NAWAS (National Warning System) was used, its fullest capability was not realized because dissemination to local offices was slow or did not occur.

Recommendation 10-1:

NWS managers at all levels should work with their NAWAS system managers to review dissemination procedures and see if these can be strengthened.

Finding 11:

The NOAA Weather Wire Services (NWWS) does not appear to be the total answer for disseminating emergency weather information to state and local emergency service managers.

Recommendation 11-1:

The NWS needs to strongly encourage those states subscribing to the NWWS to install automatic systems for distributing emergency information to appropriate local officials. Other alternatives for quickly and personally delivering such information to key state and local decision makers, such as the New York Statewide Police Information Network (**NYSPIN**), need to be explored and developed.

USER RESPONSE (CHAPTER VII)

Finding 12:

Response by the emergency management community and by the various media was generally excellent. Public response to this storm, and to coastal flood watches and warnings in general, was generally poor.

Recommendation 12-1:

The rapport and personal contacts between NWS officials and emergency managers at all levels must be maintained especially during the NWS modernization. This **can be** accomplished only through frequent visits between NWS personnel and state and local emergency officials. The NWS should look at other ways of coordinating with and informing emergency managers at whatever level is necessary during time-critical events.

Recommendation 12-2:

The NWS should investigate whether some minimum standard of preparedness training should be provided, through briefings or some other mechanism, to high level officials (e.g., mayors and governors) who can play a critical role in responses (e.g., evacuations) to emergency situations.

Finding 13:

Many residents contacted by the DST said that they did not think the storm would be as devastating as it was and took no action to protect their property or to

evacuate. Since this was not a hurricane and, in many locations, was not accompanied by “significant weather,” the storm was not perceived as a real danger.

Recommendation 13-1:

The NWS should investigate the feasibility of developing an intensity scale for extratropical storms patterned after the **Saffir-Simpson** Hurricane Intensity Scale for tropical systems.

Recommendation 13-2:

NWS offices are strongly encouraged to continue the practice of comparing potentially damaging storms with **noteworthy storms** of the past, thereby increasing the sense of urgency to the general public.

Recommendation 13-3:

NWS should produce a pamphlet dedicated solely to coastal flooding. This needs to be done as part of a systematic public information campaign designed to educate the coastal public on the dangers of coastal storms. This campaign could also include press conferences, now used to increase hurricane awareness, public information statements (PNS), and Public Service Announcements.

Finding 14:

Especially in New England, the **NWR** is not used by the general public as widely as it could be.

Recommendation 14-1:

The existence of **NWR** needs to be more highly publicized. In communities where NWR is widely accepted (e.g., the Cape Hatteras area), it is highly successful in keeping both local officials and the general public informed. Local managers should use whatever publicity sources they have available, including Public Service Announcements in the local media to encourage the use of NWR.