CHAPTER FIFTEEN

UPDATE: THE NATIONAL FLOOD INSURANCE PROGRAM AND THE COAST

By: William G. Fry, P.E., and Perry A. Rhodes, P.E.,
Respectively, Principal and Civil Engineer for
Dewberry & Davis, Fairfax, Virginia

ABSTRACT

This report will update the coastal zone practitioner on the National Flood Insurance Program (NFIP) as it affects the implementation of manmade changes along the coastline.

It is our intent to place in proper perspective this fast-changing and often difficult to interpret national program. Readers will achieve an overall understanding of the NFIP on the coast, and will be in a position to apply the program's requirements in their efforts.

We will begin with a history of the application of the NFIP to the coastal zone. The history of the problems encountered will lead into current regulations, methodologies, and the changes the Federal Emergency Management Agency plans for the future.

INTRODUCTION

The NFIP, operated by the Federal Emergency Management Agency (FEMA), has been in existence since 1968. This program has been a major force in directing the course of development in the U.S., not only on the coast, but throughout all the flood-prone areas of the country. However, with regard to the coastal areas, the program was slow to get and to give direction to development, and the application of the program in coastal areas was an area of major criticism during its early years.

It is only now, 1984, that we feel the NFIP has achieved a steady state in the coastal areas. It has established a sound technical backing for its requirements, gained a national understanding, and achieved a fairly strong assurance of being accepted by local governments.

The achievement of this steady state has been made only after a period of loosely defined rules and regulations for the coastal areas. This has left considerable confusion to builders and developers, engineers and architects, the insurance industry, and local governments. The purpose of this paper is to summarize the current rules, regulations, and technical bases of the NFIP in the coastal area. This paper will also present what can be expected in the foreseeable future.

Our presentation will cover the following topics:

- o History of the coastal zone and the NFIP
- o Flood insurance zones in the coastal areas
- o The flood plain management and construction regulations of the NFIP
- o Representative examples of flood insurance rates
- o A summary of the storm surge models
- o A summary of the wave height and wave runup models
- o A brief discussion of the application of the barrier island regulations
- o Current updates to the surge and wave height models now being completed and contemplated by FEMA

HISTORY OF THE COASTAL ZONE DESIGNATIONS

Itemized below are the key dates for the NFIP in the coastal areas.

1969 - Inundation of the 100-year flood (A zones) was identified in the coastal zone.

1972 - First V zones (coastal high hazard area[1]) in areas of obvious wave action were applied to the coastal area. Zones V1 through V30, when determined, utilized the popular surge models of the early 1970s.

1975 - The Galveston District Corps of Engineers established the three-foot wave as that wave which will induce significant damage above and beyond inundation to structures (Reference 1). From this, using a convention of maximum wave height equaling 78% of the depth, a four-foot stillwater storm depth was established to identify V zones. In other words, areas of stillwater inundation with depths greater than four feet which had significant exposure to waves were considered V zones.

1977 - The National Academy of Sciences (NAS) completed its wave height methodology for V zone identification (Reference 2). It was to be applied using established stillwater elevations.

1979 - A cost benefit study, undertaken by FEMA, showed a positive ratio, as high as 8:1 in some instances, for implemention of the wave height methodology.

September 1979 - Hurricane Frederick occurred, establishing itself as the most costly natural disaster in U.S. history.

April 1980 - The first wave height study became effective on the coast of Alabama. The Federal Insurance Administration (FIA) initiated a major program to study communities on the Gulf and Atlantic coasts.

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[1] "Coastal high hazard area" means the area subject to high velocity waters including but not limited to hurricane wave wash or tsunamis.

1981 - A storm surge model by Tetra Tech was published by FEMA (Reference 3). The purpose was to standardize coastal storm elevation determination for flood insurance applications.

1984 - Virtually all communities requiring coastal studies have studies in progress or completed.

1984 - Refinements to the NAS wave height model and the Tetra Tech surge model have been undertaken and evaluated by FEMA.

It should be noted that the coastal studies have been a major area of criticism for the Program. With the early utilization of only storm surges to identify the coastal hazards, it was well recognized that the overall coastal hazards were vastly underrated. As a result, allegations were made that the NFIP was encouraging development along the coast by providing unrealistically low insurance rates to protect those who built. Changes in technology and insurance premiums made in the past few years have done much to nullify this argument.

FLOOD INSURANCE ZONES

The medium by which the flood insurance zones are identified for a community is the Flood Insurance Rate Map (FIRM). A FIRM is created for every community participating in the NFIP. The definitions below are for effective FIRMs with detailed studies.

- Zones V1-V30 - Coastal high hazard areas inundated by the 100-year flood where a three-foot or greater wave could occur. Wave crest elevations are shown as the base flood elevation.
- Zone V - Areas of estimated inundation by the 100-year flood with depths greater than four feet and exposed to provide wave generation. No base flood elevations shown.
- Zones A1-A30 - Special Flood Hazard Areas (SFHAs) inundated by the 100-year flood with waves less than three feet. The wave crest elevations are shown as the base flood elevations.
- Zone A - Areas of approximate determination of 100-year inundation. No base flood elevations shown.
- Zone AO - SFHAs of shallow flooding caused by sheetflow from the 100-year flood. Depths are between one and three feet and are shown.
- Zone AH - SFHAs of shallow flooding caused by ponding. Depths are between one and three feet, with the ponding elevations shown.
- Zone B - Areas of moderate flood hazard, usually expected to be inundated by the 500-year flood. In coastal areas, only the stillwater elevations are utilized. No base flood elevations are shown.
- Zone C - Areas of minimal flood hazard.

FLOOD PLAIN MANAGEMENT REGULATIONS FOR ALL FLOOD-PRONE AREAS

The next two sections summarize briefly the requirements of Part 60.3, Title 44, Code of Federal Regulations (Reference 4). These are four very readable pages of the Federal Regulations, which should be reviewed by anyone practicing engineering in the coastal zone. Communities are required to adopt and enforce these minimum standards in order to be eligible for participation in the NFIP. The regulations for all flood-prone areas are discussed below and the additional regulations applicable to the coastal high hazard areas are discussed in the following section.

REGULATIONS FOR SPECIAL FLOOD HAZARD AREAS

1. Participating communities must require permits for all proposed construction in SFHAs.
2. Participating communities must review proposed development to assure approval of all state and Federal regulations including Section 404 of the Federal Water Pollution Control Act.
3. Participating communities must review all development to assure safety from flooding with appropriate building standards.
4. Participating communities must assure that all subdivisions are designed with flood damage mitigation standards, applying to both structures and utilities.
5. For subdivisions of 50 lots or five acres or greater, if base flood elevations have not been established by the NFIP, they must be developed. This implies that where only Zones V or A are shown on a map, it is a requirement that studies be undertaken to establish base flood elevations.
6. Communities must utilize any available base flood elevation data available to them.
7. Communities must notify all neighboring communities of watercourse alterations and they must ensure the conveyance of all existing watercourses.
8. Mobile homes in SFHAs must be elevated and anchored using specific design standards.
9. Communities must maintain evacuation plans for mobile home parks and subdivisions.
10. New construction of, or substantial improvements to, residential structures in Zones A1-A30 and AH zones (ponding) must have the lowest floor, including the basement, elevated to or above the base flood elevation. For non-residential structures, certified waterproofing may be utilized.
11. In AO zones (sheetflow) residential structures must have their lowest floor elevated above the adjacent grade by the depth of flooding identified (1-3 feet). Again, floodproofing is permitted for non-residential structures if certified by a registered architect or engineer.
12. There must be adequate drainage paths around all structures in Zones AH (ponding) and AO (sheetflow).

13. Floodways (that portion of a reduced flood plain which would carry the 100-year flood without greater than a one-foot surcharge to the flood elevation) must not have any construction in them which will result in any increase in flood elevations. Mobile homes are prohibited except in existing parks.

SUMMARY OF ADDITIONAL REGULATIONS FOR THE COASTAL HIGH HAZARD AREAS

1. All new construction and substantial improvements must be landward of mean high tide.
2. All new construction and substantial improvements must be on piles, secured with the lowest structural member above the base flood elevation.
3. All new construction and substantial improvements must be certified by a registered architect or engineer to be designed to withstand the wave and water forces of the 100-year storm.
4. For all new construction and substantial improvements, the space below the lowest floor is prohibited for use for habitation. It must be free of obstructions and may utilize only breakaway walls for enclosure.
5. No fill is allowed for structural support.
6. No new mobile homes may be placed, except in existing parks.
7. There must be no degradation of sand dunes and mangroves.

In summary, for the coastal high hazard area, there are additional locational requirements, structural certification requirements, structural design requirements, and environmental requirements. Of particular note is the unique requirement that the lowest structural member must be above the base flood elevation as opposed to simply the lowest habitable floor.

The NFIP is voluntary. If a community chooses not to participate, flood insurance is not available, and grants, loans, or guarantees made by Federal agencies such as the Small Business Administration, Federal Housing Administration, and Veterans' Administration are prohibited for acquisition or construction in identified areas. Lending institutions insured or regulated by a Federal agency may make conventional loans at their own discretion in these areas. By law, if a flood disaster situation occurs in a nonparticipating flood-prone community, no Federal assistance for acquisition or construction may be provided in flood hazard areas. Individual and Family Grant assistance for housing and personal property is also not available after a flood disaster.

REPRESENTATIVE INSURANCE RATES

For comparison, indicated below are the annual premiums for three different structures. The premiums are based on the maximum structure insurance of $185,000, and the maximum contents insurance of $60,000 (References 5 and 6).

- For a structure in Zones A1-A30 with the lowest habitable floor at the base flood elevation, the annual premium is $287.50.

- For a structure in Zones V1-V30 with the lowest structural member at the base flood elevation, the annual premium is $2,442.00.
- For a structure in Zones V1-V30 with the lowest structural member at four feet or more above the base flood elevation, the annual premium is $946.00.

STORM SURGE MODELS

In performing coastal Flood Insurance Studies (FISs), determination of the stillwater elevations is the initial step. FEMA has used many different sources for stillwater elevations. These sources include frequency analyses of tidal gage data and storm surge models. In 1981, FEMA adopted Tetra Tech's storm surge model for use on the East and Gulf coasts (Reference 3). This model incorporates two separate models: a hurricane model to generate hurricane wind and pressure fields and a finite difference hydrodynamic model to generate storm surges using the hurricane data. The hurricane model uses an array of five hurricane parameters to simulate the wind and pressure fields of selected storms. The storm model uses a variable grid mesh which incorporates water depth, bottom friction, shoreline configuration, barrier islands, and inlets. The model results in a time history of storm surges. These are combined with the predicted astronomical tide for the same time period to produce the stillwater elevation. A joint probability analysis is used to assign frequencies to the stillwater elevations. This model has been applied extensively in the Gulf and South Atlantic states.

For Virginia, Maryland, and Delaware, FEMA has used a joint probability analysis by the National Oceanic and Atmospheric Administration (NOAA), which utilizes the SPLASH model with modifications similar to those in SLOSH (Reference 7). It should be noted that FEMA is using SLOSH for hurricane evacuation studies. Because these studies do not assign a frequency to the storm being modeled, the results from the SLOSH model cannot be used in FISs.

In the New England states, an additional model is applied for consideration of the effects of northeasters. FEMA has adopted a model developed by Stone & Webster (S&W) which simulates wind and pressure fields for northeasters (Reference 8). This data is then used in the same manner as the hurricane fields to generate storm surges and stillwater elevations.

WAVE HEIGHT AND RUNUP MODELS

To evaluate the wave action effects, FEMA had the NAS prepare a methodology applicable to most areas along the Gulf and Atlantic coasts (Reference 2). This methodology considers the effects of wind fetches, stillwater depths and all types of stationary obstructions in determining wave heights and corresponding wave crest elevations. An incident wave height is calculated at the shoreline based on available fetch and stillwater depth. This wave height is modeled as it propagates inland. Energy losses due to vegetation, buildings, and other structures are considered, as well as wave generation over unobstructed areas. The calculated wave heights are used to determine the wave crest elevations which become the regulatory base flood elevations. This methodology has been applied to nearly all of the Gulf and Atlantic coastal communities.

The NAS methodology does not account for wave runup on steep shorelines subject to intense long period waves. In the New England states, many structures above the stillwater elevation were damaged by runup during the 1978 northeaster. To account for this hazard, FEMA contracted S&W to develop a model to determine the height of wave runup. S&W's computer model incorporates laboratory runup data from Phillip Stoa and uses the composite beach slope method developed by Thorndike Saville (Reference 9). The height of calculated runup is a function of beach slope and roughness, deepwater wave height and wave period. The maximum runup elevation is combined with the results of the NAS methodology to produce a simple yet realistic wave profile consistent with existing state-of-the-art technology to describe wave height variation in the surf and runup zones.

WEST COAST FLOODING

Most of the above-mentioned models and methodologies are not applicable to the West Coast. The West Coast is subject to severe flooding from tsunamis, winter storms, tropical storms, extratropical storms and the swells from these types of storms. For a large part of the West Coast, including Hawaii, the phenomenon that was determined to result in the worst flooding was modeled and mapped. For southern California, a joint probability analysis of astronomical tides, tsunami, offshore storms and landfalling storms is being performed for the coastline between the Mexican border and Morro Bay. FEMA has also just contracted for a tsunami model of the entire coast of Alaska. These last two models will complete the study of the areas of the West Coast subject to coastal flooding.

COASTAL BARRIER RESOURCES ACT

Another service provided by FEMA is the placing on the FIRMs of the "undeveloped barriers" identified under the Coastal Barrier Resources Act of 1982, by the Department of the Interior. Any development after October 1, 1983, in these areas is not eligible for any Federal funds, including flood insurance and disaster assistance. The classification of areas as "undeveloped barriers" has been challenged in court many times regarding the definition of "undeveloped" and "barrier." Most cases have been unsuccessful. Although not involved in the identification of the undeveloped barriers, FEMA has mapped these areas on the FIRMs for all of the affected communities. This was completed by October 1, 1983.

FUTURE ACTIONS

So far, we have briefly covered the flood hazard zones and regulations for coastal communities, and the methods of determining the flood hazards. We would now like to discuss FEMA's future involvement with coastal analyses.

Due to recent technological advances in the state of the art, unique situations encountered, and experience gained from application of their models, FEMA is currently reviewing and/or updating several of their methodologies. The National Weather Service of NOAA has been contracted to develop a comprehensive and authoritative set of hurricane climatological statistics to be utilized in future FISs. This will update a 1975 hurricane climatology study, NWS-15. All previous storms influencing the Gulf and Atlantic coasts will be analyzed to provide tabulated data of hurricane frequency parameters for determination of the wind and pressure fields for storm surge calculations. This will make variations of storm parameters smooth enough so that contractors can use the information directly. Decisions on the statistical representativeness of the sample size and final analysis will be made by NOAA and not left to individual contractors. It is estimated that this will be completed within 2 years.

In addition, FEMA has contracted a review of the complete Tetra Tech model for areas that could be potentially updated due to advances in the state of the art. Upon completion of this review, necessary updates will be made.

FEMA has just completed two updates to the NAS wave height methodology. These updates are really additions to account for unique situations. The first concerns the Mississippi Delta. The Mississippi River has deposited millions of tons of fine sediments into the Gulf of Mexico to form a soft mud bottom in contrast to the typical sand bottom of most coastal areas. This plastic, viscous bottom deforms under the action of a surface wave. This wave-like reaction requires energy from the surface waves, thus reducing the surface waves. Joseph Suhayda has just completed a methodology for FEMA to account for the wave energy losses in the Mississippi Delta. Waves in the offshore area are tracked over the muddy bottom resulting in lower wave heights at the shoreline. This methodology will be applied only to the Louisiana communities affected by this phenomenon.

The other situation FEMA has investigated is the effect of marsh grass on wave dissipation. The NAS methodology models vegetation as a rigid cylinder. This does not account for the flexibility of marsh plants. A FEMA task force is in the process of completing a methodology that accounts for different types of marsh plants, flexure of the plants, and wind energy input.

e Another service provided by FEMA is their "Design and Construction Manual for Residential Buildings in Coastal High Hazard Areas." FEMA is currently negotiating a contract for an updated and more detailed version.

CONCLUSION

By the end of FY 85, all of the coastal communities in the United States will have detailed studies completed or in progress. This will not be the end of FEMA's involvement in the coastal areas. Refinements will continue to be made with advances in the state of the art. Although FEMA does not plan any massive restudies as a result of upgrades to their methodologies, these advances will be incorporated in future revisions and restudies as they become necessary.

To summarize, we have seen the Coastal Flood Insurance Program go from being controversial and very subjective to a program utilizing recent technical developments with well defined criteria and regulations. FEMA has provided a reasonable representation of potential flood hazards for nearly all of the coastal communities in the U.S. Along with its regulations, the FIRM becomes a flood plain management tool available to the coastal areas. While not promoting development, FEMA has provided this tool so that future development in the coastal areas will be constructed to minimize potential flood damage. Without FEMA's involvement in the coastal areas, development could be rampant and unsafe, with yearly flood losses drastically escalating.

REFERENCES

1. U.S. Army Corps of Engineers, Galveston District, Guidelines for Identifying Coastal High Hazard Zones, Galveston, Texas, June 1975.

2. National Academy of Sciences, Methodology for Calculating Wave Action Effects Associated with Storm Surges, Washington, D.C., 1977.

3. Tetra Tech, Inc., Coastal Flooding Storm Surge Model, Parts I and II, Pasadena, California, May 1978.

4. Code of Federal Regulations, Title 44, Parts 59 and 60, Washington, D.C., 1984.

5. Federal Emergency Management Agency, National Flood Insurance Program, Flood Insurance Manual, Washington, D.C., June 1, 1982, revised October 1, 1983.

6. Federal Emergency Management Agency, National Flood Insurance Program, Adjusters Workshop and Handbook, 1984 edition, Washington, D.C., December 1983.

7. National Oceanic and Atmospheric Administration, National Weather Service, Storm Tide Frequency Analysis for the Open Coast of Virginia, Maryland, and Delaware, NOAA Technical Memorandum NWS HYDRO-32, Silver Spring, Maryland, August 1976.

8. Stone and Webster Engineering Corporation, Development and Verification of a Synthetic Northeaster Model for Coastal Flood Analysis, Boston, Massachusetts, 1978.

9. Stone and Webster Engineering Corporation, Manual for Wave Runup Analysis, Coastal Flood Insurance Studies, Boston, Massachusetts, November 1981.