of postdisaster responses and recommendations for improved response; and the OMB directive requiring the formation of postdisaster teams under the leadership of FEMA to assess mitigation potential.[36]

Improved stormwater management. Before 1970, community stormwater management programs emphasized design of underground systems to convey five-year to ten-year flows from subdivisions to downstream areas as quickly as possible. In the 1970s, many metropolitan areas and some smaller cities and counties adopted not only subdivision regulations but grading, fill, and drainage ordinances that also applied to broader watershed uses.[37] These ordinances were designed to maintain natural flood levels by restricting impermeable surfaces, regulating vegetation removal and requiring detention ponds and compensatory storage. Regulations also included above-ground drainage systems capable of conveying 50- to 100-year floods. Large-scale mapping and hydrologic investigations that include future watershed conditions and flood storage formed the technical basis for these measures.

Principal Federal, State, and Local Roles

Progress in floodplain management in the 1970s was due to joint federal, state, and local efforts which are discussed in greater detail in the following chapters. The federal role in nonstructural floodplain management was to provide incentives and guidance, including subsidized flood insurance; standard-setting for state and local activities as a condition to flood insurance; disaster assistance; and grants in aid for acquisition; mapping; technical assistance; public education; and research. The federal government also constructed flood control works and flood warning systems and selectively acquired floodplain areas and floodproofed structures. These activities formed an increasingly comprehensive program during the decade, even though they were often perceived as piecemeal or special problem responses.

The state role was also to set standards, map, provide technical assistance, and educate the public. Thirty-one states regulated or established standards for local floodplain regulations. However, most of the actual implementation was done by local units of government (cities, villages, towns, and counties).

Regional planning agencies were not generally authorized to adopt floodplain regulations or acquire floodplains. However, many agencies, such as the Southeastern Wisconsin Regional Planning Commission, assisted local governments to draft and administer ordinances, gather data, and plan for matters of regional concern.

Local special government divisions such as sewage and flood control districts played important floodplain management roles in some areas. Their roles will probably become more important, particularly for metropolitan areas where stormwater management is being integrated with floodplain management within each watershed.

Problems with Implementation

Despite progress in the 1970s in developing comprehensive federal, state, and local floodplain management, gaps remain and implementation is incomplete. In the following sections, problems with implementation will be described first by geographic location and then by type of program.

Coastal Areas

Floodplain management in the 1970s has been least effective along the coasts, which have the most severe hazards and the greatest development pressures.[38] Perhaps 70% of the damage-prone structures in the nation lie in coastal areas. Many are located below the 100-year flood elevation. Coastal hazard areas are of two types: (1) wave or "velocity" zones,[39] often extending 200 to 2,000 feet inland, which are subject to storm waves, inundation and sometimes erosion; and (2) backlying areas,

Typical beach, dune system, backlying salt marsh, and bay can be seen in this aerial view of a barrier island (Sappelo Island, Georgia).

Photo source: Georgia Department of Natural Resources.

During a hurricane, public safety is threatened due to limited access to and from barrier islands such as Sanibel Island, above.

Photo source: John Clark

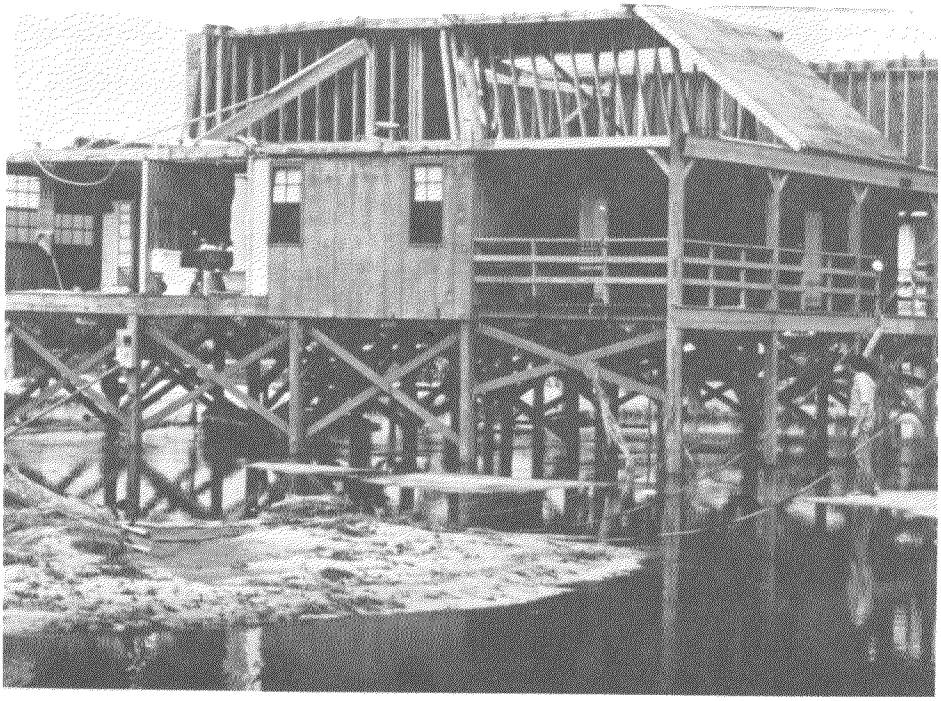
extending 2,000 feet to several miles inland, which are primarily affected by inundation.

Development in high velocity wave areas has been the major problem where the coastline is flat and waves may travel far inland. Beach front and barrier island areas with storm surge and wave elevations of 14 to 20 feet are found along much of the mid-Atlantic, Florida, and Gulf coasts. Velocity zones are less a problem along bluff shorelines of the West and upper New England, but erosion there is a significant threat.

Barrier island development is a special problem because of the combination of storm surge, waves, erosion and the inadequacy of evacuation routes to the mainland during hurricanes.[40] From the coast of Maine to Texas, there are 288 elongated, narrow "barrier" islands made up of unconsolidated and shifting sand.

Most of these islands are moving landward at rates of three or more feet each year.[41] Winds, tides, waves, currents, and rising sea levels of six to 15 inches per century cause this movement. Barrier islands are the first landforms affected by hurricanes and northeasters striking the Atlantic and Gulf coasts. With average elevations of less than six feet, the waves and storm surges deeply inundate the islands and cause major erosion.

Until the twentieth century, development on barrier islands was largely confined to fishing shacks and seasonal structures in bayside areas. In the 1960s and 1970s, the demand for second homes led to massive construction of houses and condominiums. A Department of Interior report estimated that island urbanization proceeded at twice the mainland rate during the 1970s and that 14% of the barrier island area had been developed at urban densities,[42] compared to 3% of the rest of the nation's



Hurricane wind and flood damage along the Alabama coast.

Photo source: Federal Emergency Management Agency