



**US Army Corps
of Engineers®**

Civil Works Floodplain Management Initiatives

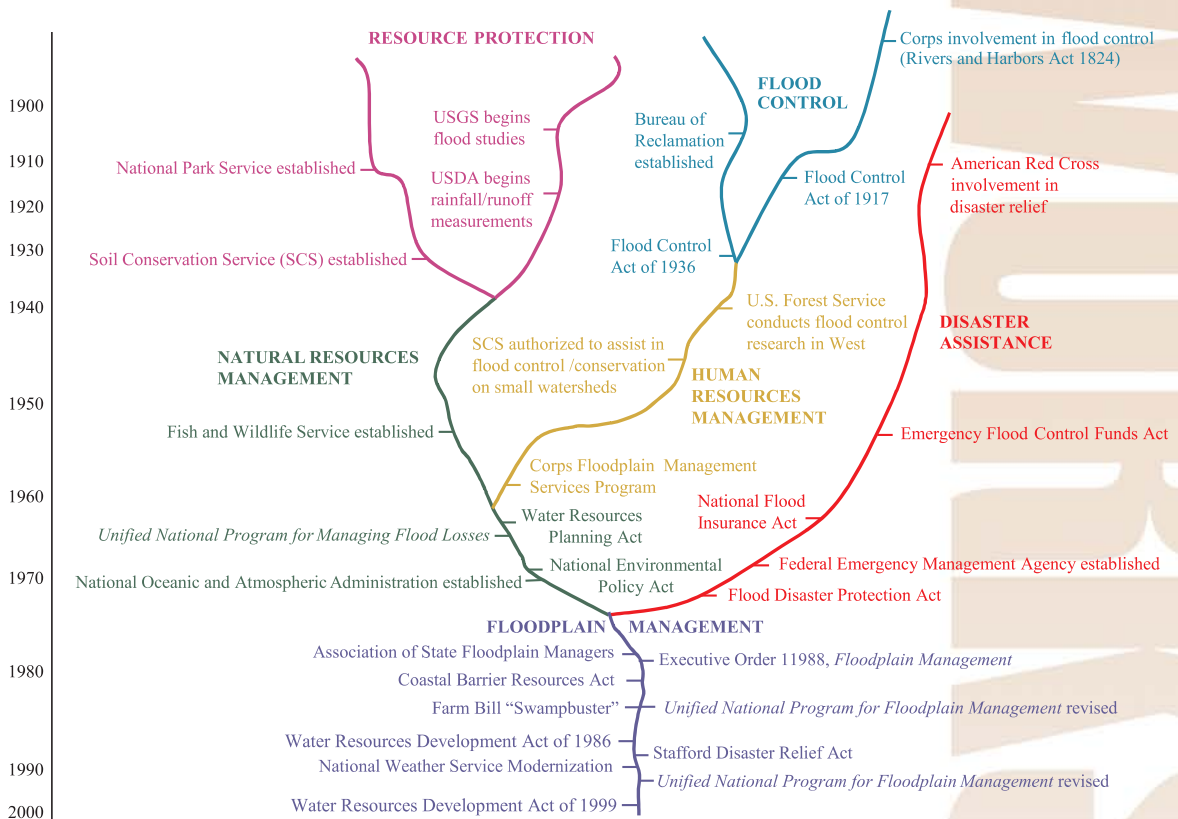
Value to the Nation

The Nation Confronts Flooding

In the late 19th and early 20th centuries, several efforts to reduce flooding focused on controlling the waters moving through flood-prone areas. The early history of this nation has the unfortunate footprints of floods and coastal storms: approximately 2,300 lives lost in the Johnstown, PA flood of 1889; over 6,000 lives lost in the Galveston, TX hurricane of 1900; around 230 lives lost in the Mississippi River Flood of 1927. It was paramount that risks to public safety be reduced and that damages to goods and services be curtailed. In response to these devastating events, Congress gave the Federal government primary responsibility to confront the Nation's flooding problems, recognizing the strength and organization of its structure, resources, inter-jurisdictional capabilities, and over-arching national policies.

As we moved through the second half of the twentieth century, the view of flood control changed to encompass a floodplain management strategy based on measures to regulate human activities and protect natural resources within the floodplain, in addition to methods and techniques to modify the waters associated with flooding. Engineers and decision-makers began to recognize that opportunity costs and water resource trade-offs needed to be considered in the planning and development of floodplain activities. Efforts were also mounting to facilitate better coordination between state/local entities and the Federal government. Presently, the Federal Emergency Management Agency (FEMA), the Natural Resources Conservation Service, the National Weather Service, and the Army Corps of Engineers have key roles during flooding and coastal storms. The current system of preparedness, forecasting, and flood control projects has reduced loss of life, but more can be done to minimize social and economic vulnerability even further, while restoring the natural conditions of floodplains.

Key Events in the Progression of Floodplain Management



(Modified from Unified National Program for Floodplain Management Report, Federal Interagency Floodplain Management Task Force, 1994)

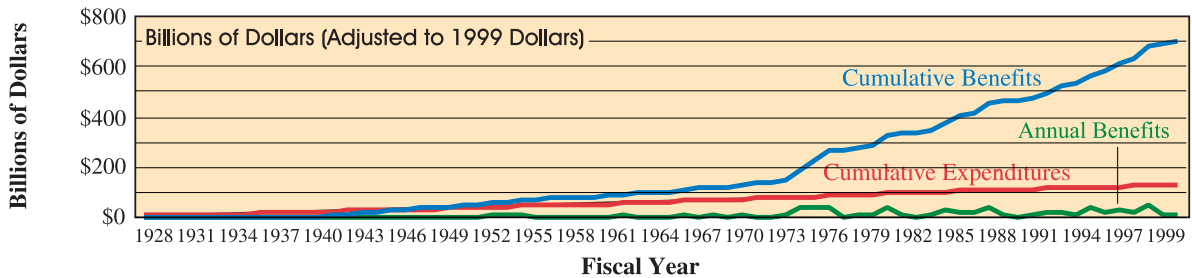
Flood Damages Prevented

The Flood Control Act of 1917 was the first official legislation that authorized the Corps to have a significant federal role in flood control activities nationwide. Today, the Corps is responsible for all projects containing Federal flood control storage, even if the project was built or is currently operated by other agencies. The Corps has constructed and currently operates 383 major lake and reservoir projects; raised and maintains over 8,500 miles of levees and dikes; and built hundreds of smaller local flood protection projects that have been turned over to non-Federal authorities for operation and maintenance. In addition, the Corps has constructed about 90 major shoreline protection projects. Today, most Corps flood and coastal storm damage reduction projects are constructed as joint ventures between the Federal government and non-Federal sponsors. Funding for flood and coastal storm damage reduction activities represents approximately 30% of the Corps Fiscal Year 2000 budget authority.

Corps flood damage reduction projects have preformed well. An estimated \$706 billion in damages have been prevented, most within the past 25 years (following the completion of the majority of projects). The cumulative cost of constructing and maintaining these projects is \$119 billion, about a six to one return on the investment. That return is expected to grow. These projects will likely provide many more benefits in the future for minimal maintenance cost.

Benefits of Federal Projects (Damages Prevented)

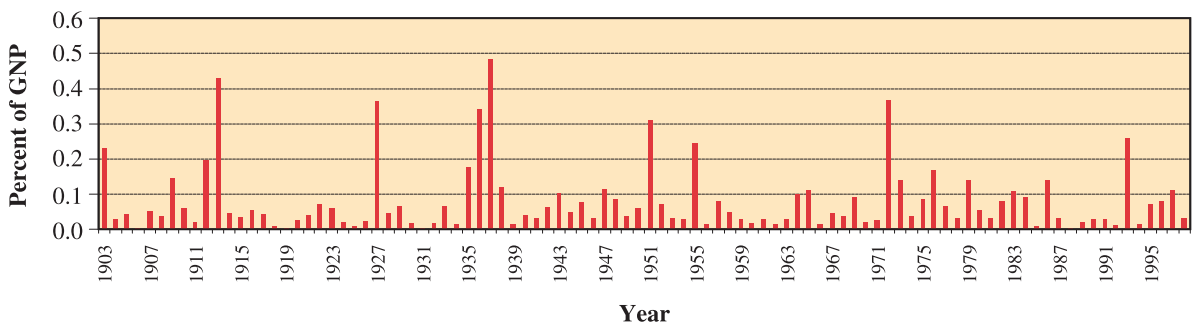
Cumulative Corps Expenditures (Principal plus Operations and Maintenance)



Residual Flood Damages

Despite the damage prevention resulting from floodplain management efforts, substantial residual flood damage problems remain across the Nation. Emergency disaster relief costs are still high, averaging around \$3 billion per year (1991-1997), and uninsured losses continue to mount. Although total residual damages remain high, they represent a relatively constant, though slightly decreasing, percent of the Gross National Product (GNP) from 1903 through 1996.

National Flood Damages Suffered



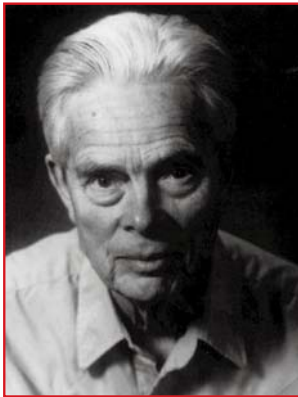
There are two aspects of the residual damage problem. One is the extensive unprotected development still remaining within the 100-year floodplain along the Nation's streams. Many of the over 20,000 communities in the United States, as well as extensive rural floodplain areas, are susceptible to flooding. Only 10-15% of these communities are protected by flood protection measures, and very few are afforded a high degree of protection. The other aspect of the residual damage problem is the continuing development just outside the 100-year floodplain. Development in these areas is not subject to floodplain regulation but is subject to less frequent, extreme floods. Also, development in flood-free areas continues to contribute to increasing storm water runoff rates, increasing the magnitude and frequency of flooding.

The Value of Floodplains

In 1991, FEMA estimated that 94 million acres of the United States lie within the 100-year floodplain. Floodplains are complex systems that provide vital functions to support ecological, social, and economic services. Since many of the functions and processes of floodplains cannot easily be put in monetary terms, it is difficult to determine the actual economic value of floodplain systems. Some examples of the useful attributes of floodplain areas are:

- Fish and wildlife habitat
- Natural vegetation and trees
- Surface water quality
- Ground water quantity
- Open space
- Agricultural land
- Recreation
- Historic and archaeological preservation
- Residential and commercial development
- Commercial transportation

Managing the Nation's Floodplains



Gilbert White

Gilbert White, a Gustafson Distinguished Professor Emeritus at the University of Colorado, is well known and respected for his views on floodplain management. As part of his dissertation in 1942, he presented principles that capture the essence of effective floodplain management. Professor White emphasized that the integration of planning and preparedness activities, such as flood insurance, zoning regulations, watershed management, and flood-proofing, coupled with management measures like flood control structures, building improvements, and emergency operations was the basis for a sound approach to comprehensive floodplain management. The ideas behind Gilbert White's principles have recently been reiterated in the findings and recommendations of the 1994 Interagency Floodplain Management Review Committee's Report (Galloway Report) and the goals and objectives of the 1994 Unified National Program for Floodplain Management Report.

"Notions of projects perturbing natural and social systems exactly as intended are being abandoned, even by engineers and economists who so long cherished them."

Gilbert White, 1986

Investigations after the 1993 Upper Mississippi River flooding led to issuance of the Galloway Report. The Interagency Committee investigated several aspects of the flood event to determine what could be done in the future to minimize the severity of the damages. As with Gilbert White, the Committee determined that a more collaborative and comprehensive floodplain management approach needs to be promoted nationwide.

"It is now time to organize a national effort to conduct effective floodplain management. It is time to share responsibility and accountability for accomplishing floodplain management among all levels of government and with the citizens of the nation. Working together, the nation's public and private sectors can accomplish the mission."

Galloway Report, 1994

Over the past 20 years, the Corps has responded to the shifting vision of floodplain management through its involvement in various national initiatives. American Heritage Rivers, Clean Water Action Plan, and Coastal America are examples of floodplain management initiatives in which Corps offices around the Nation are participating in activities that seek balance between resource use and environmental quality. In addition, the Water Resources Development Act of 1999 included a provision, authorizing the Corps to implement a program, Flood Mitigation and Riverine Restoration (Challenge 21), for the formulation, design, and implementation of non-structural floodplain management projects.

*"...this initiative expands the use of non-structural options to achieve the dual purposes of flood damage reduction and the restoration of riverine ecosystems. **Challenge 21** responds to those communities who have expressed a strong desire to aggressively reduce or even eliminate repeated losses and improve the quality of their environment by creating partnerships with these state, tribal and local entities, allowing their priorities to be realized."*

Assistant Secretary of the Army for Civil Works' testimony on the Water Resources Development Act of 1998, June 23, 1998

"The nation needs a healthy environment, capable of sustaining its development for socioeconomic purposes, for current and future generations. Potential for restoring beneficial conditions of our nation's environment, focusing on floodplains including rivers, streams, wetlands, and coastal areas, and protecting them from further damage, is boundless."

Chief of Engineers' testimony on the Civil Works Program Budget, Fiscal Year 2001, March 21, 2000

Modify human susceptibility to flood damage and disruption

The tools that support this strategy include permanent relocation; land acquisition and preservation of open space; design and location of services, utilities, and critical facilities; disaster preparedness; disaster assistance; flood-proofing; flood forecasting; warning systems; and emergency plans. Examples of Corps activities and projects that promote this strategy are:

- To date, the Corps has raised and flood proofed over 2,800 homes and structures and planning efforts are underway to provide flood proofing to an additional 9,000 homes.
- Funding for providing assistance to state and local communities through services such as flood hazard mapping, development of flood warning systems, and workshops for formulating and developing alternatives for floodplain management efforts totaled \$8.5 million for FY2000.
- The Corps has taken actions to acquire or relocate about 850 homes and structures and preserving approximately 750 acres of open space around the Nation.
- Working with local communities, the Corps has completed 35 flood warning and preparedness projects and planning is underway for an additional 18 projects.
- In September 1999, the Corps worked with volunteers to fill and place over 475,000 sandbags in Conway, South Carolina, to protect a power station and several water and sewer stations from the rising waters of the Waccamaw River.
- All Corps flood damage reduction projects are managed through a standard operating plan. Contained within these plans are specifications for project operations and communication procedures associated with emergency conditions.

Modify the impact of flooding on individuals and the community

The tools that support this strategy include emergency response and post-flood recovery. Examples of Corps activities and projects that promote this strategy are:

- More than 800 military and civilian employees performed more than \$840 million in pre-declaration and response and FEMA recovery missions throughout the Southeastern U.S. and Puerto Rico after Hurricane George in September 1998.
- The development of Regional General Permits by Corps Regulatory offices in California were instrumental in allowing cities and counties to perform maintenance and repair activities in a timely manner before, during, and after the flooding from the 1997/1998 El Nino event.
- As part of its disaster recovery mission in September 1996, the Corps delivered a total of about 340,000 gallons of water and 3.18 million pounds of ice over the ten days following Hurricane Fran.
- Following the July-August 1998 flooding in southeast Ohio, Corps personnel prepared 1,600 damage survey reports for FEMA in thirty days, assessing \$15.1 million in damages.
- Corps personnel removed a total of 75,000 tons of debris (fuel tanks, sand bags, home furnishings, appliances, and building material) from the Red River of the North after the April 1997 flooding.
- Approximately 400,00 pounds of bagged ice and 925,000 gallons of potable water were provided to citizens of Northern New Jersey after Hurricane Floyd in September 1999.

Supporting the Unified Floodplain M

As part of the broader, management, the Water K *Unified National Program for President in 1976. This re Unified National Program for reflects a shift in focus from floodplain management. T Interagency Task Forces the strengthened during the 1980 serve as the focus of the na damages within the context o four strategies shown on th through the Unified Fede floodplains wisely. It is a activities that respond to the level of floodplain use comp human and natural resources. floodplain management activi and principles laid out in the Report. As we move into activities and programs will a and objectives established thro*

Preserve and restore the natural resources and functions of floodplains

The tools that support this strategy include design and location of services, utilities, and critical facilities; land acquisition and open space; permanent relocation; restoration of floodplains and wetlands; preservation of natural functions and habitats; and beach nourishment and dune building. Examples of Corps activities and projects that promote this strategy are:

- As one of the agencies involved in the Coastal Wetlands Planning, Protection, Restoration Act of 1990 (CWPPRA) partnership, the Corps has taken the lead on projects that will restore over 3,900 acres of wetlands.
 - As part of the Upper Mississippi River Environmental Management Program, over 35,000 acres of aquatic, wetland, and floodplain communities have been restored and protected.
 - Through the beneficial use of clean dredged material, the Corps has created, restored, and protected approximately 2,500 acres of wetlands, shallow water, and beach habitats.
 - In efforts aimed at improving the natural functions of the various types of aquatic resources within floodplain areas, over 9,200 acres of wetlands, riparian, and terrestrial habitat and approximately 55 miles of stream have been restored or created in relation to existing Corps projects.
 - The Corps and the South Florida Water Management District have worked over six years in a multi-agency partnership to take a system-wide look at water in the Everglades. Some of the proposed projects included in the Comprehensive Everglades Restoration Plan, will remove approximately 240 miles of canals and levees to reestablish the natural flow of water through the Everglades and will construct approximately 35,600 acres of wetlands to treat urban and agricultural runoff.

Unified National Program for Floodplain Management

The unified national vision of floodplain management resources Council submitted the *Floodplain Management* report, which updated the 1966 *Managing Flood Losses*, clearly in flood damage reduction to through Executive Orders and 1976 report was revised and 's and 1990's and continues to national need to evaluate flood of floodplain management. The is page have been developed aral Program for managing anticipated that implementing e strategies will accommodate a atible with reducing risks to The Corps is implementing its ties to align with the strategies 1994 Unified National Program the twenty-first century, these assist in accomplishing the goals ough the Program.

Modify Flooding

The tools that support this strategy include dams; reservoirs; dikes, levees, and floodwalls; channel alterations; high-flow diversions; land treatment; on-site detention; and shoreline protection measures. Examples of Corps activities and projects that promote this strategy are:

- Flood damages prevented by Corps projects average \$22 billion annually, saving \$6 for every \$1 spent.
- Corps shoreline protection projects cover about 8 percent of the Nation's 2,700 miles of critically eroding shoreline.
- Approximately 95 million acre-feet of storage is dedicated to flood control in Corps lakes and reservoirs.
- Total floodplain damages from the Great Flood of 1993 could have been as high as \$29 billion had the structural flood protection system not existed. (Actual damages were about \$15 billion.)
- The Corps has worked with the City of Chicago and the Chicago Park District to protect the Lake Michigan shoreline, including the rebuilding of a breakwater which protects a water purification plant serving 2.5 million people.
- From 1950-1993, over 80% of the Corps Shoreline Protection funding was dedicated to beach restoration and nourishment.
- Levees and floodwalls along the Little Calumet River in Indiana will protect almost 10,000 homes and businesses.

Preparing for Flooding

Forecasting and planning for the occurrence of natural disasters are vital to reducing the loss of human life and property. When requested, the Corps provides technical support and advice to tribal, state, and local entities as well as private organizations, in determining the appropriate actions and steps they should take to reduce the likelihood or magnitude of the losses associated with flooding.

Through the **Flood Plain Management Services Program**, created by the 1960 Flood Control Act, the Corps provides floodplain information, technical assistance, and planning guidance (at 100% Federal cost) at the request of states and local governments to help them reduce potential flood damages. As a key element of the Nation's flood damage reduction efforts, the Corps' Flood Plain Management Services Program complements its protection measures by reversing pressures for development of floodplain lands. The program has provided free site-specific and community flood hazard information, advice and guidelines to thousands of public and private agencies, groups, and individuals for over 30 years. In Fiscal Year 1999, approximately 48,000 actions resulted from requests from state, local, and private groups. Thus far, specific flood hazard information (e.g., flood elevations by frequency at specific locations) has been provided to guide development involving around \$6 billion in property value.



Coordination meeting.



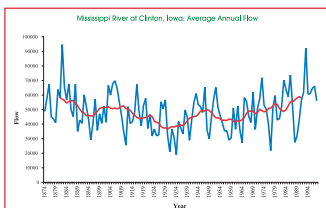
*Floodway Mapping Example
Source: FEMA*

Evidence indicates that floodplain regulation controls, as prompted by the National Flood Insurance Program (NFIP), have greatly deterred the development of property susceptible to flooding. However, such controls are not widespread and are not always strongly enforced. As a result, growth in damageable development has continued over recent decades, albeit at a reduced rate. Although the NFIP has been a powerful incentive to state and local governments to adopt regulatory controls, the insurance itself has not been a cure-all. Of the 20,000 communities in the United States, over 90 percent participate in the NFIP. However, fewer than 20 percent of all floodplain occupants are actually buying the insurance. Since 1969, the Corps has completed over 3,000 flood insurance mapping studies for FEMA and has also been instrumental in training private firms to accomplish FEMA mapping studies.

There may be certain circumstances where there is an unusual occurrence of flooding or specific locations where flooding is determined to be imminent. Under the Corps Advance Measures authority, efforts can be taken in advance of flooding to protect life and property. The town of Tillamook, Oregon found itself in this situation in 1999. With an anticipated pattern of wet weather, exacerbated by the unusual forces of the La Nina event, the town was not ready to accept the re-occurrence of flooding which had struck several times over the previous three decades. An advanced measures project was undertaken by the Corps, consisting of construction of a temporary flow restriction structure, the removal of log debris blockages, and the placement of several culverts with tide gates in levees which separated Tillamook Bay from the town. This project, completed on 24 November 1999 and costing \$375,000, prevented damages of \$2.6 million in two separate events during a three-week time period.



Tillamook flooding with advance measures in place.



Average Annual Flow at Clinton, Mississippi over the past 120 years.

The 1993 flood has caused some communities along the Upper Mississippi and Missouri Rivers to question earlier flood frequency estimates. The discharge-frequency relationship was last established in 1979 for the Mississippi River and in 1962 for the Missouri River. In light of the fact that new data needed to be collected and assessed, as well as the knowledge that modern technology, such as geographic information systems and more sophisticated hydraulic computer models are now available, Congress agreed to fund the Upper Mississippi River System Flow-Frequency Study to accomplish up-to-date analyses. The primary objective of the Study is to update the discharge frequency relationships and water surface profiles for portions of the Upper Mississippi River, the Lower Missouri River, and the Illinois River. The study is also

looking at how future climate change associated with global warming may affect flooding. The analysis of unimpaired flow data constructed by the U.S. Army Corps of Engineers found statistically significant upward trends in the annual flood in many gauge records along the Upper Mississippi and Missouri Rivers.

Responding to Flooding

Emergency preparedness and response are the responsibility of state and local agencies. When a natural disaster exhausts their resources and exceeds their recovery capabilities, Federal agencies can assist to prevent immediate human suffering and loss of human life, and mitigate property damages. The Corps is one of the primary Federal agencies that provides emergency support, which is limited to the preservation of life and the protection of residential and commercial developments.



*Satellite photo of Hurricane Floyd.
Source: National Weather Service*

The evolving science of identifying and tracking hazards and the advancements made in assessing risks have created new approaches, methodologies, and tools for emergency managers to forecast the need for response and recovery plans and activities. Prior to land fall of Hurricane Floyd in September 1999, the Emergency Operations Center (EOC), working with the National Weather Service, monitored the storm around the clock, for potential impacts to Corps water structures. The EOC staff also coordinated project operations with field offices and local sponsors. This information was also useful in preparing and mobilizing the necessary emergency services, personnel, and resources to assure a rapid and complete response.

In 1993 the Upper Midwest experienced unprecedented rainfall over an extended period of time, breaking all existing records for river levels, volume, peak discharge, duration, and frequency along areas of the Mississippi and Missouri Rivers. Actual rainfall for July 1993 ranged from 200-600% of the normal levels. This occurrence has been named the Great Flood of 1993 due to its magnitude and significant influence it had on numerous communities throughout the basin. Hundreds of local levees were overtopped, damaged, or breached during the flood. The Corps provided over \$230 million in levee rehabilitation assistance to repair 210 levees throughout the basin.



*Emergency repair work on existing levee
in Midwest.*



*Barges and ships along the
Mississippi River.*

Due to the extensive flooding throughout the Upper Mississippi Basin in 1993, the Mississippi River was closed to navigation for 36 days. Up to 2,000 barges were tied up awaiting the river re-opening to navigation. It is estimated that over \$100 million of revenue related to navigation was lost from the flood event. In an effort to minimize the economic losses associated with commercial navigation, the Corps joined forces with the U.S. Coast Guard and the towing industry to establish the Traffic Control Center. This joint effort was designed to evaluate requests for emergency vessel movements and development of implementation procedures for the re-opening of the River to commercial traffic. This partnership also provided technical analyses on the conditions of the river and effects of resuming waterborne traffic in an effort to assure levee safety and structural integrity.

The Corps Emergency Management professionals stand ready for rapid mobilization and immediate response to assist people with flood fighting and dealing with the aftermath of a disaster. Combining Corps authority with mission assignments received from FEMA, the Corps is prepared to assist state and local governments when response and recovery activities are beyond their capabilities. During Hurricane Floyd, the Corps' Wilmington District, provided about 750,000 gallons of water and 960,000 pounds of ice to affected communities in North Carolina. Wilmington District was also poised to respond to potential missions for temporary housing and debris cleanup.



*National guardsmen
transporting water to
North Carolina.*

Planning for Future Flooding

The Corps' floodplain management authorities related to actions occurring after a flood or coastal storm include planning, design, and construction of projects, protection of coastal areas, and assisting local entities in the consideration and planning of current and future floodplain land use and development. Many of the activities carried out under these cost-shared authorities include non-federal partnerships. Through the Corps planning process, relevant and viable project options for reducing the damages to human lives and property are evaluated. In addition, the Corps is responsible for determining the economic, environmental, and social effects that different approaches would have on the surrounding area. The Corps considers those measures intended to modify flooding (structural measures) and those intended to modify the human susceptibility to and impact of flooding by altering the use and occupation of the floodplain (non-structural measures).

Traditionally, the Corps was thought of as the Federal agency that could provide the technical and financial resources necessary to handle flooding problems of large magnitude through the development and implementation of structural measures. Structural measures include dams, reservoirs, levees, walls, diversion channels, bridge modifications, channel alterations, pumping, and land treatments. These types of projects are intended to reduce the frequency of damaging overflows. The Santa Ana River Mainstem Project, which includes the recently constructed Seven Oaks Dam, will provide protection to 3 million people and 255,000 structures in the Los Angeles area.



Seven Oaks Dam project area.



Emergent Wetland.

Non-structural measures are defined as those that reduce or avoid flood damages without significantly altering the nature or extent of flooding, by changing the use made of floodplains or accommodating existing uses to the potential flood hazard. As mentioned previously, the Corps has implemented a number of non-structural projects. The Flood Mitigation and Riverine Restoration Program, authorized in 1999, will emphasize the use of non-structural approaches to preventing or reducing flood damages in combination with ecosystem restoration. Projects carried out under this authority may also have structural elements. Coordination with FEMA and other Federal, tribal, state, and local entities will be an important implementation aspect if of this program.

Projects accomplished through this program must significantly reduce potential flood damages, improve the quality of the environment, and be justified considering all costs and beneficial outputs. \$200 million is authorized to be appropriated for efforts carried out under this program over the next five fiscal years.

The Corps' work in shore protection began in the 1930's when Congress directed the Corps to study ways to reduce erosion along the U.S. coastline and the Great Lakes. This was typically accomplished through the use of fixed structures, usually groins, jetties and seawalls. In the late 1940's and early 1950's a change occurred whereby the basic concept of shoreline protection shifted to beach restoration and nourishment. Beach nourishment in the late 1970's rejuvenated Miami Beach and opened its beach to the public. Beach attendance, based on lifeguard counts and aerial surveys, increased from 8 million in 1978 to 21 million in 1983. Miami Beach now has over 2 million foreign visitors who spend more than \$2 billion annually. Annual foreign revenue alone is about 40 times the \$52 million cost of this beach nourishment project that has lasted over 15 years. The capitalized project cost just over its current life, is about \$3 million per year. With foreign revenue of \$2 billion a year at Miami Beach, every \$1 invested annually to nourish the beach returns \$700 annually in foreign spending.



Before and after: beach nourishment along Miami coastline.



Field coordination.

The Corps provides assistance to state agencies through its Planning Assistance to States Program. Activities pursued under this program can include, but are not restricted to, efforts that focus on floodplains or flooding. States and Tribes request the type of assistance that they are interested in, and the resulting actions generally involve the analysis of existing data for planning purposes using standard engineering techniques, although data collection is often necessary. Much of the information gained through these efforts becomes the basis for state or tribal and local planning decisions. The Corps has worked with states and tribes around the Nation on activities related to wetland assessment, dam safety/failure, flood damage reduction, floodplain management, and coastal zone management/protection.