Informing and educating the public about both flood risk and about the importance of the natural and cultural resources of floodplains is an ongoing effort Much research has examined ways to provide information and to make people take action, and new techniques are being sought continually. Typical means of providing information to the public include distribution of pamphlets and other publications; use of radio, television, and newspapers; placement of warning signs; and many other more imaginative methods. A few jurisdictions require real estate agents to provide flood and other hazard information to prospective buyers of homes.

Awareness of the Value of Natural Floodplains

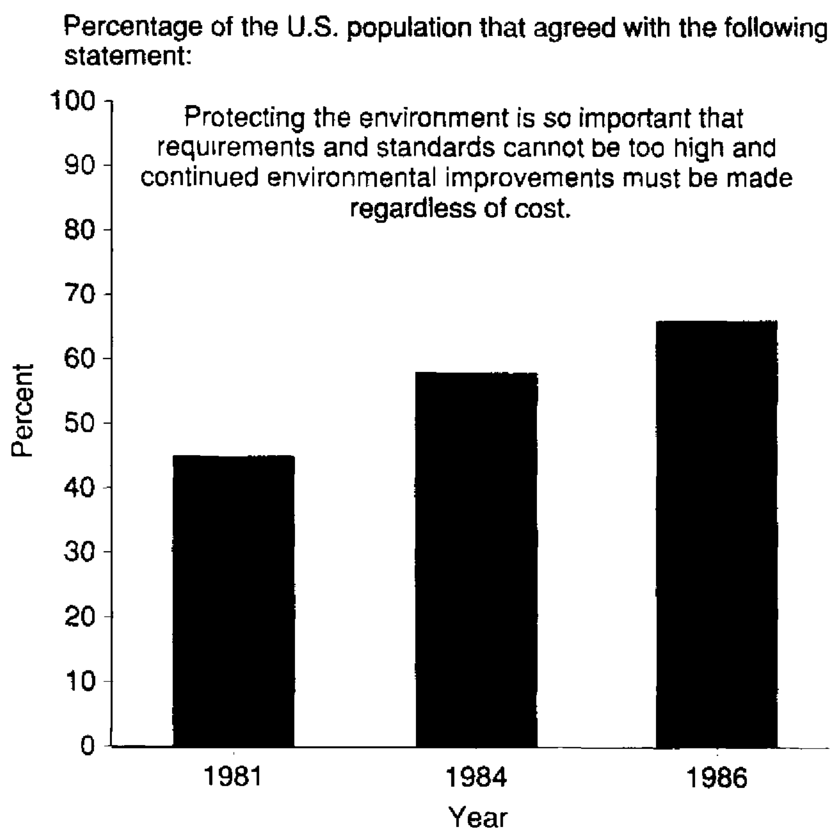
The protection of the natural and cultural resources of floodplains is beginning to emerge as a popularly expressed environmental objective; it is already encompassed in the broader environmental goals embraced throughout the nation. The general level of public environmental awareness and support for all types of protection programs has increased dramatically in the past 25 years, and the importance of preserving wetlands, protecting endangered species, and maintaining water quality is widely recognized.

This kind of awareness represents a potentially broad base of public support for floodplain management Unfortunately, this voiced support does not necessarily translate into action, particularly when an individual's own property is involved. Any restriction on individual property rights may be strongly resisted, or the loss of natural values may seem inconsequential because of the small area affected.

PUBLIC SUPPORT FOR WETLANDS

Concern for the loss of wetlands and support for their protection appear to be increasing. A 1982 Harris poll found that 83% of respondents felt that it is "very important" to preserve the nation's remaining wetlands. A 1985 poll reaffirmed this broad support. 85% of those polled favored strict enforcement of the Clean Water Act and its wetlands protection requirements.

Protecting the Environment



METEOROLOGICAL DATA: THE NWS

The collection and analysis of weather data for floodplain management—precipitation intensity, extent, and duration; wind data, and temperature—is the responsibility of the National Weather Service. The NWS's data collection system extends throughout the 50 states, offshore, and across the Pacific Ocean, and now consists of about 230 staffed stations, 165 automated stations, and almost 400 stations under contract In marine locations, automated moored and drifting data buoys are used. A network of automatic hydrological observing system stations is operated to provide near real-time data of river stages and rainfall The NWS also operates 128 weather radar stations that provide information on areal coverage, height, intensity, and movement of storms for warning and forecasting and hydrological and climatological programs. Over 1,300 ships report data systematically, and 300 others report data whenever they are in waters covered by NWS forecasts.

HYDROLOGICAL DATA: THE USGS AND THE EPA

Water data have been published annually by the U.S. Geological Survey since 1890 Records are now published annually for each state and maintained on a computerized data base, the National Water Data Storage and Retrieval System It includes data from USGS surface water records, with an index for the 320,000 water data storage sites; over 240 million daily parameters such as streamflow, groundwater levels, specific conductance, and water temperatures; 460,000 records of annual maximum streamflow and gage height values; 2.3 million analytical results describing biological, chemical, and physical water characteristics, and construction history, geohydrologic data, and one-time field measurements on 850,000 sites. The Environmental Protection Agency has a water quality data base of nationwide information on water quality, water quality standards, point-source pollution, fish kills, waste abatement needs, and other topics.

Knowledge, Standards, and Technology

Effective floodplain management requires a sound understanding of the physical, biological, and chemical processes that affect flood hazards and the natural resources of floodplains, as well as an appreciation of the social processes involved in human interaction with them. The last 25 years have witnessed a rapid expansion of the knowledge, information base, and technological expertise in floodplain management—products of the combined efforts of governments at all levels, academic institutions, and the private sector.

Climate Change and Weather Forecasting

One of the basic assumptions of hydrology and floodplain management has been that long-term climate is constant. Over the past few decades, however, new evidence has suggested that climatic changes can take place rather quickly (over a decade or so) and last for half a century or more. Therefore, the traditional 30-year averages of various climatic parameters—precipitation, for example—that have been the basis of past policy may be misleading for decisions involving long-term consequences

During the 1970s and 1980s, indications of a global warming trend increased, and some scientists hypothesized that human use of fossil fuels was amplifying the greenhouse effect sufficiently to cause changes in global climate. The normal historical relative rise in sea level is expected to continue over the next century, and as a result of the human-induced climate changes, the rate of rise is anticipated to increase. The predicted rise in global mean sea level is about 20 cm by 2030, and 65 cm by the end of the next century, with significant regional variations. This could have profound flooding implications.

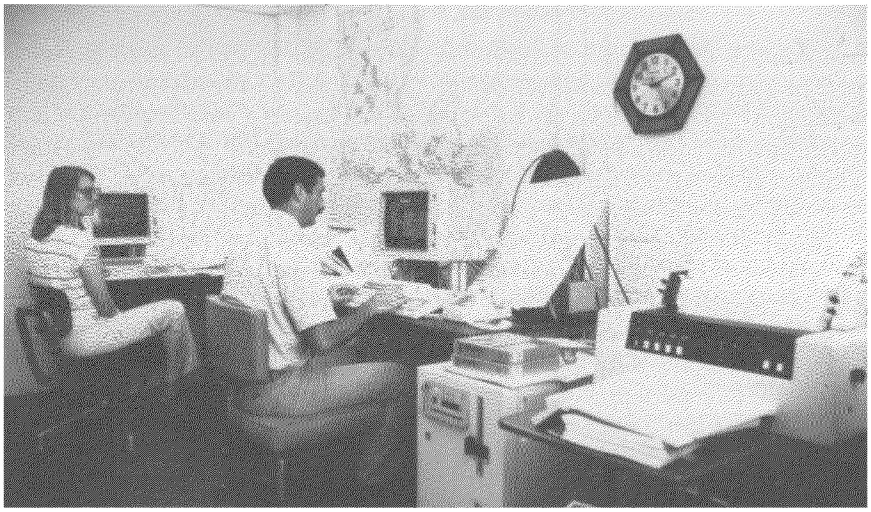
Streamflow Data

Over 90% of the 7,492 daily-record stream gages in the United States are operated by the U.S. Geological Survey in cooperation with a local sponsor. Since the first stream gage was established in 1889, the U.S. Geological Survey network expanded until 1980, but has declined since then, largely due to reductions in funding by local cooperators. This makes spatial and temporal consistency in gathering these data difficult. Even though information about runoff from small watersheds (between one and two square miles) is important for many purposes, including highway drainage design and urban drainage analysis, almost all of the nation's stream gages are located on larger watersheds. To partially fill this gap, the Agricultural Research Service has gaged hundreds of plot-sized watersheds to measure runoff for individual land uses and soils.

Hydrology and Hydraulics

Hydrologic parameters of importance to floodplain management are flood peak flows; flood volumes; time of concentration and travel; rate of rise; water velocities; sedimentation and degradation of flood channels and floodplains; flood elevations; the effect of geomorphology on floods and vice versa; the hydraulics of flood channels, floodplains, and human-made structures; and water quality as affected by floods These characteristics and their interrelationships are generally modeled mathematically.

Inexpensive, easy-to-use computers have made it possible to apply accepted methods of hydrology and hydraulics analysis to many floodplain management activities. The susceptibility to flooding of small developments and even single structures now can be evaluated relatively quickly and inexpensively. Researchers and a few practitioners are using two- and three-dimensional analyses of flood flows to obtain more realistic and reliable results than those yielded by the step-backwater analysis. Several models and methods are available for mapping the 100-year flood in coastal areas, for determining stillwater flood elevation from hurricanes along the Atlantic and Gulf coasts, and for accounting for the effects of wave heights, wave runup, and marsh grass. Other models address flooding on the Great Lakes, flooding from tsunamis, and other special situations. Sediment transport models are being developed, calibrated, and applied in many areas. All these techniques, which



In recent years, microcomputers have made it possible for agencies and jurisdictions at all levels to use sophisticated hydrologic and hydraulic models to analyze potential flooding at virtually any scale.

Microcomputer workstation at the Floodplain Management Section, Louisiana Department of Transportation and Development

only a decade ago were very expensive and hence infrequently applied, help evaluate the effects of future urbanization, structures, and other land use changes. Although the computer revolution has improved many aspects of flood hydrology and hydraulics, it has also made possible misuse of the standardized techniques by those not fully aware of the assumptions and limits inherent in the methods.

Flood Forecasting and Warning

Weather forecasting, and hence flood forecasting, is improving with remote sensing capabilities and the availability of more real-time data. New radar equipment, such as NEXRAD, and other tools promise better precipitation forecasts for small-scale storms and flood forecasting for small watersheds. The combination of new satellite data on snow pack and real-time data on precipitation and temperatures may be combined with established runoff models and recurrence interval techniques to produce seasonal flood forecasts.

There are a small number of automated flash flood warning systems throughout the country, notably in Arizona, California, Colorado, Connecticut, Maryland, Nevada, New York, Pennsylvania, and Texas. The performance of these systems has been uneven, most have not been tested under actual flooding situations to determine if they will indeed provide the anticipated level of warning. As the technology improves and operation and maintenance experience is gained, additional automated systems will come into use, significantly reducing the loss of life from flash floods.

Soil Identification and Mapping

Soil maps and data have proven useful in identifying and classifying floodplains and wetlands. The modern soil survey, with improved techniques and standards, began in the mid-1950s By 1983, the Soil Conservation Service had mapped and classified about two-thirds of the U.S. land area (except Alaska), or nearly 1.3 billion acres. The Soil Conservation Service expects to complete soil surveys for the entire country by 2000 The agency is beginning to digitize existing soil surveys, and most of the remaining soil survey maps may be prepared with digital methods at the outset. This should improve the level of detail of soil classifications, standardize the map scales, and provide additional supporting information.

COMPUTER MODELS FOR HYDROLOGY AND HYDRAULICS

Computer programs like the Soil Conservation Service's TR-20 and the U S Army Corps of Engineers' HEC-1 can be used to mathematically model hydrologic conditions based on such parameters as flood peaks, volumes, rate of rise, and velocity. Other programs in use today are the Soil Conservation Service's TR-55 for small urban drainages and the Environmental Protection Agency's SWMM for urban drainages where water quality is important.

To determine a water-surface elevation for a single point on a stream, the Manning equation is often used and can give good results where normal flow prevails and there are no downstream obstructions However, when there are obstructions or other special conditions, a backwater analysis is used, and computer models have been developed to perform it as well The most widely used backwater model is the Corps' HEC-2 A special dynamic routing model has been developed by the National Weather Service for flood routing and inundation from dam breaks

The NWS also developed the first widely applied model, known as SPLASH, for early mapping of coastal flood zones under the National Flood Insurance Program. A more sophisticated model, SLOSH (Sea, Lake, and Overland Surge from Hurricanes), was developed in 1975 to model flood levels at the coastline for hurricanes of a particular magnitude, forward speed, and track. Today, the Coastal Flooding Hurricane Storm Surge Model is used by the Federal Emergency Management Agency to analyze coastal flood hazards.

Warning siren tied to flood sensors, Lavaca River, near Hallettsville, Texas.