PREVENTING FLOOD DAMAGE THROUGH THE USE OF AUTOMATED FLOOD WARNING SYSTEMS AND FLOODPROOFING OF STRUCTURES

Douglas W. Glowacki
Connecticut Department of Environmental Protection

Introduction

The State of Connecticut's Department of Environmental Protection (DEP) owns and operates an automated flood warning and response system. In 1988 the DEP hired a full-time meteorologist and electronics technician to program the computers and maintain the field gauges that make up the flood warning system. In addition, Doppler radar and satellite data are also received by the DEP. The DEP serves as the forecasting and weather monitoring arm of the Office of Emergency Management during severe weather events in Connecticut, and has been activated on over two dozen flooding events since 1988.

The Connecticut Automated Local/Statewide Evaluation in Real Time (ALERT) system is an automated early flood warning system. The ALERT system was installed in Connecticut by the Natural Resources Conservation Service (NRCS) in cooperation with DEP in 1985. The system was installed as a direct result of severe flooding that killed 13 persons in June 1982. The purpose of the flood warning system is to aid the DEP and National Weather Service (NWS) in issuing faster flood watches and warnings, and to assist communities in responding more rapidly to flash flooding.

The system consists of 48 rainfall gauges, 21 river gauges, 6 weather stations, and 3 coastal tide gauges (1995). These gauges monitor rainfall and river levels statewide, and transmit their data via VHF radio signals to a pair of computer base stations in Hartford, Connecticut (Figure 1). Radio repeaters are used to relay data from the field gages to the centrally located computers.

The base stations are located at the City of Hartford Public Works Department, and at the State Office Building within the offices of the DEP/Inland Water Resources Division (IWRD) in Hartford. Once received, the precipitation, river, tidal, and weather data are stored in the base station computers. Special software is used to analyze the data and alert IWRD staff of potential flooding conditions before they occur. The data is also uploaded in near real-time to the NWS Northeast River Forecast Center (NERFC) in

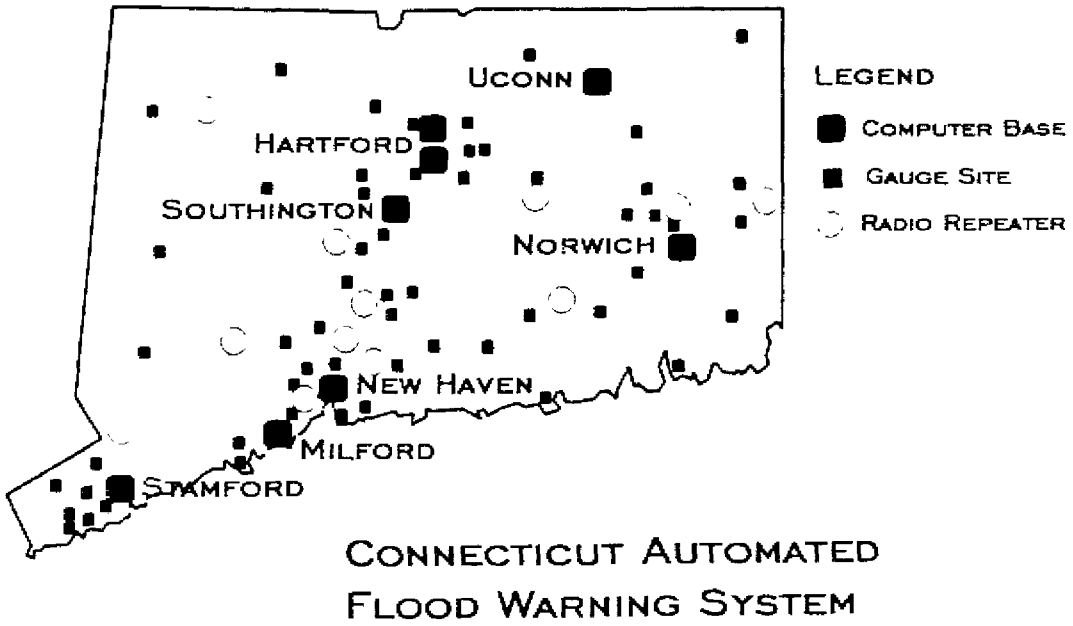

Figure 1. Statewide flood warning system.

Taunton, Massachusetts, and used to monitor rainfall and prepare river flood forecasts.

In addition to the statewide ALERT system there are five local river basin automated flood warning systems. Five towns that suffer from repeated flooding have installed ALERT systems to increase their flood warning and response time. Each town has its own computer base station that can monitor local conditions as well as communicate via phone modem with the central base stations in Hartford. Once connected to either of the Hartford base stations, towns can view heavy rainfall outside their own system before it arrives. Data from these individual systems are also relayed into the central computers in real time via radio repeaters.

Individual towns that join the statewide system by installing a local system receive financial and technical assistance from the DEP and the federal government. Because of this assistance, the cost to each town to install a new system is minimal compared to the dollars saved during a flood. On average, a local automated flood warning system includes three rainfall gauges, one river gauge, and a computer station. The average cost of a system is approximately $50,000. In Connecticut, towns installing new systems can receive grants of up to 67% of the total cost. Currently, the towns of Wallingford and North Haven are installing local ALERT systems, joining the communities of Hartford, Milford, Southington, Norwich, and

Stamford, and the South Central Connecticut Regional Water Authority already in the ALERT system network.

The Benefits of an Automated Flood Warning System

Communities that suffer from repeated water damage caused by the flash flooding of small rivers and streams can typically increase their warning time by a minimum of 3-4 hours, providing emergency personnel with an invaluable tool for responding to flooding emergencies. The Connecticut ALERT system is designed to provide NWS forecasters with the necessary data to make forecasts within two hours of the start of heavy rainfall. Storm data is stored for retrieval and analysis, which typically includes an estimate of the magnitude or frequency of the flood event. The ALERT system also provides fairly accurate rainfall and meteorological data to the Departments' Forestry Division Fire Monitoring Program, and approximately two dozen engineering and water quality testing firms. Water quality tests often can only be conducted under specific runoff and rainfall conditions.

The No Action Benefit

An added real benefit of Connecticut's ALERT system that is often overlooked is the "no action" benefit. This refers to cases where a community can choose not to act in an otherwise borderline situation because their personnel know that flooding will not occur. The instantaneous collection of data by the automated system allows towns to keep work crews from acting unless it is necessary. For instance, the unnecessary mobilization of a 10-person sandbag crew for one 8-hour shift may cost an average of $5,000 in staff and materials.

In addition, Connecticut's system is designed to operate in a sleep mode requiring no human monitoring unless flooding is occurring. This is made possible by voice synthesizers and auto-dialing phones within the system at two locations, allowing the computers monitoring flooding conditions to automatically call IWRD, NWS, and local staff at home and alert them of potential flooding.

The Flood Audit Program

In Connecticut an essential element of the installation of an automated flood warning system is the survey of critical entry elevations of homes and businesses within the 100-year floodplain of selected rivers. These surveys are used to prepare a flood audit for each building. The flood audit contains information on floodproofing and prevention techniques, and an emergency action plan that provides the homeowner or business with detailed emergency actions to take in case of flooding. When flooding is imminent, audit holders may be called by phone and given the latest forecast. As seen on the Day curve (see Figure 2) the greater the warning lead time (the time lag between the start of heavy rainfall and the beginning of flooding) the greater chance that the damage can be reduced (Day et al., 1969). Because objects such as

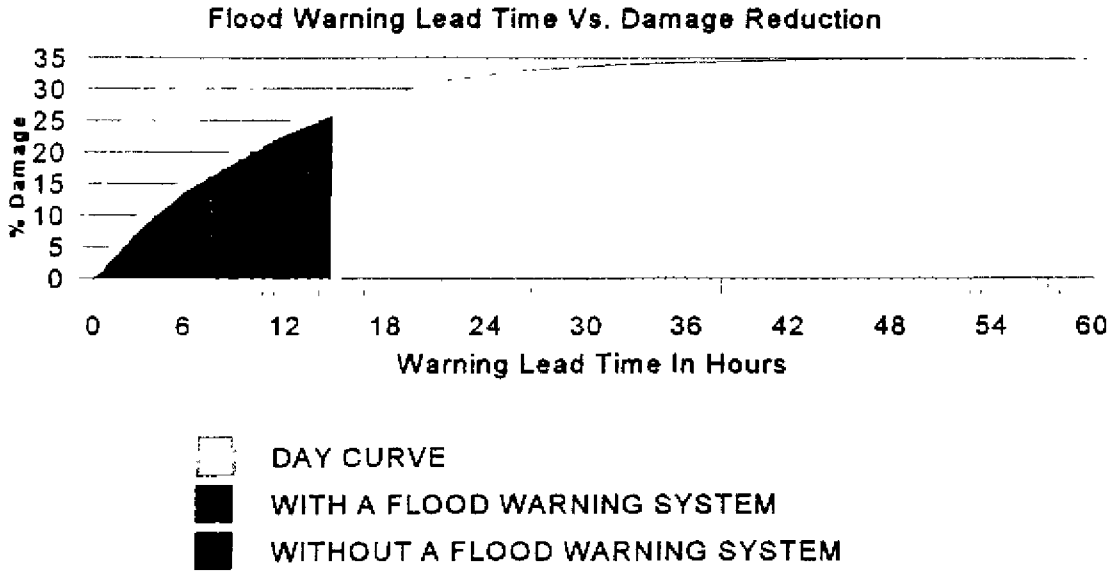

Figure 2. The Day curve.

water heaters, carpets, out buildings, and furnaces cannot be moved quickly, damage reductions reach a maximum value of around 35% of avoidable damage for a warning lead time of 48 hours or greater. Audit holders are also given a customized list of actions that can be taken well in advance of the next flood to reduce damage, such as installing check valves or strapping down oil tanks. Connecticut's system is designed to operate most effectively for rivers with 4-16 hours of warning lead time.

Pilot Projects

Connecticut has undertaken several pilot projects to enhance its ability to warn residents against flooding. Some of these projects include:

- The installation of 300 advanced technology National Oceanic and Atmospheric Administration weather warning radios in schools, police, fire, and emergency services departments statewide. These radios operate on the WRSAME (Weather Radio Specific Area Message Encoder) system which allows the NWS to direct its warnings to specific locations. Cost: $140,000.

- The installation of automated water level gauges within a Corps of Engineers dike system in Hartford, Connecticut. This system allows the City Public Works Department to monitor the entire stormwater collection and pumping system from a single location. Cost: $62,000.

- The City of Milford is installing a coastal flood warning system consisting of a public address system and 57 hurricane evacuation signs that also show the land surface elevation at each location in relation to mean sea level. Cost: $85,000.

- The state DEP is installing an automated coastal flood warning system to monitor water levels, wave heights, wind speeds, and temperatures at three coastal locations within Long Island Sound. Hurricane evacuation signs showing evacuation routes and ground surface elevation relative to mean sea level will be installed at over 300 locations. Cost: $82,000.

References

Connecticut Department of Environmental Protection
1992 "Flood Warning & Response, An Operational Guide."

Day et al.
1969 Untitled paper on flood warning lead time.

PROVIDING LOCAL FLOOD WARNING CAPACITY ON THE KENNEBEC RIVER: A GRASS-ROOTS APPROACH

Tom Marcotte
Carl McKenney
Town of Skowhegan, Maine

To fuel the industrial revolution, the power of flowing water was harnessed through dams. Above and below these dam sites, communities developed as people relocated to work in the water-powered mills. The story was the same any place in New England where there was enough geological chance to form a water fall that could be dammed. When the tide of industrial growth changed from water to electricity, the dams were upgraded to become hydropower generators. The growth that had begun in the late 1700s continued and homes and businesses intermingled with factories on the banks of Maine rivers. Before development took place, any flooding that occurred on these rivers was contained in uninhabited "intervales," which are in reality terraced floodplains formed over the centuries. Along the Kennebec River, the intervales were used for farming until the demise of agriculture as a strong economic force. Once the floodplains were no longer viable as farmland, they began to look very attractive as building sites. The ground was flat and the soils supported lawns, just as they had crops.

By the spring of 1987, hundreds of years of human interaction with the river had placed the communities along the Kennebec in jeopardy. Very few people were aware of just how powerful the river could be, and words such as "flood of record" or "hundred-year flood" had little meaning except to a handful of river watchers who had noted some disturbing increases in the frequency and severity of flooding. The April Fools Day flood changed the way people throughout Somerset County looked at flooding and flood awareness. The flood did $20 million worth of damage in the Kennebec basin and $60 million statewide.

During the many hours of debriefing that followed the disaster, one fact emerged: there was not adequate warning given to local emergency managers. This is not to say that the information to provide the warning was not available, rather it describes a scenario where the information did not get down to the local level in a means that was readily understandable. While

there was much discussion after the flood, it took five years before a set of events would take place to begin the process of improving flood warning.

The first event was a flood awareness workshop sponsored by the newly appointed County Director of Emergency Management. During the workshop, it was very evident that the people charged with managing emergencies had never seen a map of the flood hazard area. Firefighters, police, and public works departments were all in attendance at the meeting and when presented with the information available to them from a Flood Insurance Rate Map, asked, "Why haven't we seen this before?" The answer was that the maps and the Flood Insurance Study that accompanies them were usually the responsibility of the Planning Board and were used only to locate new structures and to set insurance rates—which was and still is the primary reason for the maps to exist.

Now that the problem had been identified, a solution had to be found. Merely distributing the maps out to the various public agencies was not in itself enough. A warning network had to be established that could be used any place in the river valley by any individual who had received training in monitoring the river's rise. Before this project began there was no unified network of river gauges available to local emergency managers. The U.S. Geological Survey had several gauges in the basin but the data from them was not readily available, and the gauges were used primarily for flood forecasting. At the local level, a method was needed to translate the forecast information into numbers that would help those monitoring the river and who were ultimately responsible for the evacuation of people and property. The solution to this part of the problem took the form of a Hazard Mitigation Assistance Grant from the Federal Emergency Management Agency (FEMA).

Because of the grant, Somerset County was able to site 29 flood warning gauges. The gauges are tied to mean sea level (NGVD) and each site has at least two permanent survey markers to allow replacement of the gauges if they are destroyed. A local surveying company worked with the project managers to develop a network of vertically and horizontally controlled survey points through the use of survey-grade global positioning system satellite receivers. The accuracy that was achieved through this method of surveying exceeded the accuracy that could have been obtained through more conventional means. By using GPS, the surveying phase of the project was accomplished in one week at half the originally projected cost. The survey points have also been added to the map of Somerset County on file at the Maine Office of Geographic Information Systems.

After the surveying had been completed, each municipality in the river valley could position flood warning gauges that would fit their local needs but would still be tied into the overall flood warning network. Training was given to members of fire departments, police departments, and public works departments in reading both the gauges and the FIRMs and in using a uniform reporting form. The County Office of Emergency Management will provide overall coordination during an actual event and through the use of the FIRMs and its computer will be able to use the flood forecasts form the Maine Emergency Management Agency to provide information to the river

monitors, which will allow them more time to carry out evaluations, should they be necessary.

In addition to providing enhanced warning capabilities in the river valley, this project has served to focus people's attention on the need for proper management of the floodplain. The permanent gauges are a constant reminder that there is a potential for disaster. Property owners can also take advantage of the surveyed elevation points in obtaining flood insurance. These points are the best available information of the height of structures above the base flood elevation established by FEMA.