RHODE ISLAND
Floods and Droughts

Following establishment of the first Christian settlement in Providence in 1636, population centers of Rhode Island developed first adjacent to Narragansett Bay and then along major rivers. During the American Industrial Revolution in the 1800's and early 1900's, the rivers provided water for power, processing, and waste disposal to numerous mills, which were built near every major stream. Concentration of population centers in coastal areas and along rivers, and construction of many buildings in flood-prone areas, eventually resulted in occasional loss of life and damage to mills and other structures due to tidal and river flooding.

Infrequent, extended droughts have caused economic loss by decreasing crop yields and farm income and by decreasing the water supply needed by commerce and industry. Because water currently (1988) is used in Rhode Island primarily for public water supply rather than for agriculture, the effect of droughts on water supply has been the principal concern of its inhabitants. In 1985, 69 percent of the freshwater used in Rhode Island was for public supply; less than 4 percent was used for irrigating crops (U.S. Geological Survey, 1990).

Rhode Island encompasses 1,212 square miles, of which about 13 percent is inland water. Inland water includes 357 freshwater ponds, lakes, and impoundments that constitute an area of 29 square miles (Rhode Island Water Resources Board, 1970); the saline waters of Narragansett Bay account for the remainder. Most of the impoundments were constructed during the 1800's to provide water supply to mills during dry weather. Since the turn of the century, new impoundments have been constructed mainly to provide for public water supply.

Figure 1. Principal sources and patterns of delivery of moisture into Rhode Island. **Size of arrow implies relative contribution of moisture from source shown.** (Source: Data from Douglas R. Clark and Andrea Lage, Wisconsin Geological and Natural History Survey.)

Quantitative measures of floods and droughts are obtainable from records of precipitation and streamflow. In this report, floods and droughts are assessed largely on the basis of streamflow records compiled by the U.S. Geological Survey. Systematic collection of streamflow records in Rhode Island by the Geological Survey began in 1929 when a continuous-recording gage was installed on the Blackstone River at Woonsocket. Broader geographic coverage began during 1939–41 when eight additional gages were installed on other major rivers. Precipitation records, which are more extensive than streamflow records, are available for more than 100 years at some stations in Rhode Island.

GENERAL CLIMATOLOGY

Rhode Island's climate is primarily continental. The climate varies with altitude and terrain and is modified by the State's proximity to the ocean. Most frontal systems that move across the country exit through the Northeast and affect Rhode Island. Therefore, the State has changeable weather and dependable precipitation. Principal airmasses that dominate Rhode Island are (1) polar continental, which is cold, dry air from Canadian and Arctic areas; (2) tropical maritime, which is warm, moist air from the Gulf of Mexico and adjacent subtropical waters; and, to a lesser degree, (3) polar maritime, which is cool, damp air from the North Atlantic (fig. 1). Tropical continental airmasses from the dry areas of the Southwest and Mexico and the airmasses from the Pacific Ocean generally have the least effect on the State.

Maritime airmasses deliver the greatest quantity of moisture to the State (fig. 1). In addition to the oceans, important moisture sources include local and upwind land surfaces, as well as lakes and reservoirs, from which moisture evaporates into the atmosphere. Typically, as a moisture-laden ocean airmass moves inland, it is modified to include some water that has been recycled one or more times through the land-vegetation-air interface.

Most precipitation occurs in association with frontal activity as warm, moist air (warm front) is pushed over a cold wedge or as an advancing wedge of cold air (cold front) lifts the warm, moist air above condensation levels. Convective showers, often thunderstorms, contribute to summer precipitation and occur most commonly in the higher altitudes of northwestern Rhode Island. In some years, tropical cyclones, which include tropical storms or hurricanes, bring excessive rain. Annual precipitation ranges from about 40 inches near Narragansett Bay (fig. 2) to 50 inches in the northwestern hills. At Providence, precipitation records spanning 166 years indicate a range from 25.4 inches in 1965, which is 56 percent of normal, to 65.1 inches in 1972, which is 144 percent of normal. Precipitation varies little during the year; generally, November and December are the wettest months, and June is the driest. Annual snowfall ranges from about 30 inches along the coast to about 50 inches in the northwest. At Providence, total snowfall records indicate a range of 11.3 inches in 1972–73 to 75.6 inches in 1947–48.

Large floods are rare in Rhode Island but may occur during any season. Spring floods generally are caused by intense rainfall combined with warm, humid winds that rapidly melt an accumulated snowpack. In summer, local flooding generally is caused by severe thundershowers, whereas flooding of larger areas commonly is caused by tropical cyclones and coastal storms.

Summer dry spells, during which crops and lawns may require irrigation, are fairly common; however, prolonged droughts are rare.

Extended droughts result when dry, continental air predominates and prevents coastal storms and tropical cyclones from moving into the State.

MAJOR FLOODS AND DROUGHTS

Streamflow records were used to determine the approximate areal extent of major floods and droughts during 1929–88. The most significant floods and droughts in Rhode Island are listed chronologically in table 1; rivers and cities are shown in figure 2. Annual-maximum discharges recorded at six selected streamflow-gaging stations, the drainage basin boundary upstream from each station, and the area affected by the severity of four major floods are shown in figure 3. Annual departure from long-term average streamflow and the severity of three major droughts are shown in figure 4. The six gaging stations were chosen because they were currently in operation, had an adequate length of record, and were on largely unregulated streams that have diverse basin sizes and hydrologic settings. The delineation of areas of flooding was supported by other, shorter term records and by records from gaging stations in adjoining States. Although flow of the South Branch Pawtuxet River at Washington (fig. 3, site 3) is regulated by Flat River Reservoir, the gaging station was included because the records were needed to describe flooding in the Pawtuxet River basin. Streamflow data are collected, stored, and reported by water year (a water year is the 12-month period from October 1 through September 30 and is identified by the calendar year in which it ends).

FLOODS

The flow of many Rhode Island rivers is affected by various degrees of regulation and quantities of reservoir and pond storage. The rivers most significantly affected are the Blackstone and Pawtuxet Rivers. The Blackstone River has been regulated since 1961 by West Hill Reservoir in Massachusetts, which has a storage capacity of 542 million ft^3 (cubic feet). This reservoir is on a tributary that enters the Blackstone River about 6 miles upstream from the Rhode Island state line. The South Branch Pawtuxet River has been regulated since about 1875 by Flat River Reservoir, which has a usable capacity of 250 million ft^3. The main stem of the Pawtuxet River, in addition to being affected by the Flat River Reservoir, has been affected since 1926 by regulation of the Scituate Reservoir and its five feeder reservoirs, which have a combined usable capacity of 5,300 million ft^3. The flood peaks of March 1936 and July 1938 near the mouth of the Pawtuxet River are estimated to have been decreased in height by 2.1 feet and 0.6 feet, respectively, as the result of available storage in Flat River and Scituate Reservoirs (U.S. Army Corps of Engineers, 1939).

Only West Hill Reservoir is designed principally to store floodwater; Flat River Reservoir is used primarily for recreation, and Scituate Reservoir is used for water supply. Moreover, public-supply demand is approaching the quantity that Scituate Reservoir can yield reliably; therefore, the flexibility to use its storage capacity to mitigate peak floodflows has been lessened. As a result, downstream reaches of the Pawtuxet River may experience greater stages and discharges during future floods. River stage is affected by local topography and other factors so that, for a given flood discharge, the depth of flow may differ greatly from place to place on the same stream. Similarly, depth of flow among streams differs greatly.

Some of the most severe floods of record were in March 1936, July and September 1938, August 1955, March 1968, January 1979, and June 1982. Four major floods are described in this section. They were among the most severe in Rhode Island in terms of magnitude, areal extent, loss of life, and property damage.

During August 18–19, 1955, Hurricane Diane passed through Rhode Island just south of Providence. Torrential rain caused the greatest flood known at Woonsocket (Bogart, 1960), where damage was estimated by the U.S. Army Corps of Engineers (1956) to be $21 million. The storm caused three deaths, record high tides, and extensive damage to bridges, buildings, and industries throughout the State. Peak discharge of the Branch River at Forestdale (fig. 3,

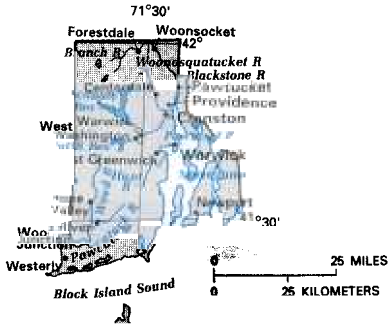


Figure 2. Selected geographic features, Rhode Island.

Table 1. Chronology of major and other memorable floods and droughts in Rhode Island, 1927–88

[Recurrence interval: The average interval of time within which streamflow will be greater than a particular value for floods or less than a particular value for droughts. Symbol: >, greater than. Sources: Recurrence intervals calculated from U.S. Geological Survey data; other information from U.S. Geological Survey, State and local reports, and newspapers]

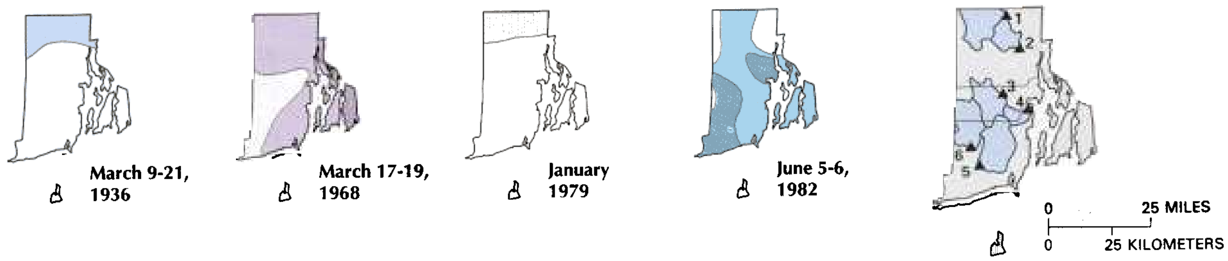
Flood or drought	Date	Area affected (fig. 2)	Recurrence interval (years)	Remarks
Flood . .	Nov. 2–4, 1927	Statewide	50	Deaths, 2. Severe damage to mills, highways, and bridges.
Drought	1930–31	Statewide	Unknown	Estimated streamflow about 70 percent of normal.
Flood . .	Mar. 9–21, 1936	Statewide	25 to 50	Deaths, 2; damage, $80,000 in Pawtuxet River basin.
Flood . .	July 18–24, 1938	Statewide	Unknown	Six-inch torrential rain. Damage, $1 million to crops and businesses.
Flood . .	Sept. 17–22, 1938	Coastal areas	Unknown	Hurricane floodtide. Large loss of life and property damage.
Drought	1941–45	Statewide	20 to >50	Streamflow about 70 percent of normal. Particularly severe in Pawtuxet and Blackstone River basins.
Drought	1949–50	Statewide	15 to 20	Estimated streamflow 70 percent of normal.
Flood . .	Aug. 18–19, 1955	Blackstone River basin	>100	Hurricane Diane. Deaths, 3; damage, $21 million at Woonsocket.
Drought	1963–67	Statewide	>50	Water restrictions and well replacements common.
Flood . .	Mar. 17–19, 1968	Statewide	25 to >50	Damage, $9 million, mostly to dwellings.
Flood . .	Jan. 1979	Blackstone and Pawtuxet River basins.	25 to 50	Major sewage-treament plants flooded. Damage, $6 million.
Drought	1980–81	Statewide	10 to 25	Ground water deficient in eastern part of State. Considerable crop damage in 1980.
Flood . .	June 5–6, 1982	Statewide	25 to 100	Thunderstorms. Pawcatuck and Pawtuxet River basins hardest hit. Deaths, 3; damage, $3 million.
Drought	1987–88	Southern areas	Unknown	Crop damage, $25 million.

site 1) was 4,240 ft³/s (cubic feet per second) and of the Blackstone River at Woonsocket was 32,900 ft³/s.

During March 17–19, 1968, Rhode Island received 4–7 inches of rainfall. Runoff and snowmelt from a preceding storm on March 12–13 combined with runoff from this storm to produce peak discharges on many streams that exceeded previous known maximums. Peak flows were greatest in the Hunt and Pawcatuck River basins (fig. 3; sites 4–6) in south-central and western Rhode Island, where flood discharges had recurrence intervals that exceeded 25 years (Wood and others, 1970). No loss of life was attributed directly to the March 1968 flood, but damage to dwellings was extensive; industrial, commercial, and public losses also were substantial. At Pawtucket, water use was restricted when the Blackstone River flooded a water-purification plant. Damage was estimated at $9 million (Wood and others, 1970).

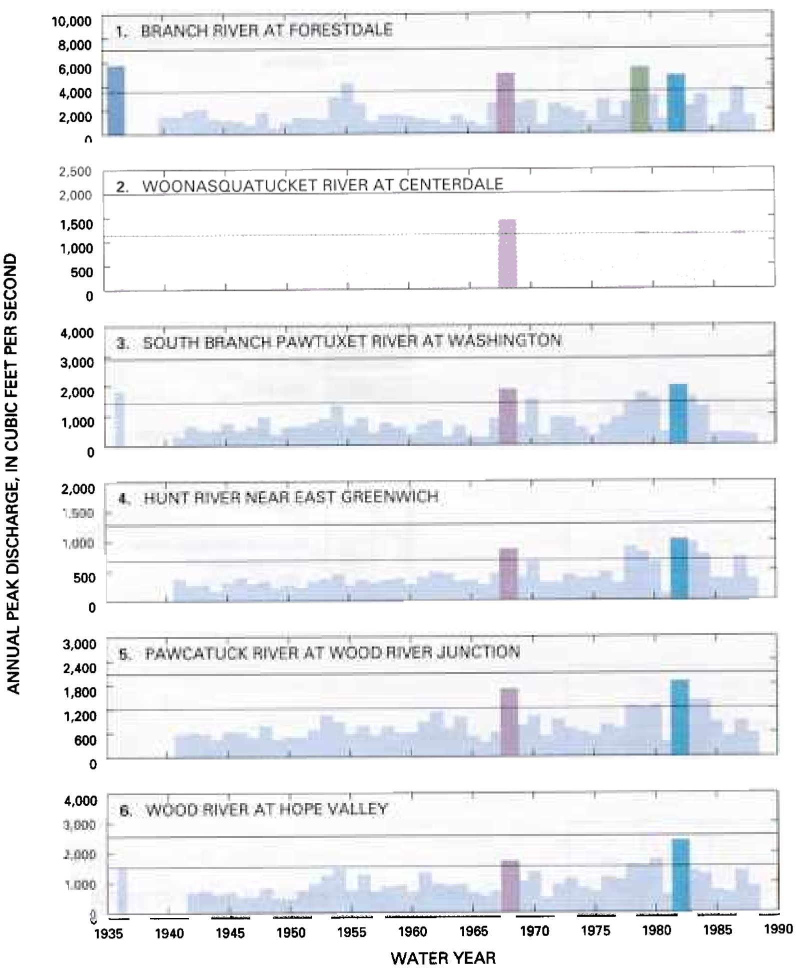
In late January 1979, 5 inches of rain caused some of the largest streamflows of record. The resulting flood caused estimated damage of $6 million (Providence Sunday Journal, January 28, 1979), mostly to homes and businesses. Damage in Cranston, Warwick, Providence, and West Warwick was severe. Flooding in the Pawtuxet River basin (fig. 3, site 3) inundated sewers beneath the flood plain of the Pawtuxet River and caused the West Warwick and Warwick sewage-treatment plants to discharge untreated wastewater into the river. The West Warwick treatment plant ultimately had to be closed. Because Scituate Reservoir was nearly full before the storm, its capacity to capture and store runoff to the Pawtuxet River during the

Areal Extent of Floods



U.S. Geological Survey streamflow-gaging stations and corresponding drainage basins — Numbers refer to graphs

Peak Discharge



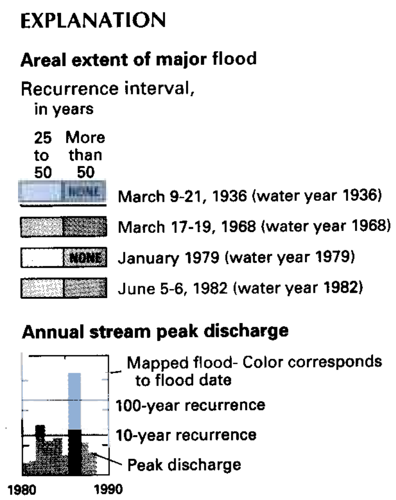


Figure 3. Areal extent of major floods with a recurrence interval of 25 years or more in Rhode Island, and annual peak discharge for selected sites, water years 1936–88. (Source: Data from U.S. Geological Survey files.)

flood was diminished. At Woonsocket, a recently completed flood-control project lessened flooding in much of the downtown area despite a surge in flow created when a dam failed upstream at Grafton, Mass.

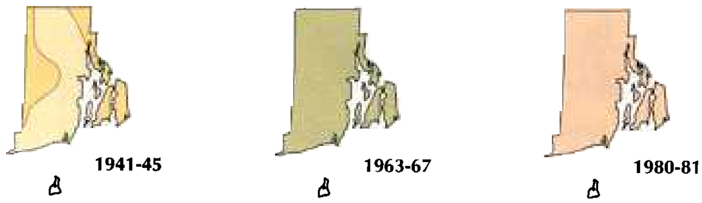
A torrential storm on June 5–6, 1982, produced as much as 8 inches of rain and caused Statewide flooding. Substantial damage was done to buildings on the flood plain bordering the lower reaches of the Pawtuxet River. A large bridge was damaged, and the municipal sewage-treatment plants in Warwick and West Warwick were flooded. Damage to crops was extensive. The storm occurred early in the growing season, and the torrential rainfall caused soil and fertilizer losses that affected the development of row crops. Three deaths and damage of about $3 million occurred as a result of the flood (Providence Journal, June 8, 1982).

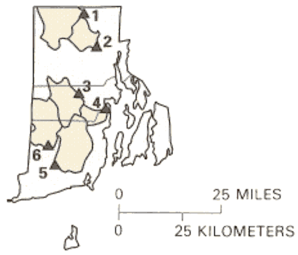
DROUGHTS

For purposes of this report, major droughts were considered to be those that were hydrologically significant and that lasted for 1 year or longer. Consideration also was given to a drought's effect on public and agricultural water supplies and to its economic effects. Graphs showing annual departures from average streamflow illustrate the effects of drought on the flows of six rivers (fig. 4). Negative departures from mean annual flow indicate less than normal flow; positive departures indicate greater than normal flow.

Rhode Island has had at least six major droughts since 1929 (table 1). The geographic extent and recurrence intervals of three of these droughts (1941–45, 1963–67, and 1980–81) are shown on the maps in figure 4.

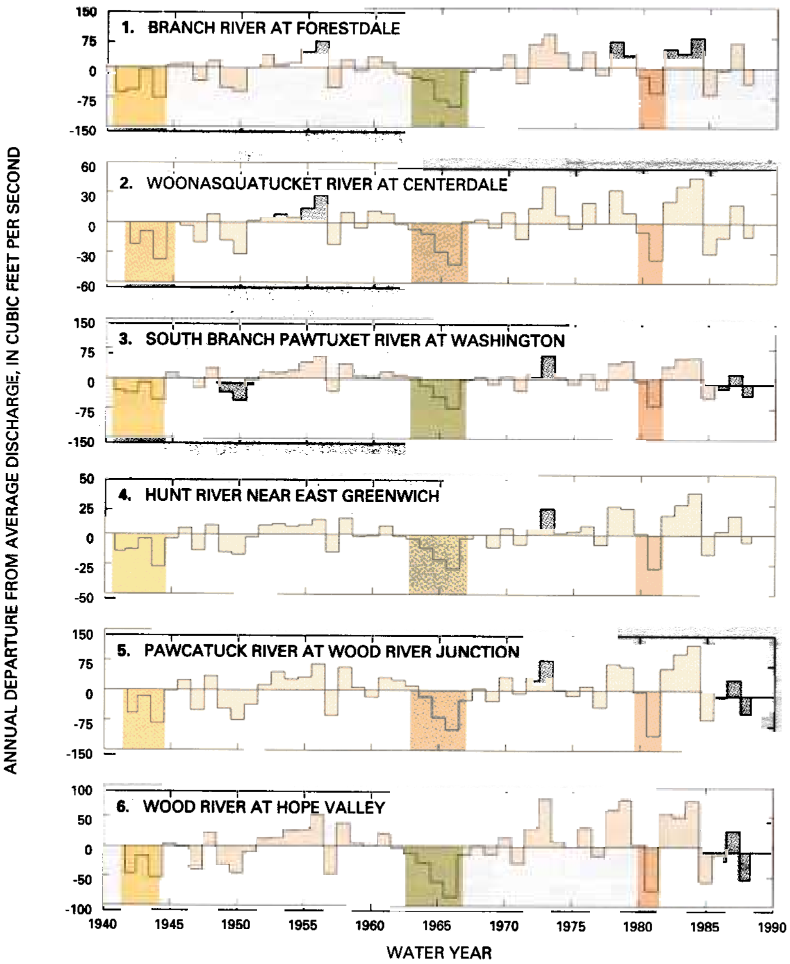
Areal Extent of Droughts





U.S. Geological Survey streamflow-gaging stations and corresponding drainage basins — Numbers refer to graphs

Annual Departure



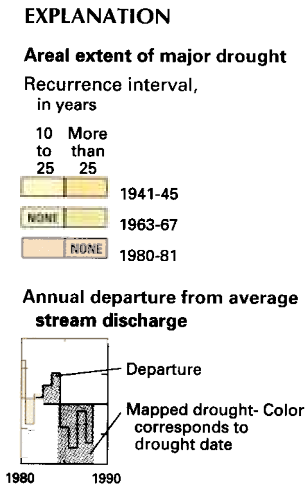


Figure 4. Areal extent of major droughts with a recurrence interval of 10 years or more in Rhode Island, and annual departure from average stream discharge for selected sites, water years 1941–88. (Source: Data from U.S. Geological Survey files.)

Although only the gaging station at Woonsocket was in place during the nearly nationwide drought of the early 1930's, data from this gaging station and from nearby stations in adjacent States indicate that streamflow in Rhode Island was far below normal in 1930–31. Annual discharges of the Blackstone River at Woonsocket in 1931 and 1932 are, respectively, the second and fourth lowest flows recorded at this station from 1930 to 1988. During the multiyear droughts of 1941–45 and 1949–50, the estimated streamflow in Rhode Island was about 70 percent of normal (Bue, 1970). The recurrence interval of the 1941–45 drought ranged from about 20 years in the central part of the State to more than 50 years in the eastern and western parts (fig. 4).

The protracted drought of 1963–67, which had a recurrence interval greater than 50 years, is the longest and most severe in the history of the northeastern United States (Barksdale and others, 1966). In Rhode Island, effects of the drought, as indicated by streamflow records, were felt from about January 1963 to April 1967. During this interval, cumulative streamflow deficiency was equivalent to more than 1 year of average runoff. At the peak of the drought, 1965–66, streamflow, reservoir levels, and ground-water levels declined to record or near-record minimums throughout the State. Water shortages and restrictions on nonessential water use occurred in several communities. Several municipal-supply wells were drilled to augment dwindling public supplies, and many domestic wells were drilled to replace shallow wells that had become dry. Less than normal precipitation, especially during 1964–66, decreased crop yields and farm income. In 1966, inflow to Scituate Reservoir, the State's principal source of public water supply, was the least recorded since construction of the reservoir in 1926. Nevertheless, the reservoir was at about 60 percent of capacity in 1966 and contained enough water to support withdrawals at the existing rates of use for another year.

The drought of 1980–81 adversely affected water supplies throughout the State. In some instances, the effects equaled or exceeded those of the 1963–67 drought because demand on available water supplies was greater. In 1981, 7 of 31 major public-supply systems experienced shortages, and several of the systems imposed water-use restrictions, one as early as February 1981. Most of the State's streams had a net decrease in cumulative runoff from December 1979 through November 1981. The average discharges of streams in central and southern Rhode Island during water year 1981 were the lowest, or second lowest, for the period 1941–88 (fig. 4, sites 1–6).

Future long-term droughts in Rhode Island will have a greater effect on developed surface-water sources than on ground-water sources because demand for surface water has increased as demand for ground water has decreased. In 1965, estimated use of surface water and ground water for public supply was 84 and 17 million gal/d (gallons per day), respectively (Murray, 1968). In 1985, withdrawals were 101 and 15 million gal/d, respectively (Solley and others, 1988).

WATER MANAGEMENT

Rhode Island law designates the State Water Resources Board to oversee development of surface- and ground-water resources. The Department of Environmental Management regulates modifications to freshwater swamps, marshes, bogs, flood plains, streams, and ponds and classifies and protects the quality of surface and ground water. Additionally, municipal and private water-supply agencies manage surface-water resources for public supply by impounding water in reservoirs, regulating releases to streams, and transferring water between basins. Each of these State and local agencies is responsible, to different degrees, for actions that affect control and management of water resources during floods and droughts.

The Rhode Island Office of Emergency Planning, in cooperation with the Federal Emergency Management Agency, has developed an emergency operations plan that provides for response to a wide range of potential disasters, including floods (William Cambio, Rhode Island Office of Emergency Planning, oral commun., January 1990). This agency serves as a focal point for coordinating disaster response and provides direct support to local communities by obtaining and providing resources from outside the State. The plan calls for initial emergency response to be by local jurisdiction, to the extent possible. Each of the State's 39 municipalities is required to have a similar emergency response plan; as of 1989, plans are in place for 19 of the largest municipalities.

Flood-Plain Management.—Prevention of deaths from floods and prevention or reduction of property and environmental damage are flood-plain management goals. In Rhode Island, actions intended to meet these goals include control of floodwaters, improvement of stream-channel capacity, limitation by nonstructural means of the extent and types of development within a flood plain, and protection of existing flood-plain development by structural means.

Control of floodwaters involves management of available reservoir storage to decrease the magnitude of peak flow by storing water during a flood and releasing it slowly after floodwaters have receded. The major storage reservoirs that affect floodflows of Rhode Island streams are (1) West Hill Reservoir in Massachusetts, a flood-control structure operated by the U.S. Army Corps of Engineers; (2) Scituate Reservoir, which has a limited capacity to regulate peak flood discharges; and (3) Flat River Reservoir, a privately owned reservoir that may be used to regulate peak discharges at the discretion of its owners. Additionally, the State's other manmade impoundments and natural ponds, lakes, and extensive wetlands that border streams may modify floodflows to the extent that storage is available.

The U.S. Army Corps of Engineers has increased stream-channel capacity in some Rhode Island streams. At Woonsocket, during 1963–67, about 6,550 feet of channel of the Blackstone River and two tributary streams was widened, deepened, and straightened; about 1,600 feet of new channel was constructed; an old dam was replaced; about 10,200 feet of dikes and floodwalls was built; and two pumping stations were installed (U.S. Army Corps of Engineers, 1981).

A unique nonstructural measure was implemented during 1982–85 by the U.S. Army Corps of Engineers, in cooperation with the city of Warwick, to limit structural damage on the flood plain of the Pawtuxet River. The measure involved moving or eliminating 61 homes, purchasing 19 vacant lots, constructing 12 above-ground utility-room additions to residences in an area that historically had experienced less severe flooding, and installing an automated flood forecasting and warning system so that the remaining homes could be evacuated (U.S. Army Corps of Engineers, 1988). Rhode Island also participates in the National Flood Insurance Program of the Federal Emergency Management Agency (New England River Basins Commission, 1976).

Structural measures to protect existing flood-plain development are implemented mainly by the U.S. Army Corps of Engineers and are funded by Federal, State, and local governments. In addition to the Woonsocket project, structural measures include construction in 1966 of a hurricane barrier on the Providence River (in Providence) to prevent inundation of downtown Providence by storm surges caused by hurricanes and coastal storms.

Flood-Warning Systems.—Flood-warning systems, aided by technological advances in satellite communications, can be significant in preventing or decreasing deaths and property damage. Flooding in the Blackstone River basin is monitored by a satellite-data-collection station that is operated by the U.S. Army Corps of Engineers on the Blackstone River at Woonsocket. Flooding in the Pawtuxet River basin is monitored by the flood-warning system operated by the city of Warwick. The system consists of a radio-telecommunications network that is linked to U.S. Geological Survey streamflow-gaging stations and other monitoring stations on the Pawtuxet River.

The River Forecast Center of the National Weather Service prepares flood forecasts by using a hydrologic-forecast model to compute flood heights for points along major rivers. Observed river stage and discharge, rainfall, snow accumulation, and temperature predictions are used in this model to estimate flood heights. Information is disseminated to the public by television and radio stations. The Reservoir Control Center of the U.S. Army Corps of Engineers at Waltham, Mass., also receives, processes, and disseminates hydrologic and meteorologic data to appropriate agencies during floods, in addition to using these data to manage the flood-control structures for which it is responsible.

Water-Use Management During Droughts.—There are no comprehensive State or local plans for the specific purpose of managing water resources during drought emergencies. However, the Governor has authority to declare water emergencies, impose water-conservation measures on users, and allocate water supplies as necessary for the welfare of the people of Rhode Island. The State Public Utilities Commission also has the authority, under the General Laws of Rhode Island (RIGL 39–1 1912), to impose mandatory restrictions on water use in drought-stricken areas of water-utility service. However, its jurisdiction is restricted to proprietary public utilities and municipal water systems that provide water supplies to other systems. The most effective authority for managing water resources during droughts is that of public water-supply systems, which can impose appropriate water-use restrictions on their customers.

Water-supply shortages caused by drought or contamination have prompted several municipalities to establish emergency connections to other public-supply systems. Consequently, many public water-supply systems in Rhode Island are now better prepared to deal with water-supply emergencies.

SELECTED REFERENCES

Barksdale, H.C., O'Bryan, Deric, and Schneider, W.J., 1966, Effect of drought on water resources in the Northeast: U.S. Geological Survey Hydrologic Investigations Atlas HA–243.

Bogart, D.B., 1960, Floods of August–October, 1955, New England to North Carolina: U.S. Geological Survey Water-Supply Paper 1420, 854 p.

Bue, C.D., 1970, Streamflow from the United States into the Atlantic Ocean during 1931–60: U.S. Geological Survey Water-Supply Paper 1899–I, 36 p.

Halberg, H.N., Knox, C.E., and Pausek, F.H., 1961, Water resources of the Providence area, Rhode Island: U.S. Geological Survey Water-Supply Paper 1499–A, 50 p.

Murray, C.R., 1968, Estimated use of water in the United States, 1965: U.S. Geological Survey Circular 556, 53 p.

New England River Basins Commission, 1976, The Southeastern New England water and related land resources study: Providence, R.I., New England River Basins Commission, Planning Area Reports 7–10.

Rhode Island Statewide Planning Program, 1982, Summary and analysis of State law relating to water supply and drinking water quality: Rhode Island Statewide Planning Program Technical Paper 104, 83 p.

Rhode Island Water Resources Board, 1970, Rhode Island lakes and ponds—An inventory: Comprehensive Water and Related Land Use Planning Task 8, 113 p.

Solley, W.B., Merk, C.F., and Pierce, R.R., 1988, Estimated use of water in the United States, 1985: U.S. Geological Survey Circular 1004, 82 p.

Thompson, M.T., Gannon, W.V., Thomas, M.P., and others, 1964, Historical floods in New England: U.S. Geological Survey Water-Supply Paper 1779–M, 105 p.

U.S. Army Corps of Engineers, 1939, Pawtuxet River, Rhode Island: Providence, R.I., Report on Survey for Flood Control, 65 p.

______1956, New England floods of 1955—Part 4, Flood damages: Boston, Mass., New England Division, 33 p.

______1971, Flood plain information, Blackstone River, Cumberland, Lincoln, Central Falls, and Pawtucket, Rhode Island: Boston, Mass., New England Division, Flood Plain Information Report, 63 p.

______1981, Water resources development in Rhode Island, 1981: Boston, Mass., New England Division, Report on Corps of Engineers Activities, 74 p.

______1988, Water resources development in Rhode Island, 1987: Boston, Mass., New England Division, Report on Corps of Engineers Activities, 93 p.

U.S. Geological Survey, 1937, The floods of March 1936, pt. 1. New England rivers: U.S. Geological Survey Water-Supply Paper 798, 466 p.

______1968, Magnitude and frequency of floods in the United States—Part 1–A, North Atlantic slope basins, Maine to Connecticut: U.S. Geological Survey Water-Supply Paper 1671, 260 p.

______1986, National water summary 1985—Hydrologic events and surface-water resources: U.S. Geological Survey Water-Supply Paper 2300, 506 p.

______1987, Water resources data, Massachusetts and Rhode Island, water year 1985: U.S. Geological Survey Water-Data Report MA–RI–85–1, 235 p.

______1990, National water summary 1987—Hydrologic events and water supply and use: U.S. Geological Survey Water-Supply Paper 2350, 553 p.

Wood, G.K., Swallow, L.A., Johnson, C.G., and Searles, G.H., 1970, Flood of March 1968 in eastern Massachusetts and Rhode Island: U.S. Geological Survey Open-File Report 70–373, 81 p.

Prepared by Patrick N. Walker, U.S. Geological Survey; "General Climatology" section by Robert Lautzenheiser, State Climatologist, New England Climate Service

FOR ADDITIONAL INFORMATION: Chief, Rhode Island Office, U.S. Geological Survey, John O. Pastore Federal Building and U.S. Post Office, Providence, RI 02903–1720