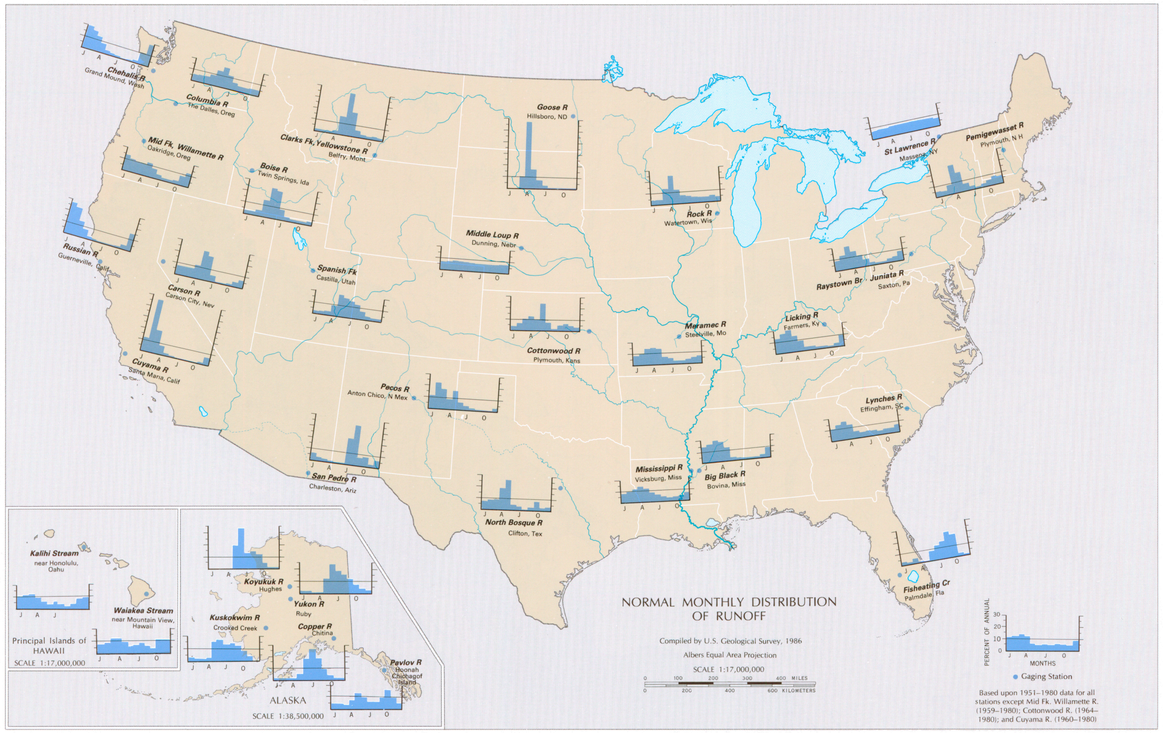


RUNOFF

The water that flows in rivers, creeks, and ephemeral streams represents water from precipitation that does not evaporate or transpire to the atmosphere and cannot be retained in surface water reservoirs (including lakes, ponds, snow, and ice fields) or in underground reservoirs. This water is termed "runoff." The annual runoff is determined on the basis of continuing measurements of stage and discharge of streams at about 7,000 gaging stations located throughout the United States.

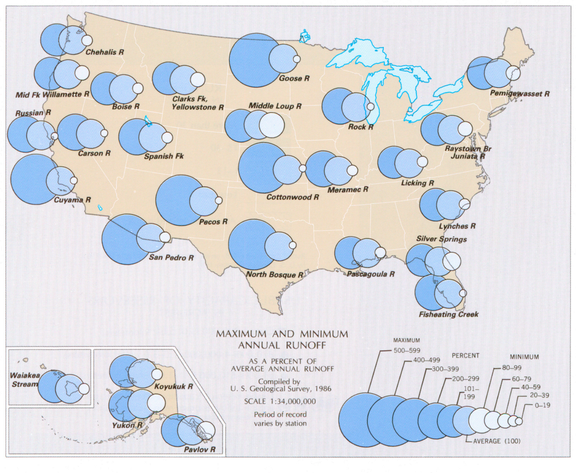
Precipitation is the source of essentially all freshwater resources, and the amount and place that precipitation falls on the land are the most important factors controlling the variability and availability of surface water resources. Average annual precipitation in the United States ranges from a few tenths of an inch per year in desert areas of the Southwest to about 400 inches per year at some locations in Hawaii. Nationwide, average precipitation is relatively abundant—about 30 inches per year. However, about one-third of the conterminous United States, mostly in the West and Midwest, receives less than 20 inches of precipitation during an average year.

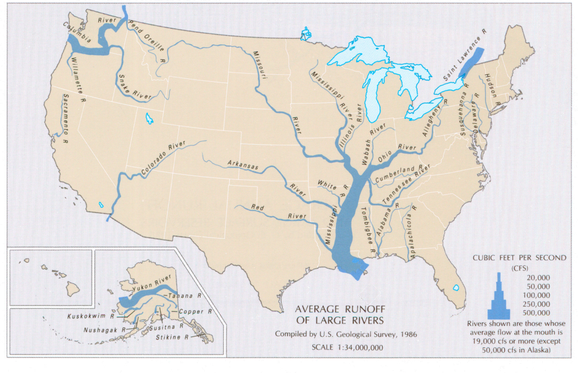
Seasonal variations in runoff are characteristic of most streams with distinct periods of high flow followed by periods of low flow within a given year. High flows result from storm runoff and snowmelt; low flows result from periods of low precipitation and high evapotranspiration. Low flows are sustained by seepage from ground-water systems. The times of high and low flows differ from basin to basin, depending on climatic factors, and also from year to year. Each geographic region has a characteristic pattern of seasonal runoff, called the stream regimen, which can be represented by long-term average monthly flows. The map above shows the normal monthly distribution of runoff for selected streams in various regions of the United States. The maximum runoff in several of the rivers occurs during a distinct rainy season: winter along the Pacific Coast, summer in southern Arizona, and autumn in Florida. In most rivers the greatest monthly runoff occurs during the spring, because of snowmelt (especially in mountain streams), spring rains, or both. The large rivers carry the aggregate runoff from the smaller tributaries and this delays their peaks into late spring or early summer. For instance, the Columbia River commonly reaches its peak in June. The flow of the St. Lawrence River is affected by storage in the Great Lakes and varies little from month to month throughout the year.

Year to year variations in runoff are caused by changes in weather patterns and precipitation. Such variations are greatest in arid and semiarid regions where a small change in precipitation has a large effect on runoff. The map below shows maximum and minimum annual runoff as a percentage of the long-term average annual runoff at several gaging stations in the United States. The maximums and minimums for the individual rivers occurred in various years.

The variations in runoff that reach their extremes in floods and droughts have been reduced by storage in artificial reservoirs along many rivers. Reservoirs can be used to modify the seasonal variations in runoff; those whose capacity exceeds the average annual inflow, that is, those with "holdover" storage, may also be effective in reducing annual variations. The map below shows the average runoff of the large rivers in the United States. The map clearly shows that the Mississippi River is the largest river in the United States with its average runoff about double that of the Columbia River, which is the second largest U.S. river.

Low streamflows at a site differ from year to year, primarily in response to weather conditions, ground-water inflow, and snowmelt. The variation in annual low flows commonly is described by a "low-flow frequency curve," which shows how frequently different rates of streamflow can be expected to recur on the average. Low-flow frequency curves also are used to define (mainly for water management) "dependable flow." The dependable flow of a stream is a low rate of its flow, commonly defined as the average minimum flow for some period of successive days in a year. The map on the right shows the rivers in the United States whose 7-day average low flow is expected to be less than 300 cubic feet per second during only 10 percent of the years on the average (7-day, 10-year low flow). This also may be referred to as the 90-percent dependable flow because the flow of 300 cubic feet per second can be depended upon during any successive 7 days in 9 out of 10 years. The map also shows the rivers whose flow with storage are expected to be greater than 300 cubic feet per second at all times.

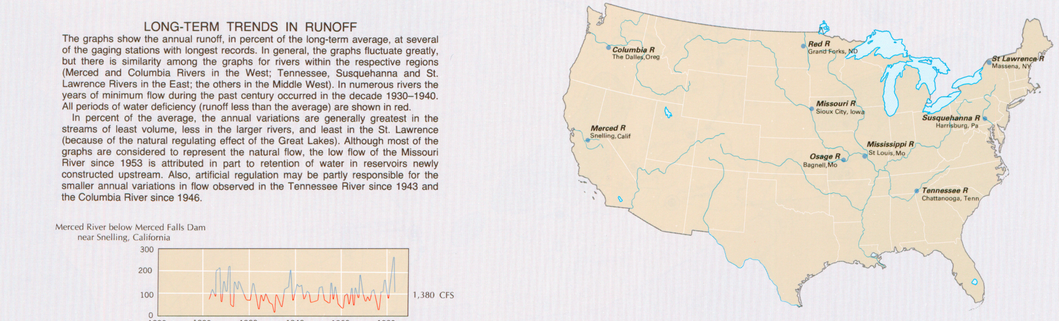


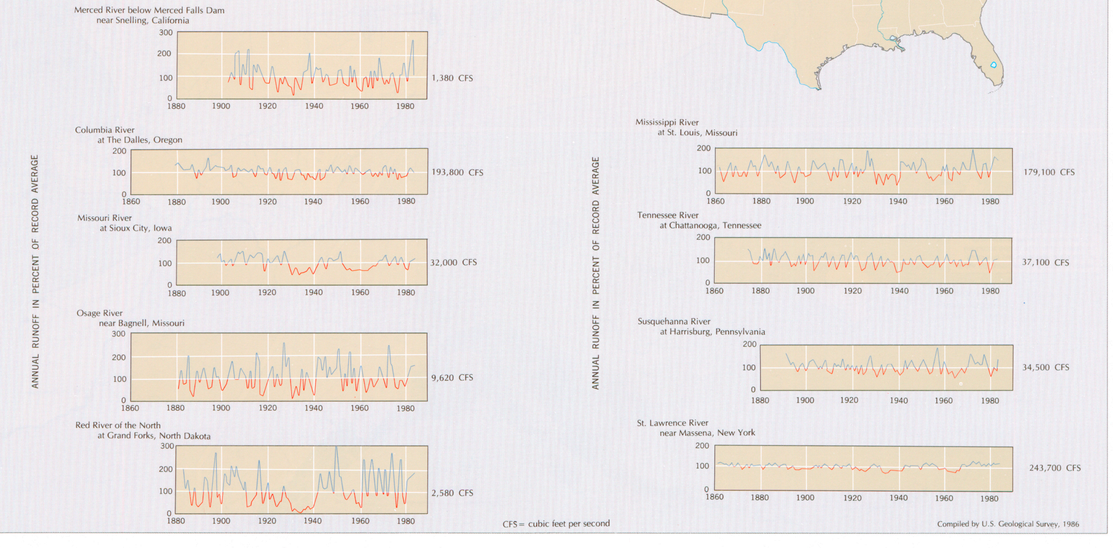


LONG-TERM TRENDS IN RUNOFF

The graphs show the annual runoff, in percent of the long-term average, at several of the gaging stations with longest records. In general, the graphs fluctuate greatly, but there is similarity among the graphs for rivers within the respective regions (Merced and Columbia Rivers in the West; Tennessee, Susquehanna and St. Lawrence Rivers in the East; the others in the Middle West). In numerous rivers the years of minimum flow during the past century occurred in the decade 1930–1940. All periods of water deficiency (runoff less than the average) are shown in red.

In percent of the average, the annual variations are generally greatest in the streams of least volume, less in the larger rivers, and least in the St. Lawrence (because of the natural regulating effect of the Great Lakes). Although most of the graphs are considered to represent the natural flow, the low flow of the Missouri River since 1953 is attributed in part to retention of water in reservoirs newly constructed upstream. Also, artificial regulation may be partly responsible for the smaller annual variations in flow observed in the Tennessee River since 1943 and the Columbia River since 1946.





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