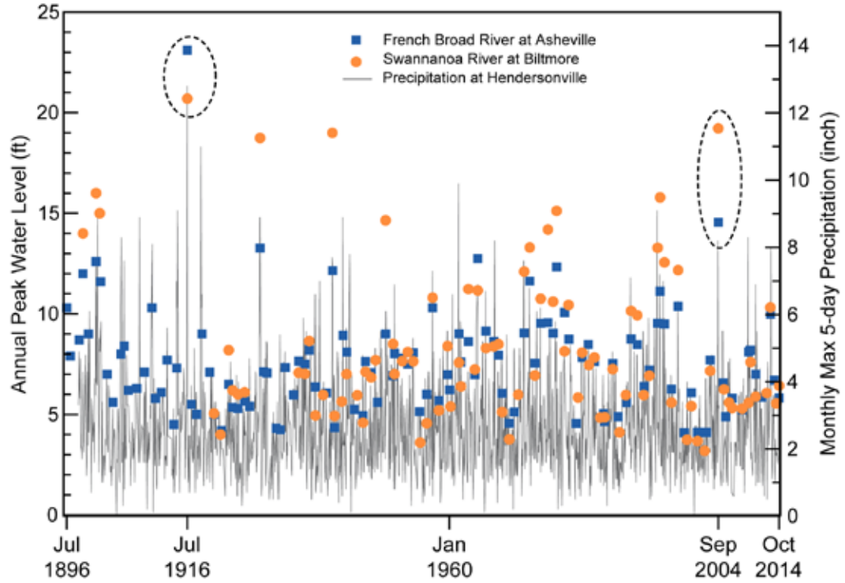
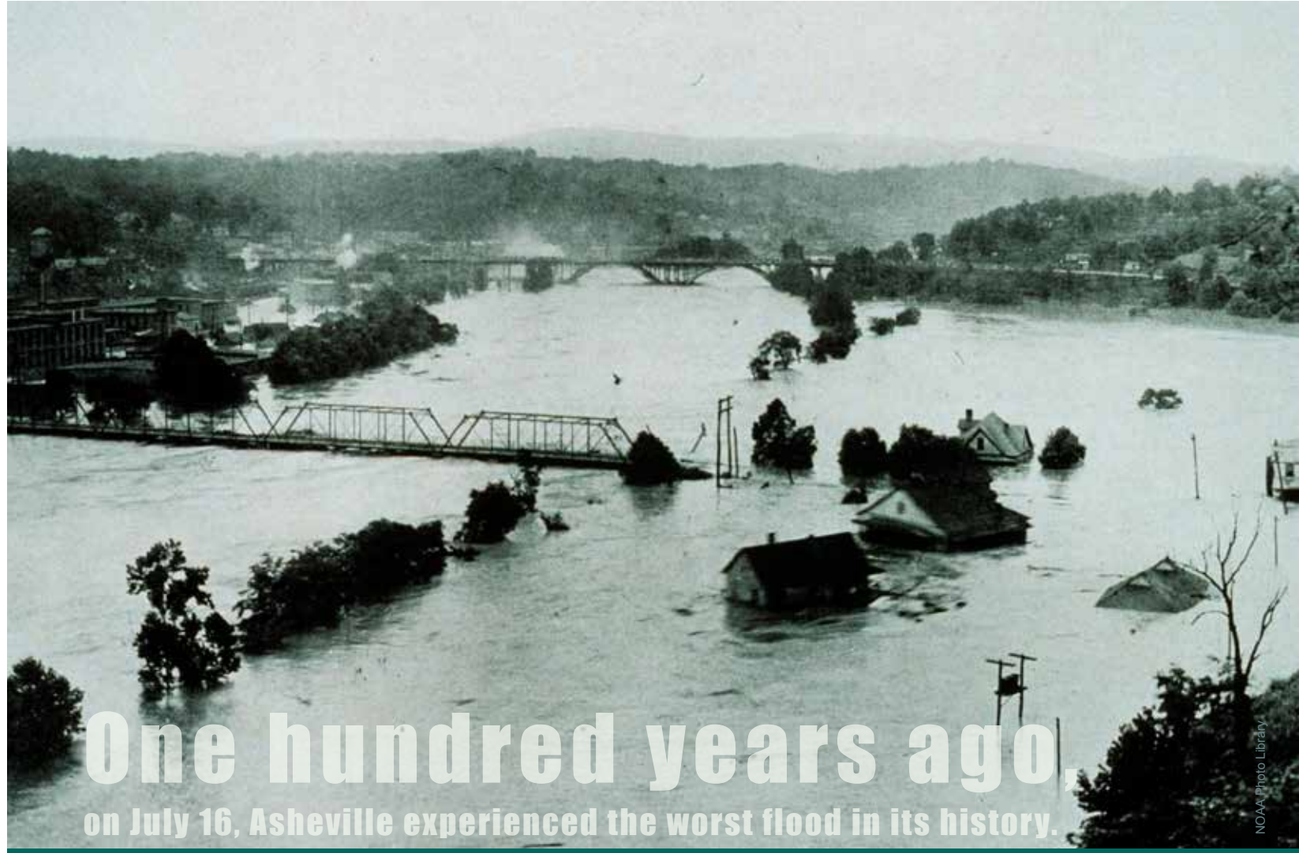


The annual peak water level at Asheville and Biltmore and monthly maximum 5-day precipitation at Hendersonville from 1896 through 2014. The 1916 and 2004 flood events are circled.

Flooding outside Biltmore Village in Asheville, North Carolina, after Hurricane Ivan on September 17, 2004.



THE GREAT FLOOD 1916

Western North Carolina: A Meteorological Timeline

On July 16, 1916, tremendous flooding swept through Asheville as the normally shallow French Broad and Swannanoa Rivers jumped their banks after heavy rain fell over Western North Carolina (WNC). An unknown number of people died in the region. For Asheville alone, an estimated several dozen citizens lost their lives.

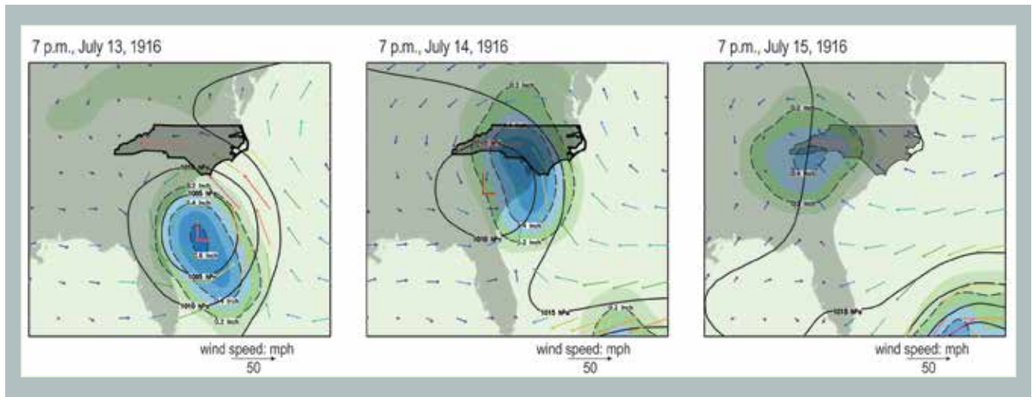
The flood destroyed hundreds of homes in the area and engulfed industrial plants, warehouses, and businesses along the French Broad. It damaged or washed away railroad tracks and demolished all three bridges across the river in Asheville. Riverside Park, a popular amusement park and gathering place on the French Broad, also succumbed to the flood.

Upstream from Asheville, the waters breeched or destroyed all the dams that supplied hydropower to the city. At the entrance to the Biltmore Estate, water reportedly reached 9 feet deep during the flood. Overall, the damage totaled an estimated $21 million—the equivalent of $500 million in today's dollars.

One hundred years after the "Great Flood of 1916," scientists at the National Centers for Environmental Information reviewed historical data and accounts describing the events. With this information, they hoped to better understand the meteorological conditions that led to the disaster in WNC in general, and in Asheville in particular.

According to the data, the remnants of two tropical systems that passed near the area within a week led to the devastating flooding. The first storm made landfall on the Gulf Coast, the second along the Atlantic Coast near Charleston, South Carolina. Both of these storms brought heavy rain to the French Broad River watershed above Asheville: the first on July 8–10 and the second on July 15–16, 1916. A third storm remained off the Atlantic Coast until it reached New England, but it may have influenced the track of the Charleston Storm.

This timeline details the meteorological events during the weeks leading up to the flood, according to a variety of data sources.



The progression of the Charleston Storm from July 13 to 15, 1916. The arrows indicate wind direction and speed; the longer the arrow, the higher the wind speed. Rainfall totals are depicted with green and blue shading.

JUNE 28
A tropical storm formed in the western Caribbean off the coast of Nicaragua.

JUNE 30
The month of June ended with slightly wetter-than-normal conditions in WNC.

JULY 5–6
During the night, the storm that formed in the western Caribbean made landfall between Biloxi and Mobile, Alabama, as a Category 3 hurricane with 121-mph winds. It moved northwest to north-central Mississippi while weakening to a tropical storm.

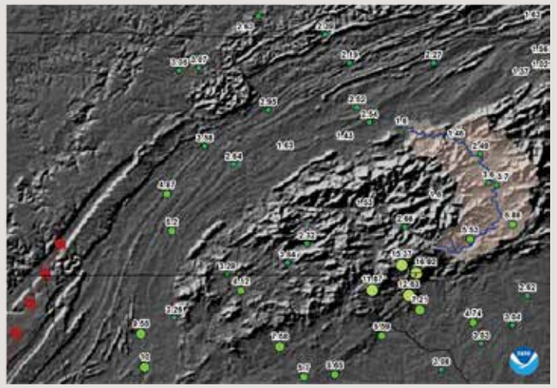
JULY 7–8
The center of the storm then moved east to central Alabama, and rain began to affect WNC.

JULY 9
At Asheville, the French Broad River reached 4.8 feet, 0.8 feet above flood stage, as rain continued to fall over its watershed. The Gulf Coast Storm moved northward to Chattanooga, Tennessee, where it dissipated.

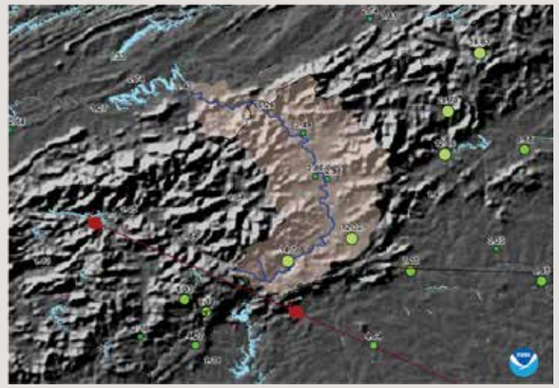
JULY 10
According to measurements taken by volunteer weather observers, storm totals between July 8 and 10 in the upper French Broad River watershed were substantial but not disastrous. Brevard and Hendersonville—the only two stations upstream from Asheville that have data from that time—recorded 5.53 and 5.86 inches, respectively. Heavier rain stayed to the south, primarily over South Carolina and Georgia, but reached as far north as Rock House (16.93 inches) and Highlands (15.37 inches), just outside of the French Broad River watershed. Meanwhile, the Asheville station reported 3.70 inches of rain.

JULY 11
At Asheville, the French Broad River reached 8.8 feet. A comparatively dry four-day period began in WNC. At the same time, a second tropical storm—referred to as the Charleston Storm—formed about 300 miles east of Nassau, Bahamas.

JULY 12–13
The Charleston Storm strengthened to a Category 3 hurricane with 115-mph winds and moved to just off the Atlantic Coast at Charleston, South Carolina.



Total rainfall for July 8–10, 1916. The track of the Gulf Coast Storm is shown to the west. The French Broad watershed is depicted with rose-colored shading.



Total rainfall for July 15–17, 1916. The track of the Charleston Storm is shown to the south and southwest. The French Broad River watershed is depicted with rose-colored shading.

Comparison of the French Broad and Swannanoa Rivers During Average and Flood Years

French Broad River			Swannanoa River		
	Annual Peak Water Level (Feet)	Annual Peak Stream Flow (cfs)		Annual Peak Water Level (Feet)	Annual Peak Stream Flow (cfs)
1916	23.1	110,000	1916	20.7	23,000
2004	14.6	43,100	2004	19.2	12,900
Average	8.0	16,300	Average	8.0	3,500

JULY 14
The Charleston Storm weakened slightly to 109 mph before making landfall north of Charleston in the morning hours. It quickly lost strength inland, reached Columbia as a tropical storm, and then moved towards Greenville, South Carolina. The presence of another tropical system in the Caribbean at that time may have contributed to the inland track of the Charleston Storm.

Between July 11 and 14, relatively little rain fell across the French Broad River watershed, with a total of 0.53 inches recorded at Brevard and 0.5 inches at Hendersonville.

JULY 15
The Charleston Storm lost its tropical characteristics and became a weak low pressure system near present-day Fontana Lake in the Smoky Mountains west of Asheville. By the morning of July 15, the French Broad River at Asheville had receded to 4 feet—exactly flood stage. That afternoon, heavy precipitation began to fall over parts of the WNC mountains.

JULY 16
Personal accounts suggest that, by the morning of July 16, the sun was shining in Asheville. Nevertheless, weather observations from that date indicate that heavy rain continued in other parts of WNC. Along the French Broad River—upstream from Asheville—dams broke, reportedly sending a flash flood down the river and causing it to rise rapidly in the city. At 8 a.m., it already stood at 13.5 feet, 9.5 feet above flood stage. At 9 a.m., it had reached 18.6 feet. By 10 a.m., the river gauge had washed away along with the bridge on which it was mounted.

The river crested at an estimated 23.1 feet, with a peak flow of 110,000 cubic feet per second (cfs). The Swannanoa River, a right tributary that joins the French Broad near the entrance to the Biltmore Estate, crested at 20.7 feet, with a flow of 23,000 cfs. This caused severe flooding on the Biltmore Estate and in Biltmore Village. Neither river has reached a comparable level in the 100 years since.

By the afternoon, more than 10 inches of rain had fallen over the upper portions of the French Broad River watershed, with lower totals to the north. Reported storm totals include 14.7 inches at Brevard, 12.32 inches at Hendersonville, and only 2.98 inches at Asheville. Much of this rain fell in the span of 24 hours, including the 10 inches reported at Hendersonville on July 16. That value remains the highest 24-hour rainfall total reported at that location in its 118-year record.

Stations on the eastern slope of the Blue Ridge Mountains reported the heaviest rainfall. At the unofficial Orchard Station at Altapass near Grandfather Mountain, an observer reported a total of 22.22 inches in the 24 hours ending at 2 p.m. on July 16. To this day, this amount continues to be North Carolina's state record for the highest measured 24-hour precipitation total. At the official station at Altapass, 1 mile to the west and across a ridge from the Orchard Station, the reported total was about 1.5 inches less. While this water did not run off into the French Broad River or any of its tributaries, it was indicative of this event's intensity.

This catastrophic event reminds us of society's vulnerability to natural hazards, such as extreme rainfall and flash flooding. The heaviest rainfall was not in Asheville but upriver, so it also reminds us of the interconnectedness of our towns with the surrounding environment. We cannot stop extreme weather events, but we can make our communities more resilient to these events. For more information on building resilient communities, check out the Climate Resilience Toolkit at toolkit.climate.gov.

Sources: National Oceanic and Atmospheric Administration; U.S. Geological Survey; Monthly Weather Review; Taylor Norris, UNCA Thesis.