

Mapping Rainfall and Flooding ^[1]

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Although Hurricane Floyd was the biggest storm of 1999 and the one most remembered, eastern North Carolina was hit by *three* hurricanes in a six-week period in September and October that year. All brought large amounts of rain. Hurricane Dennis (September 4...05) saturated the ground. Floyd (September 14-16) created the worst of the flooding. Then, a month later, Hurricane Irene (October 17) brought rivers and streams back to the flood stage.

The maps and charts on this page will help you analyze where and when the rain fell and why the flooding was so bad.

Paths of the hurricanes

The image below is a satellite image of eastern North Carolina, with tracks for Hurricanes Dennis, Floyd, and Irene, September...05October 1999. The red lines represent boundaries of river basins. If you look closely, you can see flooding along the Tar, Neuse, and Waccamaw rivers, as well as sediment plumes in Albemarle Sound and the Pamlico River.

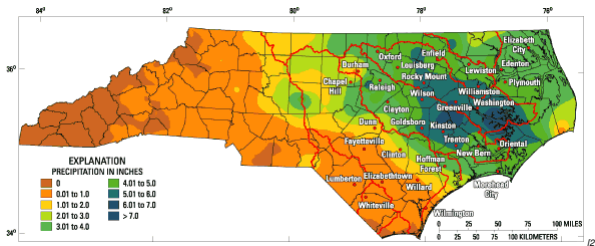
A slow-moving storm

Hurricane Floyd was a very large storm -- much larger than most hurricanes, even many that were far more powerful. It also moved very slowly across eastern North Carolina, which is why rainfall totals were so high. The following animation shows satellite images of the storm for September 15 and 16; the numbers at the bottom show the date and time of each image.

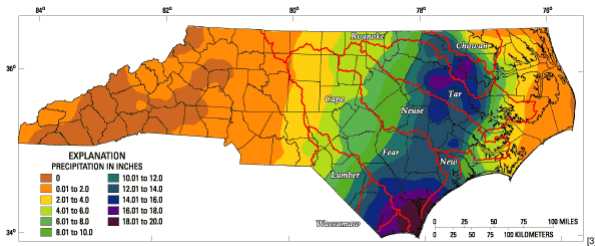
Satellite images show the path of Hurricane Floyd.

Rainfall from Hurricanes Dennis and Floyd

The maps below show rainfall in eastern North Carolina during the passage of hurricanes Dennis and Floyd, with the locations of selected rain gauges.



Rainfall during Hurricane Dennis, September 4 - 5, 1999. ^[2]



Rainfall during Hurricane Floyd, September 14 - 16, 1999. ^[3]

Rainfall amounts

The table below shows rainfall amounts from hurricanes Dennis, Floyd, and Irene at various locations in central and eastern North Carolina, with normal totals for the same period. The locations are divided by river basin (see below).

Rainfall from hurricanes Dennis, Floyd, and Irene, September–October 1999 .

Location	Hurricane Dennis (Sept. 3–7)	Hurricane Floyd (Sept. 14–17)	Hurricane Irene (Oct. 17–18)	Sept.–Oct. 1999 total	Annual average rainfall
Tar-Pamlico River Basin					
Oxford	6.07	5.67	1.94	20.15	43 (est.)
Louisburg	5.59	8.88	2.01	24.34	45.56
Rocky Mount	5.06-7.59	14.07-18.00	5.16	37.72	44.24
Enfield	7.01	11.84	4.30	32.39	44.54
Greenville	7.03	12.63	3.29	30.20	49.00
Washington	7.60	10.73	5.07	31.05	46.96
Neuse River Basin					
Durham	3.30	5.98	0.91	18.60	48.10
Raleigh	8.46	6.55	1.50	24.24	41.43
Clayton	5.35	9.80	2.59	20.98	45.11
Goldsboro	7.19-7.94	12.06-12.70	4.36	32.10	49.27
Wilson	7.60	10.73	5.07	31.05	46.96

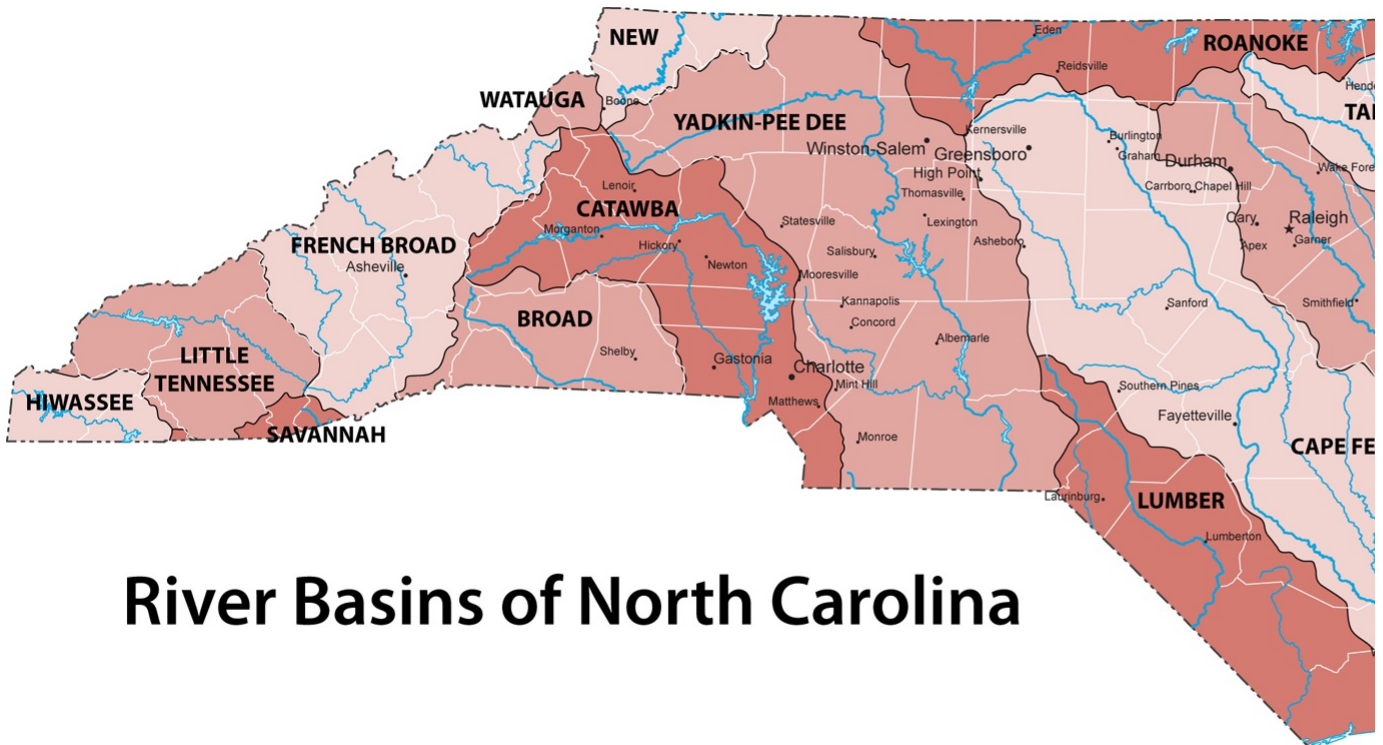
Location	Hurricane Dennis (Sept. 3–7)	Hurricane Floyd (Sept. 14–17)	Hurricane Irene (Oct. 17–18)	29.48 Sept.–Oct. 1999 total	Annual average rainfall
New Bern	4.00	5.51	6.39	19.82	53.11
Trenton	7.42	14.98	—	>24.60 ^a	52.22
Cape Fear River Basin					
Chapel Hill	12.52	4.67	0.84	26.55	46.02
Dunn	4.50	7.65	4.34	23.81	47.72
Fayetteville	2.12	7.23	4.19	21.83	46.72
Clinton	2.96	11.50	4.33	27.50	49(est.)
Willard	1.30	13.23	—	>21.01 ^a	53.04
Elizabethtown	>1.19 ^b	>14.19 ^b	>6.69 ^b	>28.00 ^b	46.78
Wilmington	0.59	19.06	2.73	27.10	54.27
Waccamaw and Lumber River Basins					
Lumberton	1.34	9.82	5.48	24.16	46.54
Whiteville	1.52	16.76	5.97	34.27	48.73
Other sites					
Lewiston	3.56	9.73	3.47	19.55	46.82
Williamston	7.20	16.28	5.54	35.55	48.07
Edenton	5.07	6.18	6.12	23.59	48.54
Elizabeth City	7.68	2.64	5.06	17.73	48.48
Plymouth	5.03	7.37	--	>15.15 ^a	51.06
Morehead City	4.29	4.33	—	>11.21 ^a	55.05
Hoffman Forest	6.49	9.78	—	>19.58 ^a	55.60

(a) October rainfall records are unavailable.
(b) Partial record; some missing values for period.

River basins

By comparing the maps and data of rainfall totals with this map of river basins, we can see why flooding occurred where it did. *River basin* is all the land drained by a given river. All rain that falls in the Cape Fear River basin, for example, runs off into streams and smaller rivers that eventually join the Cape Fear before it ends in the Atlantic Ocean. If there is a great deal of rainfall in a river basin, that river is likely to flood downstream -- even if the locations downstream didn't get much rain.

Based on this map and the data map above, which rivers would you predict were most likely to flood?



River Basins of North Carolina

^[4] Rivers and river basins of North Carolina, with cities and county outlines shown for reference. (Click the map for a closer look.)

Flood levels

The data below, provided by the U.S. Geological Survey, shows how high the water was at various streamgaging stations (stations where stream or river information is measured) at the peak of flooding. The recurrence interval is how often the river was expected to be that high. Note that in some places, the waters overflowed the 500-year floodplain -- the region where flooding would reasonably be expected an average of once every 500 years! (See this discussion of [floodplains](#).)

Compare these flood levels with your predictions above. Were you right?

Hurricane Floyd flood information for selected streamgaging stations in North Carolina and Virginia

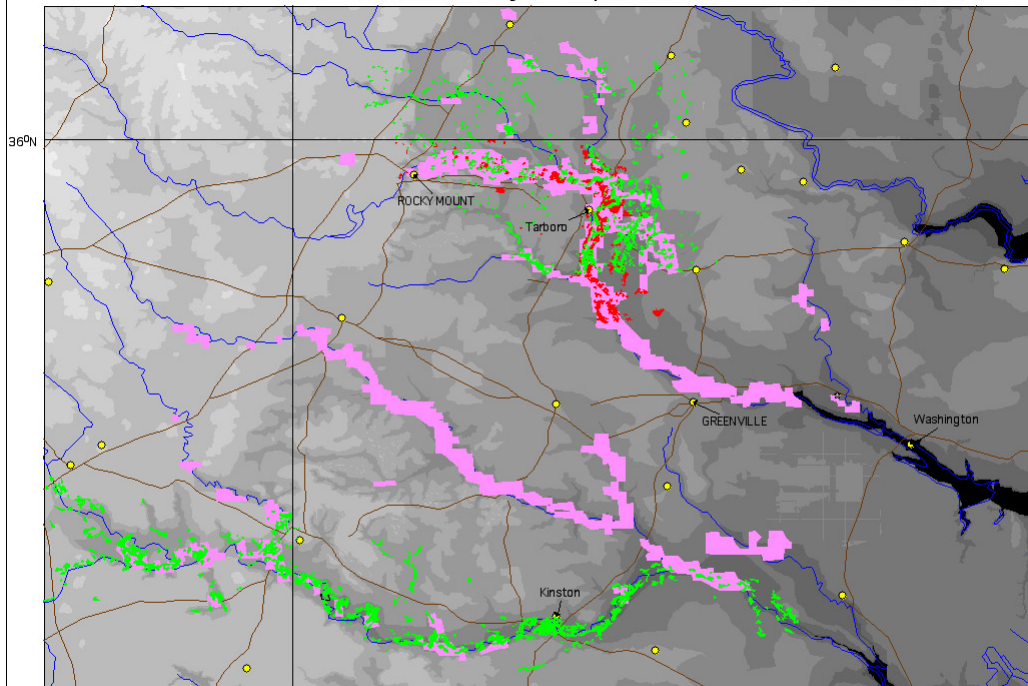
Station name	1999 floods	Peak stage	Recurrence interval
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	Date	(ft)	(years)
Chowan River Basin			
Nottoway River near Sebrell, Va.	9/20	27.01	50-100
Blackwater River near Franklin, Va.	9/18	26.27	100-500
Meherrin River near Lawrenceville, Va.	9/18	29.95	10-25
Potecasi Creek near Union	9/16	28.9	>500
Ahoskie Creek at Ahoskie	9/17	17.32	>500
Roanoke River Basin			
Cashie River near Windsor	9/16	18.52	>500
Tar-Pamlico River Basin			
Tar River near Tar River	9/16	17.59	10
Tar River at Louisburg	9/17	26.05	50-100
Tar River below Tar River Reservoir	9/17	32.89	100-500
Tar River at Rocky Mount	9/17	31.66	100-500
Swift Creek at Hilliardston	9/17	21.30	>500
Little Fishing Creek near White Oak	9/16	30.8	>500
Fishing Creek near Enfield	9/18	21.65	500
Tar River at Tarboro	9/19	41.51	>500
Conetoe Creek near Bethel	nd	19.79	nd
Tar River at Greenville	9/21	29.72	nd
Chicod Creek near Simpson	9/18	21.46	nd
Pamlico River at Washington	9/16	8.14	nd
Van Swamp near Hoke	9/16	7.43	25
Neuse River Basin			
Neuse River near Falls	10/14	5.95	5-10
Crabtree Creek at U.S. 1 at Raleigh	9/16	16.88	nd
Neuse River near Clayton	9/17	20.67	25-50
Neuse River at Smithfield	9/18	26.72	>50
Swift Creek near McCullars Crossroads	9/16	13.06	10
Middle Creek near Clayton	9/16	13.02	10-25
Little River near Princeton	9/17	16.58	>500
Neuse River near Goldsboro	9/20	28.85	50
Neuse River at Kinston	9/22 9/23	27.71	50-100
Contentnea Creek near Lucama	9/16	25.0	100
Nahunta Swamp near Shine	9/17	21.00	>500
Contentnea Creek at Hookerton	9/18	28.28	>500
Neuse River near Fort Barnwell	9/20	22.75	nd
Trent River near Trenton	9/17	22.33	>500
New River Basin			
New River near Gum Branch	9/16	25.12	>500
Cape Fear River Basin			
Haw River near Bynum	9/16	13.42	<2
Deep River at Moncure	9/6	9.15	2-5
Cape Fear River at Lillington	9/16	14.46	2
Flat Creek near Inverness	9/16	3.84	2-5
Cape Fear River at Lock 3	9/17	21.59	10
Cape Fear River at Lock 1	9/20	23.30	5-10
Hood Creek near Leland	9/16	13.89	100
Black River near Tomahawk	9/18	27.14	100-500
Northeast Cape Fear River near Chinquapin	9/18	23.51	>500
Lumber and Waccamaw River Basins			
Waccamaw River at Freeland	9/20	19.30	>500
Lumber River at Boardman	9/19	10.70	25

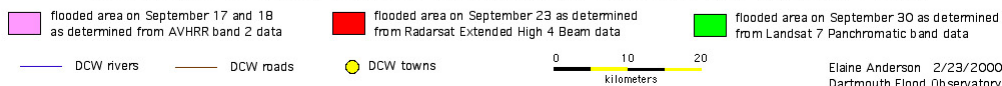
Source: "Two Months of Flooding in Eastern North Carolina, September - October 1999: Hydrologic Water-Quality, and Geologic Effects of Hurricanes Dennis, Floyd, and Irene," by Jerad D. Bales, Carolyn J. Oblinger, and Asbury H. Sallenger, Jr. USGS report.

Mapping the flood

How far did the floodwaters spread? The map below combines satellite data from three different sources to give you a picture. How far floodwaters spread depends not only on how high the water is but on the local terrain. If the land near a flooded river is quite flat, the floodwaters may spread quite a distance.



Comparison of Flood Mapping using AVHRR, Radarsat and Landsat 7 data



This flood map shows a comparison of the flood data collected by AVHRR (pink pixels), Radarsat (red pixels), and Landsat 7 (green pixels). These colors show areas that were flooded in the wake of Hurricane Floyd. Due to interference from clouds and forest canopies, geographers often get the best insight into a flood when they use data from multiple satellite sensors.

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