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Hurricane Florence

Hurricane Florence was a powerful and long-lived Cape Verde hurricane that caused catastrophic damage in the Carolinas in September 2018, primarily as a result of freshwater flooding. Florence dropped a maximum total of 35.93 inches (913 mm) of rain in Elizabethtown, North Carolina, becoming the wettest tropical cyclone recorded in the Carolinas, and also the eighth-wettest overall in the contiguous United States.[1] The sixth named storm, third hurricane, and the first major hurricane of the 2018 Atlantic hurricane season, Florence originated from a strong tropical wave that emerged off the west coast of Africa on August 30, 2018. Steady organization resulted in the formation of a tropical depression on the next day near Cape Verde. Progressing along a steady west-northwest trajectory, the system acquired tropical storm strength on September 1, and fluctuated in strength for several days over open ocean. An unexpected bout of rapid intensification ensued on September 4–5, culminating with Florence becoming a Category 4 major hurricane on the Saffir–Simpson scale (SSHWS), with estimated maximum sustained winds of 130 mph (215 km/h).

Strong wind shear tore the storm apart, and Florence degraded to a tropical storm by September 7. Shifting steering currents led to a westward turn into a more suitable environment; the system regained hurricane strength on September 9 and major hurricane status by the following day. At 16:00 UTC on September 10, Florence again became a Category 4 hurricane, later reaching a new peak intensity with 1-minute winds of 140 mph (220 km/h) and a central pressure of 939 mbar (27.7 inHg). Afterwards, Florence weakened slightly as it underwent an eyewall replacement cycle, but began to strengthen again late on September 11. However, increasing wind shear caused the storm's winds to gradually taper over the next few days, though the storm's wind field continued to grow. By the evening of September 13, Florence had been downgraded to a Category 1 hurricane, though the storm began to stall as it neared the Carolina coastline. Early on September 14, Florence made landfall just south of Wrightsville Beach, North Carolina, and weakened further as it slowly moved inland. Florence degenerated to a post-tropical cyclone over West Virginia on September 17, and two days later, the remnants of Florence were absorbed into another frontal storm.

Early in the storm's history, the system brought squall conditions to

Hurricane Florence

Category 4 major hurricane (SSHWS/NWS)

Hurricane Florence near peak intensity southeast of Bermuda on September 10

Formed	August 31, 2018
Dissipated	September 19, 2018
	(Remnant low after September 17)
Highest winds	*1-minute sustained:* 140 mph (220 km/h)
Lowest pressure	939 mbar (hPa); 27.73 inHg
Fatalities	30 direct, 23 indirect
Damage	> $38 billion (2018 USD) (Sixth-costliest tropical cyclone on record)
Areas affected	West Africa, Cape Verde, Bermuda, Eastern United States (especially The Carolinas), Atlantic Canada

the Cape Verde islands, resulting in some landslides and flooding; but overall effects were negligible. With the threat of a major impact in the Southeastern and Mid-Atlantic United States becoming evident by

Part of the **2018 Atlantic hurricane season**

September 7, the governors of North Carolina, South Carolina, Virginia, Georgia, and Maryland, and the mayor of Washington, D.C. declared a state of emergency. On September 10 and 11, the states of North Carolina, South Carolina, and Virginia all issued mandatory evacuation orders for some of their coastal communities, predicting that emergency personnel would be unable to reach people there once the storm arrived.

Despite making landfall as a weakened Category 1 hurricane, Florence still had enough wind speed to uproot trees and cause widespread power outages throughout the Carolinas. A ridge of high pressure over eastern North America stalled Florence's forward motion for several days while making landfall; moving forward at only 2–3 miles per hour (3.2–4.8 km/h); the storm continually dumped heavy rain along coastal areas from September 13, when the outer rain bands first began to be felt, to September 15, when the storm was still stalled out only a few miles west of Wilmington. Coupled with a large storm surge, this caused widespread flooding along a long stretch of the North Carolina coast, from New Bern to Wilmington. As the storm moved inland, from September 15 to 17, heavy rain caused widespread inland flooding, inundating cities such as Fayetteville, Smithfield, Lumberton, Durham, and Chapel Hill, as major rivers such as the Neuse River, Eno River, Cape Fear River, and Lumber River all spilled over their banks. Most major roads and highFways in the area experienced some flooding, with large stretches of I-40, I-95, and US Route 70 remaining impassable for days after the storm had passed. The city of Wilmington was cut off entirely from the rest of the mainland by floodwaters. The storm also spawned tornadoes in several places along its path. Many places received record-breaking rainfall, with more than 30 inches (760 mm) measured in some locations. At least 53 deaths were attributed to the storm,[2][3][4] and damage is currently estimated at more than $38 billion (2018 USD).[5]

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Meteorological history

Map plotting the track and the intensity of the storm, according to the Saffir–Simpson scale

On August 28, 2018, the National Hurricane Center (NHC) began monitoring a tropical wave—an elongated trough of low air pressure—over Western Africa for possible tropical cyclogenesis within the subsequent five days, as it progressed westward.[6] Development into a tropical cyclone became increasingly likely on the following day,[7] and a more defined low coalesced along the coast of Senegal on August 30.[8] Favorable environmental conditions, including ample moisture and low wind shear,[9] enabled further organization and development of broad shower and thunderstorm activity. Lacking a well-defined center but posing an immediate threat to Cape Verde, the NHC began issuing advisories on the system as Potential Tropical Cyclone Six later that day.

Easterly trade winds propelled the disturbance along a west to west-northwest trajectory.[10] Through much of the day and into August 31, convection remained confined to the southwest of the disturbance within a monsoon trough and precluded its classification as a tropical cyclone.[11] Toward the end of August 31, the system's convective organization became sufficient for the NHC to mark the formation of Tropical Depression Six, as the system passed south of Santiago in Cape Verde. Surface pressures on the island fell to 1005 mbar (hPa; 29.68 inHg) at 18:00 UTC.[12]

By September 1, the primary steering factor shifted to a strong subtropical ridge anchored well to the north. Moderate wind shear temporarily stunted development and displaced convection to the eastern side of the depression.[13] Pronounced banding features surrounded the circulation and the depression intensified to a tropical storm; the NHC accordingly assigned the system the name *Florence*.[14] Steady development marked the system's intensification. Satellite intensity estimates indicated Florence achieved maximum sustained winds of 60 mph (95 km/h) by 09:00 UTC on September 2.[15] Thereafter, shear and entrainment of dry air displaced convection from the surface low, leaving it exposed.[16] Considerable uncertainty in the forecast for Florence arose, as weather models began to depict various different solutions.[17] Fluctuations in organization and intensity continued through September 3.[18][19]

Development of a small central dense overcast and a mid-level eye feature signified that Florence achieved hurricane strength early on September 4, roughly 1,240 miles (2,000 km) west-northwest of the Cape Verde islands.[20][21] Unexpectedly the system rapidly organized within a small area of low wind shear in an otherwise adverse upper-level environment. Florence's small size enabled it to take advantage of this localized area.[22] The hurricane's core structure, eye, and outer banding improved markedly, catching forecasters off-guard and intensifying beyond model outputs.[23] In stark contrast to model guidance, Florence continued to intensify and attained major hurricane status at 12:35 UTC on September 5.[24][25] Sustained winds rose to 130 mph (215 km/h) and its pressure fell to 953 mbar (hPa; 28.14 inHg)—this ranked it as a Category 4 hurricane on the Saffir–Simpson scale. Situated at 22.7°N 46.6°W,[26] Florence became the northernmost Category 4 hurricane east of 50°W ever to be recorded.[27]

The hurricane's unforeseen intensification caused it to track farther north, out of the localized low shear.[28] Persistent shear finally took its toll on Florence on September 6 through September 7, causing convection to become asymmetrical and tilting the storm's core southwest to northeast.[29][30] Rapid degradation of Florence's structure occurred by the early hours of September 7. The storm's low-level circulation became exposed as its convection became displaced to the northeast, and the previously well-defined eye dissipated. Scatterometer data revealed the system weakened to tropical storm intensity by 03:00 UTC. Meteorologist Robbie Berg described the intensity forecasts for Florence as a "self-defeating prophecy" owing to the "nuances of the environmental shear".[28][31] A building mid-level ridge halted Florence's northward movement, leading to a westward turn.[28][31] Weather models became increasingly consistent on the storm's future track, leading to greater confidence in a major impact to the Southeastern United States.[32] This trajectory proved climatologically unusual, with United States hurricane landfalls primarily originating farther south and west than Florence.[33]

Environmental conditions became increasingly conducive to reorganization on September 8 as NOAA Hurricane Hunters began reconnaissance of the cyclone.[34] Convective banding blossomed around the storm and a formative eye appeared on satellite imagery.[35] The storm's central dense overcast became more defined, and a complete eyewall developed within its core. Florence reattained hurricane-status by 15:00 UTC on September 9, with the Hurricane Hunters observing 76 mph (122 km/h) sustained winds at the surface.[36] Fueled by sea surface temperatures of 84 to 85 °F (29 to 29.5 °C), Florence rapidly intensified overnight. Convective bursts with frequent lightning surrounded the eyewall,[37] giving rise to a well-defined 12 mi (19 km) wide eye. Expanding outflow ventilated the cyclone, enabling

Hurricane Florence on September 13, 2018, as seen from the International Space Station

continued growth.[38] The system rapidly re-achieved Category 4 intensity by 16:00 UTC on September 10, with reconnaissance aircraft recording surface winds near 130 mph (215 km/h) and a central pressure of 946 mbar (hPa; 27.93 inHg).[39] Hurricane Florence achieved its peak intensity late on September 10, with 1-minute sustained winds of 140 mph (220 km/h) and a minimum central pressure of 939 mbar (hPa; 27.73 inHg).[40] The extent of hurricane-force winds doubled in size and well-defined mesovortices rotated along the inner eyewall.[41] Slight weakening ensued thereafter as an eyewall replacement cycle started; convection surrounding the eyewall became ragged and the eye itself filled.[42][43] This process completed on the following day, with the newly formed eye spanning 35 mi (55 km) across. Extensive outflow became established over the cyclone, extending northwest and east, providing ample ventilation and deformation which enabled Florence to continue expanding.[44] The future track of the hurricane became increasingly complex as it approached the Carolinas. A strengthening trough moving inland over the Pacific Northwest amplified ridging over the Northeastern United States and western Atlantic Ocean, steering Florence to the west-northwest. A collapse of steering currents was anticipated around the time of landfall on September 14, which would result in the hurricane meandering near the coast or just inland for a prolonged period of time.[45]

Fluctuations in the organization of Florence continued through the remainder of September 11 into September 12.[46] Increasing wind shear caused the inner structure to degrade, and the system degraded to Category 3 status by 18:00 UTC.[47] Continued weakening occurred and Florence later fell below major hurricane intensity later that night. The weakening pace slowed as the satellite presentation improved somewhat on September 13, with an eye attempting to emerge again. The hurricane's motion slowed significantly and it began to turn northwest towards the Carolina border. At 11:15 UTC (7:15 a.m. EDT) on September 14, Florence made landfall just south of Wrightsville Beach, North Carolina as a Category 1 hurricane, with sustained winds of 90 mph (150 km/h) and a central pressure of 958 mbar

(28.3 inHg).[48] Although the hurricane began a weakening trend after making landfall, the forward speed decreased, causing Florence to move very slowly west to southwestward as it produced torrential rainfall over the Carolinas. Late on September 14, Florence weakened to a tropical storm over extreme southeastern North Carolina.[49] Florence continued weakening while dropping heavy rain, and weakened into a tropical depression by 09:00 UTC on September 16, while located over South Carolina. By this point, Florence had also begun to gradually accelerate westward.[50] At that time, the NHC issued its final advisory on Florence, transferring responsibility to the Weather Prediction Center (WPC).[51] On September 17, Florence slowly turned to the northeast, while continuing to weaken. Late on the same day, Florence weakened into a remnant low, while situated over West Virginia.[52] On September 18, the remnants of Florence emerged off the New England coast,[53] before being absorbed into a frontal system over the North Atlantic, on September 19.[54]

Preparations

Cape Verde and Bermuda

Upon the designation of Potential Tropical Cyclone Six on August 30, the government of Cape Verde issued tropical storm warnings for the islands of Brava, Fogo, and Santiago.[55] Domestic airlines cancelled 20 flights on August 31 and September 1; maritime travel was also suspended for this period.[56] Mariners were advised to remain cautious of large swells around the islands, potentially reaching 9.8 to 16.4 ft (3 to 5 m).[57] Under the threat of damaging waves, the Autoridade Nacional de Proteção Civil evacuated 125 people, primarily elderly, from Furna and Rincão.[58] Eleven military personnel were deployed to Rincão to assist in evacuations and preparations.[59] Tropical storm warnings were discontinued on September 1, as the system progressed westward and no longer posed a threat to the archipelago.[60]

In anticipation of adverse conditions, Norwegian Cruise Lines and Oceania Cruises adjusted itineraries for *Norwegian Escape*, *Norwegian Dawn*, and *Sirena* to avoid crossing the hurricane's path and not dock in Bermuda.[61]

United States

President Donald Trump holding a briefing in the Oval Office in advance of Hurricane Florence

As forecast models indicated an increasing threat to the Southeastern United States, North Carolina Governor Roy Cooper declared a state of emergency on September 7. Transportation rules for farmers were waived to enable faster harvesting.[62] President Donald Trump declared an emergency in North Carolina, granting the state access to federal funds.[63] An overnight curfew was established for Lumberton for the duration of the hurricane.[64]

South Carolina Governor Henry McMaster followed suit on the next day.[65] The South Carolina Emergency Management Division (SCEMD) and Harvest Hope Food Bank began mobilizing resources for potential recovery efforts.[66] The SCEMD raised operation conditions to level 3 on September 9, and began preparations for the "possibility of a large-scale disaster", with forecasts showing Florence striking the state as a major hurricane.[67] Local officials established overnight curfews for the cities of Aynor, Conway, Dillon, Myrtle Beach, and Surfside Beach to limit the number of people on the roads and enable effective emergency responses. The entirety of Horry and Marion counties also fell under curfews.[64][68][69]

On September 8, Virginia Governor Ralph Northam also declared a state of emergency.[70] On September 10, Maryland Governor Larry Hogan declared a state of emergency for the entire state, with the potential of "historic, catastrophic and life-threatening flooding in Maryland".[71] On September 11, Washington, D.C. Mayor Muriel Bowser declared a state of emergency for the entire District of Columbia due to the "imminent threats on the people of D.C., including threats to health, safety and welfare" caused by Florence.[72][73] On September 12, Georgia Governor Nathan Deal issued a state of emergency for the entire state.[74]

Evacuation and closures

Mandatory evacuation orders for residents and tourists on Hatteras Island in Dare County began on September 10, with orders expanding to the rest of the county the following day.[75] Evacuations along the rest of the Outer Banks and in Brunswick County went in effect on September 11.[76] On September 10, Governor Henry McMaster ordered evacuations for the entire coastline of South Carolina,[77] constituting roughly 1 million people.[78] On September 10, Virginia Governor Ralph Northam ordered mandatory evacuations for low-lying coastal areas in the Hampton Roads and Eastern Shore regions effective September 11, constituting 245,000 people.[79] The US Navy has moved 30 ships stationed off the coast of Virginia farther out to sea, to protect the ships and the coastline.[80]

'Red Cross Shelter Serves Florence Evacuees' - News report published by Voice of America on September 14, 2018

In North Carolina, mandatory evacuations were issued on September 11 for Brunswick County, Carteret County, Craven County, Onslow County, Pamlico County, Tyrrell County, North Topsail Beach, Emerald Isle, Ocracoke Island, Atlantic Beach, Indian Beach, Kure Beach, Pine Knoll Shores, and Wrightsville Beach. A mandatory evacuation for visitors and tourists was issued on September 11 for Holden Beach, Oak Island, and Currituck. Voluntary evacuations were issued for Bertie County, Beaufort County, and Surf City.[81] A voluntary evacuation was also issued for New Hanover County on September 10, including Wilmington, NC.[82]

> "They haven't seen anything like what's coming at us in 25, 30 years, maybe ever. It's tremendously big and tremendously wet."
>
> President Donald Trump, September 11, 2018, White House press briefing (https://twitter.com /CNNPolitics/status /1039600340507783168)

The University of North Carolina at Wilmington issued a mandatory evacuation effective on September 10.[83] All students were evacuated by noon on September 11. The university collaborated with the University of North Carolina at Asheville to house students who had no options for safe shelter.[84] College football games scheduled at North Carolina State University,[85] East Carolina University, Wake Forest University, Appalachian State University, the University of North Carolina at Chapel Hill, and the University of South Carolina were cancelled as a result of the storm.[86][87][88] Several universities in North Carolina have announced closings in preparation for the hurricane. [89][90][91]

In South Carolina, in 26 eastern counties, public schools were closed until further notice beginning on September 10. State offices in these counties were also ordered closed, while county-level officials could decide when to close their offices.[92]

Atlanta Motor Speedway, Bristol Motor Speedway, Charlotte Motor Speedway and Talladega Superspeedway opened their campgrounds to evacuees of Hurricane Florence free of charge.[93][94][95] In West Virginia, Governor Jim Justice

ordered for construction along northbound Interstate 77 (West Virginia Turnpike) between the Virginia border in Mercer County and Charleston to be suspended in order to improve traffic flow for evacuees. In addition, West Virginia state parks offered reduced rates for rooms, cabins, and campsites until September 18 in order to provide assistance to evacuees.[96]

Impact

Cape Verde and Bermuda

Disruptive rainfall and strong winds affected Brava, Fogo, and Santiago in Cape Verde, causing some landslides and localized flooding. Impacts from the storm were otherwise minimal, with no material damage reported.[56]

Large swells and rip currents from the storm reached Bermuda on September 7.[97]

United States

North Carolina

In Wrightsville Beach, North Carolina, 27 people required lifeguard rescue between September 8 and 9.[98] On September 13, New Bern, North Carolina, was inundated with storm surge around 6 feet (1.8 m). Water levels rose in the west side of the Pamlico Sound. A gauge in Oriental, North Carolina, recorded water height of about 5.5 feet (1.7 m) above normal on the Neuse River.[99] Employees at ABC affiliate WCTI-TV (which serves the surrounding market that includes Greenville and Jacksonville) were forced to evacuate its New Bern studio facility that evening due to the rising waters; WCTI station staff were asked to relocate to the studios of sister station WPDE in Myrtle Beach, South Carolina to continue coverage of the storm, with WCTI switching to a simulcast of WPDE's live coverage of the storm until its staff relocated to the WPDE facility.[100][101][102] Reports indicated that around 150 people were in need of rescue in New Bern because of the heavy flooding.[103]
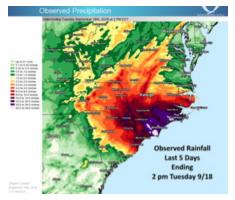

Radar image of Hurricane Florence a few hours after landfall on September 14

Florence's flooding in North Carolina and Virginia was compounded by earlier flooding during the summer that left the ground heavily saturated.[105]

Florence made landfall in Wrightsville Beach, North Carolina on September 14, and by mid-morning rescuers had already evacuated more than 200 people from floodwaters, with about 150 more awaiting rescue. The storm had reportedly cut power to more than 500,000 customers in North and South Carolina by the time of landfall and caused the roof of a hotel in Jacksonville, North Carolina to collapse that morning.[106] On September 14, about 100 civilians, city workers, and National Guard worked to fill sandbags and protect Lumberton, North Carolina from an identified weak spot that caused massive flooding during Hurricane Matthew in 2016.[107]

Heavy rains continued to affect the Carolinas after landfall. A weather station in Swansboro, North Carolina, recorded 33.90 inches (861 mm) of rain, establishing a new record for a tropical cyclone in that state.[108][109] By September 17, Florence had dropped a maximum total of 35.93 inches (913 mm) of

5-day map accumulation with Florence over the Carolinas

rain in Elizabethtown, North Carolina, becoming the wettest tropical cyclone recorded in the state.[1]

Costliest U.S. Atlantic hurricanes			
Cost refers to total estimated property damage			
Rank	**Hurricane**	**Season**	**Damage**
1	Katrina	2005	$125 billion
	Harvey	2017	
3	Maria	2017	$90 billion
4	Sandy	2012	$65 billion
5	Irma	2017	$53.4 billion
6	Florence	2018	>$38 billion
7	Ike	2008	$30 billion
8	Andrew	1992	$27 billion
9	Ivan	2004	$20.5 billion
10	Wilma	2005	$19 billion
Source: National Hurricane Center[104][5][nb 1]			

Statewide, approximately 2,200 primary and secondary roads closed due to flooding,[110] including large sections of Interstates 40 and 95.[111][112]

Strong winds in New Hanover County toppled numerous trees and power lines, while more than 90% of the county was left without electricity. The storm dropped up to 27.2 in (690 mm) of rain near Kings Grant.[113] By the morning of September 16, Wilmington had recorded more rain from Florence than any other single weather event in the city's history. Additionally, Florence contributed to the wettest year in Wilmington history, with annual rainfall totals eclipsing the previous record set in 1877.[114] The city of Wilmington became entirely isolated, as all roads to the city flooded and were deemed impassable,[115] though one unidentified road was opened briefly on September 17.[116] The majority of residents remained without electricity, as of September 16. The city's airport and port were also closed.[115][117] Although cell phone service remained operational, excess demand strained networks. More than 450 people required rescue across Wilmington. Woody White, New Hanover County chairman of the board of commissioners, issued a statement advising all travelers to avoid the Wilmington area.[115] There was a report of looting and burglary at a Wilmington area Family Dollar, with the theft of non-essential items such as sports apparel and athletic shoes during the height of the storm.[118][119] The city-wide curfew issued in advance of the storm was extended because of these incidents.[115]

Early on September 17, a tornado was confirmed in Elm City, North Carolina.[120]

The Cape Fear River crested at 61.4 ft (18.7 m)—about 35 ft (11 m) above flood stage—near Fayetteville early on September 19. The magnitude of flooding greatly exceeded the levels observed due to Hurricane Matthew in 2016. The nearby Little River inundated large areas across Cumberland and Harnett counties. Overtopped bridges isolated communities and hampered relief efforts.[121]

South Carolina

Heavy rainfall also occurred in South Carolina, with 23.63 in (600 mm) of precipitation observed near Loris, setting a new state record for rainfall from a tropical cyclone.[122] More than 100 people were rescued from their homes and cars in Loris. The Waccamaw River in Conway crested at 22.1 ft (6.7 m) on September 26, exceeding the Hurricane Matthew record of 19.1 ft (5.8 m). At a neighborhood along South Carolina Highway 905, about 5 ft (1.5 m) of water entered some homes. Farther south along the Waccamaw River, homes in a neighborhood in Socastee were flooded

with as much as 8 ft (2.4 m) of water. In western Horry County, the community of Dongola was left isolated for 10 days. The overflowing river flooded almost 1,000 homes and businesses. The storm also spawned two tornadoes in Horry County, both rated EF0. The first twister touched down just north-northeast of Myrtle Beach, causing minor damage to pine trees near Route 17 before lifting after moving only about half a mile. The other tornado touched down near Longs and also damaged pine trees and a roof.[113]

Flooding was also reported in Marion County, especially in Brittons Neck and Gresham. A number of people evacuated and were still not able to access their homes by October 1. In Nichols, flooding damaged about 150 homes which had been rebuilt after Hurricane Matthew. Strong winds downed trees and power lines, while at least one home in Nichols suffered roof damage. Approximately 400 homes in Dillon County were flooded. A total of 21 homes in Darlington County received severe flood damage, while another home was destroyed.[113]

In Chesterfield County, the Pee Dee River crested at 46.51 ft (14.18 m) at Cheraw. Three nearby dams failed, causing significant flooding in Cheraw and the town of Chesterfield. Many roads became impassable or were washed out. A total of 226 homes were damaged and other 2 were destroyed.[123] A Superfund site was also damaged, causing PCB to enter homes, a toxic substance which required cleanup efforts by the Environmental Protection Agency.[124] In Lancaster County, flash flooding left a number of roads impassable and washed out several other streets. A park was flooded after the Gills Creek overflowed. Winds downed about 20 trees in the Lancaster area, one of which fell onto a home and others falling onto a road. Power lines were downed across Route 521, obstructing all four lanes.[123]

Elsewhere

A warehouse in Chesterfield County, Virginia, destroyed by a tornado

The storm spawned 10 tornadoes in Virginia, including 2 in Chesterfield County, 1 in Hanover County, 1 in Mecklenberg County, 1 in Powhatan County, and 5 in Richmond. Most of these tornadoes caused little damage other than downed trees, tree limbs, or electrical poles. However, the twister in Chesterfield County, rated EF2, damaged several buildings between Winterpock and Bon Air and destroyed a warehouse, causing one death and at least one injury. The tornado in Mecklenberg County, rated EF0, touched down between Boydton and Skipwith. Extensive tree damaged was reported, with several homes and outbuildings damaged by falling trees.[125]

Large swells ahead of the hurricane reached Assateague State Park, Maryland, by September 9, prompting the Maryland Department of Natural Resources to close beach access indefinitely.[126]

Deaths

Rip currents and rough seas in New Smyrna Beach, Florida, caused 13 rescues; one victim died at a hospital and two others had impact injuries.[3] One man drowned on September 11, at Florida's Playalinda Beach, while trying to rescue a 10-year-old boy caught in a rip current.[4] One child drowned in Green Swamp near Sumter, South Carolina after water released from the Second Mill Pond flowed into the river.[127]

Two people in North Carolina died while trying to evacuate: one in Columbus County and Wayne County.[128][129] In Wilmington, a mother and her baby were killed when a tree landed on their house. In Hampstead, a woman died of a heart attack; downed trees on roads kept first responders from reaching her. A person was killed in Lenoir County

while plugging in a generator in the wet conditions.[130] A house fire in Fayetteville killed a husband and wife. Freshwater flooding killed at least eleven people: one in Anson County, eight Duplin County, and two in Scotland County.[110][129][131] One man was killed in Kinston by strong winds while checking on his hunting dogs.[132] A three-month-old baby died in Gaston County when a tree crushed a mobile home.[128] In Union County, a woman drove around a barrier into a flooded road and her vehicle was swept away. Rescuers saved the mother, but her one-year-old baby drowned.[133] An 18-wheeler aquaplaned off Interstate 85 near Kings Mountain and crashed into a tree; the vehicle tore in half, killing the driver.[134] Two other

Deaths by U.S. state

State	Deaths		
	Direct	Indirect	Total
Florida	2	0	2
North Carolina	21	18	39
South Carolina	4	5	9
Virginia	3	0	3
Total	30	23	53

accidents each killed one person: an old man died of oxygen loss related to chronic obstructive pulmonary disease during a power outage, and a person collapsed and died in Sampson County while helping an evacuee.[129] One person drowned in the swelling Cape Fear River near Cedar Creek after refusing evacuation orders.[135] On September 20, a man in Brunswick County died after being crushed by a tree he was clearing.[136] In late September, two people were killed in North Carolina while repairing damage from Hurricane Florence to their homes, bringing the death toll in the state to 39.[2]

Three deaths originally attributed to the hurricane were later considered unrelated. One woman died of unknown causes in a shelter, and two people found dead on Harkers Island were deemed victims of a murder-suicide.[128][137]

Two people died of carbon monoxide poisoning in Loris, South Carolina. A vehicle with three occupants lost control on a flooded road in Georgetown County; one passenger died, while the driver and other passenger escaped. A woman died when her vehicle crashed into a downed tree near Union.[131] A vehicle lost control along Interstate 20 near Columbia and crashed into a bridge support, killing the driver. Another fatal accident occurred near Columbia when a woman drove into a flooded road and crashed into a tree.[138] On September 18, a van was transporting two mental health patients from Horry County to Darlington; the vehicle was swept away by swift-moving water along U.S. Route 76—the swollen Little Pee Dee River was 0.5 mi (0.80 km) from this location.[139] The two deputies in the van managed to escape and survived;[140] however, the two women in the back were shackled, and the deputies were unable to free them before the van was overcome with water.[141] The deputies were put on administrative leave.[142]

On September 17, ten tornadoes (EF0 through EF2)[125][143] touched down in Virginia, resulting in one death in Chesterfield County, Virginia.[144][145] Another person died when his vehicle was swept away along a flooded road in Louisa.[146]

Agriculture and environmental effects

The large-scale flooding affected swaths of North Carolina's agricultural industry and proved particularly damaging to livestock. Through September 18, the North Carolina Department of Agriculture stated 3.4 million chickens and turkeys and 5,500 hogs died in flooded farms. Dozens of farms remained isolated with animals unable to be fed. Piles of manure stored at these farms were swept into swollen rivers,[147][148] about a dozen pits holding animal waste were damaged by the flooding and debris.[149]

On September 16, approximately 5 million gallons of partially treated wastewater spilled into the Cape Fear River after a treatment plant lost power.[147] An estimated 2,000 yd³ (1,530 m³) of coal ash from the closed Sutton Power Station near Wilmington was also swept into the river. Torrential rains from the storm itself, estimated at 30 inches (760 mm),

also caused a swamp to spill into the cooling pond.[150] On September 19, the H.F. Lee Energy Complex in Goldsboro flooded to the point where their three ponds were completely underwater and began releasing coal ash into the Neuse River.[151]

Domestic and zoo animals

During and after the storm made landfall, local rescuers and nationwide donors and organizations worked to aid the many pets that had been left by their owners, or alongside their owners.[152][153] Others drove to South and North Carolina in order to evacuate animals and bring them outside of the hurricanes impact zone while shelters in other states accepted animals from the states.[154] Many rescuers were looking for local residents in need of assistance or evacuation aid, and discovered some animals in flooding cages, some attempting to seek shelter, and some stranded on porches.[155]

United States Coast Guard rescuing animals from the flooded area in Delco, North Carolina

Zoo animals such as those from the Virginia Zoo were sheltered within indoor and sheltered portions of their enclosures.[156] Other zoos such as the North Carolina Zoo were lightly impacted by the storm and opened on September 18, and offered free admission for evacuees from September 18 to 21.[157]

Aftermath

Evacuees

On September 19, after the rain had stopped, a majority of evacuees were urged by officials to stay away from their homes as the rivers continued to rise; the potential threat of floods remained high, roads remained closed, and thousands lacked power to their homes.[158]

Power restoration

In the aftermath of the storm, over 40,000 workers from across the U.S. and Canada went to the Carolinas to help restore power, according to the Edison Electric Institute.[159]

Roads

The continued flooding closed many major roads for days after the incident. On September 15, NCDOT asked drivers to avoid driving in North Carolina altogether, instructing them to take a detour at Richmond, Virginia using Interstate 64 West to Interstate 81 south, to Interstate 75 south in Tennessee to Interstate 16 east in Georgia back to Interstate 95.[160] Parts of I-95 and I-40 in North Carolina reopened ten days later September 23, while hundreds of other roads remained closed.[161] Thousands of dead fish had to be cleaned off of Interstate-40 in Pender County, North Carolina, with other marine life such as a 20-foot-long whale being reported washed onto beaches and residential areas, having to be removed and buried.[162]

Relief efforts

President Donald Trump visited North and South Carolina on September 19, and spoke to emergency workers in an airplane hangar at the Marine Corps Air Station Cherry Point.[163] South Carolina Governor McMaster applied for $1.2 billion in federal funding for recovery. This included $165 million under the National Flood Insurance Program and $125 million for agriculture.[110] On September 23, the United States Congress began deliberation of a $1.7 billion aid package for the Carolinas.[164]

Investigation

The deaths of two women who were being transported to a mental health facility led to an opening of an investigation, which is being conducted by the State Law Enforcement Division and Highway Patrol. The deputies involved were placed on administrative leave.[142]

See also

- List of Category 4 Atlantic hurricanes
- Lists of tropical cyclones by area:

   - Bermuda • Florida • Maryland • North Carolina

- 1933 Chesapeake–Potomac hurricane – Category 4 hurricane that took a similar track to Florence as it approached the US, before making landfall near Chesapeake Bay
- Hurricane Hazel (1954) – One of the strongest tropical cyclones to affect the Carolinas
- Hurricane Gracie (1959) – Category 4 hurricane that made landfall in South Carolina
- Hurricane Hugo (1989) – Powerful Cape Verde hurricane that caused widespread destruction in the Carolinas
- Hurricane Fran (1996) – Category 3 hurricane that took a similar track to Florence and affected the Mid-Atlantic
- Hurricane Floyd (1999) – Another storm that caused catastrophic flooding in eastern North Carolina
- Hurricane Isabel (2003) – Took a similar path to Florence late in its lifetime; made landfall in North Carolina as a Category 2 hurricane
- Hurricane Joaquin (2015) – Category 4 hurricane that contributed to historic flooding in the Carolinas, even though the storm itself never made landfall in the Carolinas.
- Hurricane Harvey (2017) – Another Category 4 hurricane that caused catastrophic flooding around Houston, becoming the wettest tropical cyclone in the U.S.

Notes

1. All damage figures in this table are in the USD amounts of their respective year.

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External links

- The National Hurricane Center's advisory archive on Hurricane Florence (http://www.nhc.noaa.gov/archive /2018/FLORENCE.shtml)
- Weather Underground Hurricane Florence tracker (https://www.wunderground.com/hurricane/atlantic /2018/hurricane-florence?map=forecast)
- Weather Underground Weather Map & Forecasting Models (https://www.wunderground.com /wundermap?lat=31.7&lon=-67.7&wxstn=0&satellite=1&hur=1)
- Safety information and tips from Ready.Gov

    - Hurricanes (https://www.ready.gov/hurricanes)
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- Safety information and tips from the Centers for Disease Control and Prevention

- - Hurricane Florence (https://www.cdc.gov/disasters/hurricanes/hurricane-florence.html)
- AccuWeather predicts that Florence's death toll may total 600 when including 6-month tail period after storm (https://www.accuweather.com/en/weather-news/accuweather-predicts-that-florences-death-toll-may-total-600-when-including-6-month-tail-period-after-storm/70006207) - AccuWeather

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