Actuarial Weather Extreme Series

Hurricane Helene – September 2024

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Hurricane Helene

Hurricane Helene made landfall in Florida as a catastrophic Category 4 hurricane on September 26th, 2024, leaving a trail of devastation in its wake. However, the storm's subsequent inland movement brought unprecedented rainfall to the southeastern United States, resulting in severe and widespread flooding, billions of dollars in economic loss, and hundreds of deaths.[1] This paper will delve into the meteorological aspects of Hurricane Helene, focusing on the exceptional rainfall totals and the devastating storm surge that impacted the region, particularly western North Carolina. By analyzing data from the Automated Surface Observing System (ASOS) and the United States Geological Survey (USGS), this study aims to quantify the extraordinary nature of the storm's precipitation and inland flooding events.

The devastating impact of Hurricane Helene raises critical questions about the increasing frequency and intensity of extreme weather events in recent decades. Climate change is widely recognized as a major contributor to these trends. Rising sea levels, warmer ocean temperatures, and changes in atmospheric circulation patterns have all been linked to more intense hurricanes and increased coastal flooding. While Helene will go down as one of the most destructive hurricanes in modern history, it may be a sign of things to come.

[1] *Hurricane Helene live updates: More than 200 dead as hope fades in search for survivors*. (2024, October 3). NBC News. https://www.nbcnews.com/news/weather/live-blog/hurricane-helene-live-updates-rcna173767

October 3, 2024

Figure 1

SATELLITE IMAGERY OF HURRICANE HELENE AS IT MAKES LANDFALL

Image downloaded from MODIS Land Rapid Response Team, NASA GSFC on October 3rd, 2024: https://modis.gsfc.nasa.gov/gallery/individual.php?db_date=2024-09-28

Figure 1's satellite image above illustrates how massive this storm became and the path of its destruction through Georgia and heading up to the Carolinas.

Note on Data

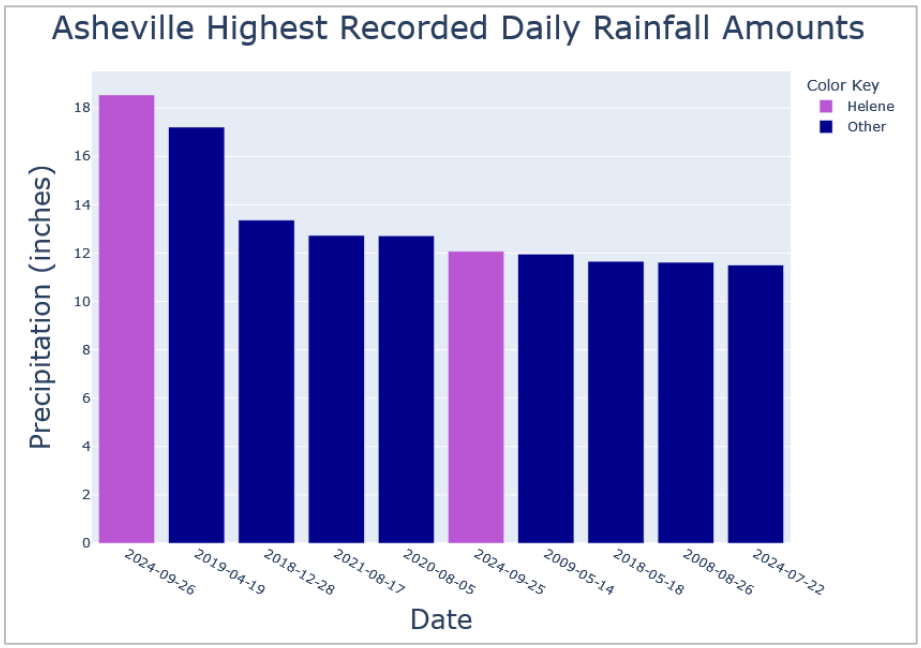
Throughout this report, data from ASOS is used instead of another source of data, the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Information (NCEI). This data source was unavailable at the time of this writing because the data server with the Global Historical Climatology Network (GHCN) data is in Asheville, NC – one of the hardest hit locations in the path of Hurricane Helene. This is another example that the impacts of these disasters can have a global reach.

Unprecedented Rainfall

The flooding impacts of Helene are devastating to the area and will be felt for years to come. The flooding was caused by a swift deluge and an amount of rainfall that has not been recorded before. Daily data from ASOS shows that the two of the top 10 rainfall days in Asheville's recorded history (first observations coming from 1964) comes from this hurricane, with September 26th easily having the most precipitation. Even before the hurricane officially made landfall, the outside of the hurricane was already delivering massive amounts of rainfall to the area.

Figure 2

DAYS WITH THE MOST PRECIPITATION, ASHVILLE, NORTH CAROLINA



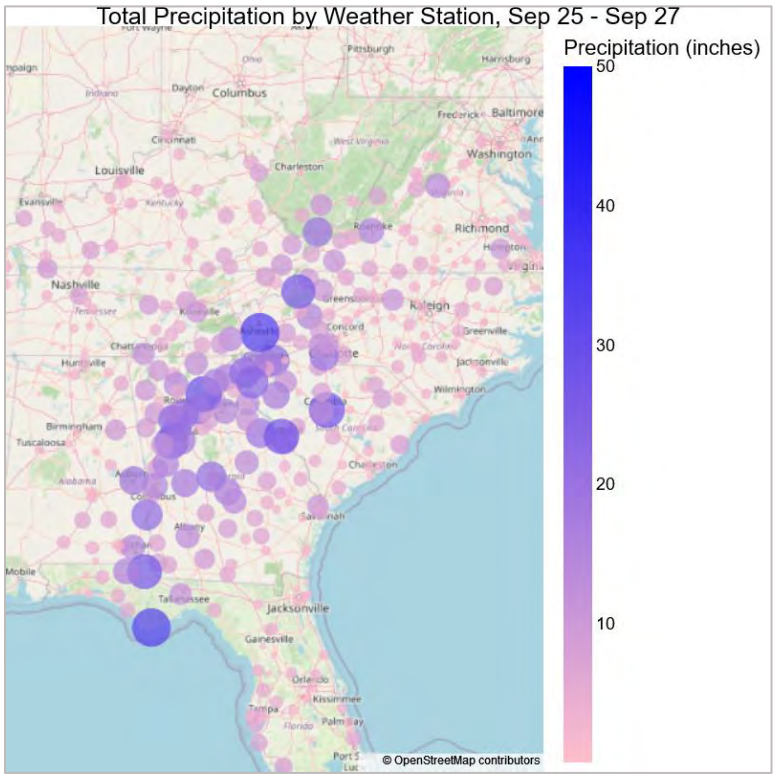
Data accessed from Iowa State University's Iowa Environmental Mesonet on October 2nd, 2024: https://mesonet.agron.iastate.edu/request/download.phtml?network=NC_ASOS

Figure 2 shows that the day of landfall (September 26th) and the day before landfall (25th) were the days with the most and 6th most precipitation in Asheville's recorded history.

Although Asheville was hard hit, they were far from the only area to feel the effects of the hurricane. Below is a map that shows the total precipitation by weather station for the period of September 25th to September 27th. Many of these stations had missing or partial data for this period, possibly with their instruments and sensors overwhelmed by the storm.

Figure 3

THREE-DAY PRECIPITATION FOR THE PERIOD FROM SEPTEMBER 25-27



Data accessed from Iowa State University's Iowa Environmental Mesonet on October 2nd, 2024: https://mesonet.agron.iastate.edu/request/download.phtml?network=NC_ASOS

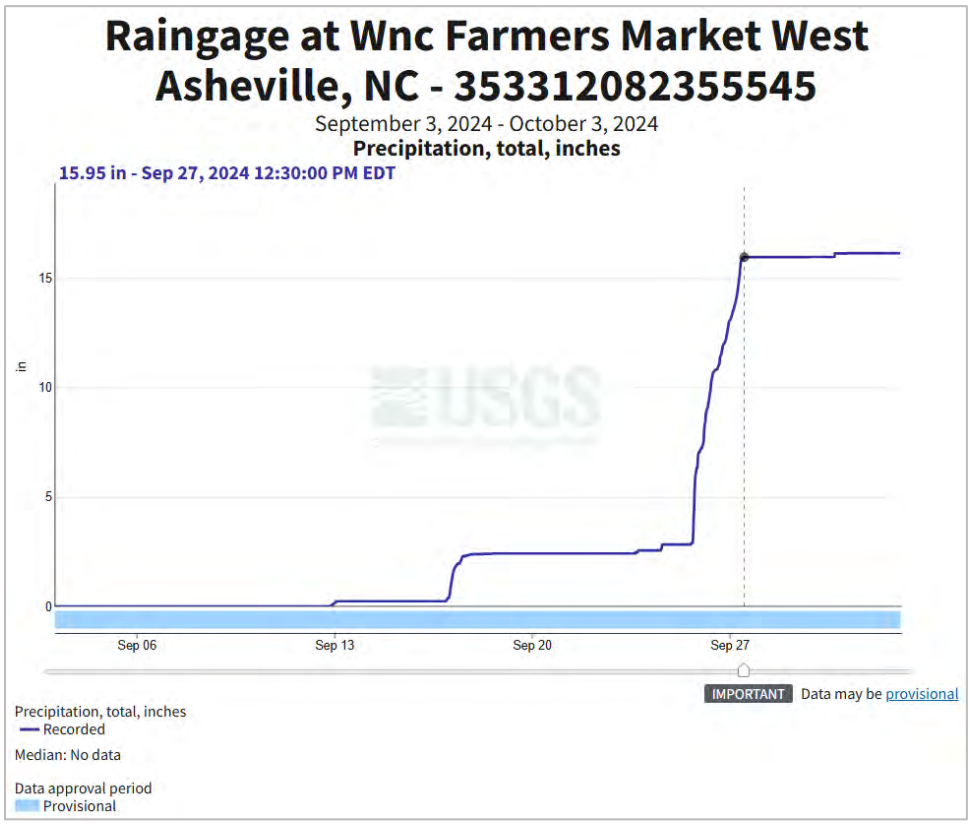
Figure 3 shows that the hurricane's path of precipitation started at the panhandle and extended upward to northern Georgia, and the western Carolinas.

Intensity and Flooding

A contributing factor to the intensity of this storm was how quickly the precipitation fell on the affected areas. We can use United States Geological Survey (USGS) data to track cumulative precipitation at specific points and gage heights in water bodies to see how quickly the precipitation fell. As can be seen from the charts below, in some instances, the precipitation was so much, the sensor was not able to track it all.

Figure 4

PRECIPITATION DATA FROM WNC FARMERS MARKET IN ASHVILLE, NORTH CAROLINA



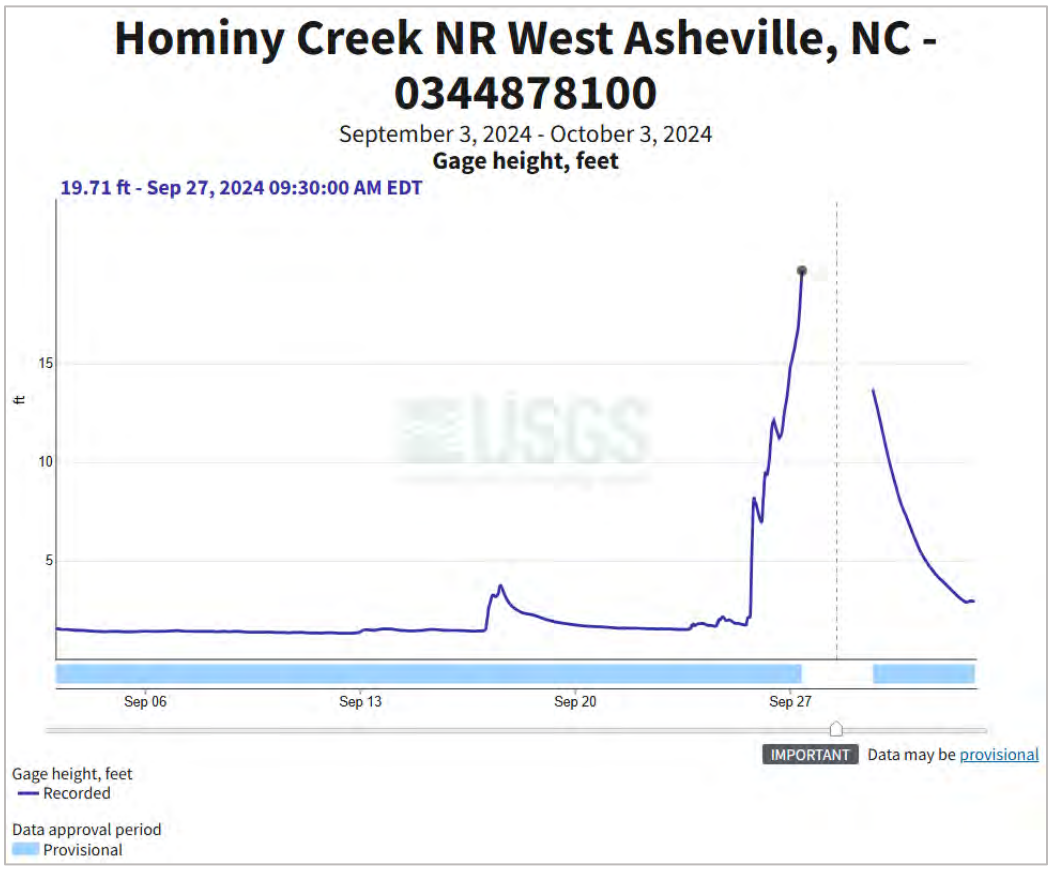
Graphic accessed from USGS's Water Data site on October 3rd, 2024: https://waterdata.usgs.gov/monitoring-location/353312082355545/#parameterCode=00045&period=P30D&showMedian=true

Figure 4 displays the huge amount of rain that fell all in the span of 48 hours. This sensor was able to track about 10 inches occurring in about 2 days.

As the precipitation started to increase, so did the river levels. Two river gages are shown below, one is the Hominy Creek Gage, and one is the French Broad River Gage. These show that when the hurricane hit, the water rose significantly in a very short period of time: so much that the sensors were not able to capture the data. In addition, flood stages and discharge data are given for the French Broad River Gage, showing how the current changed with such added precipitation.

Figure 5

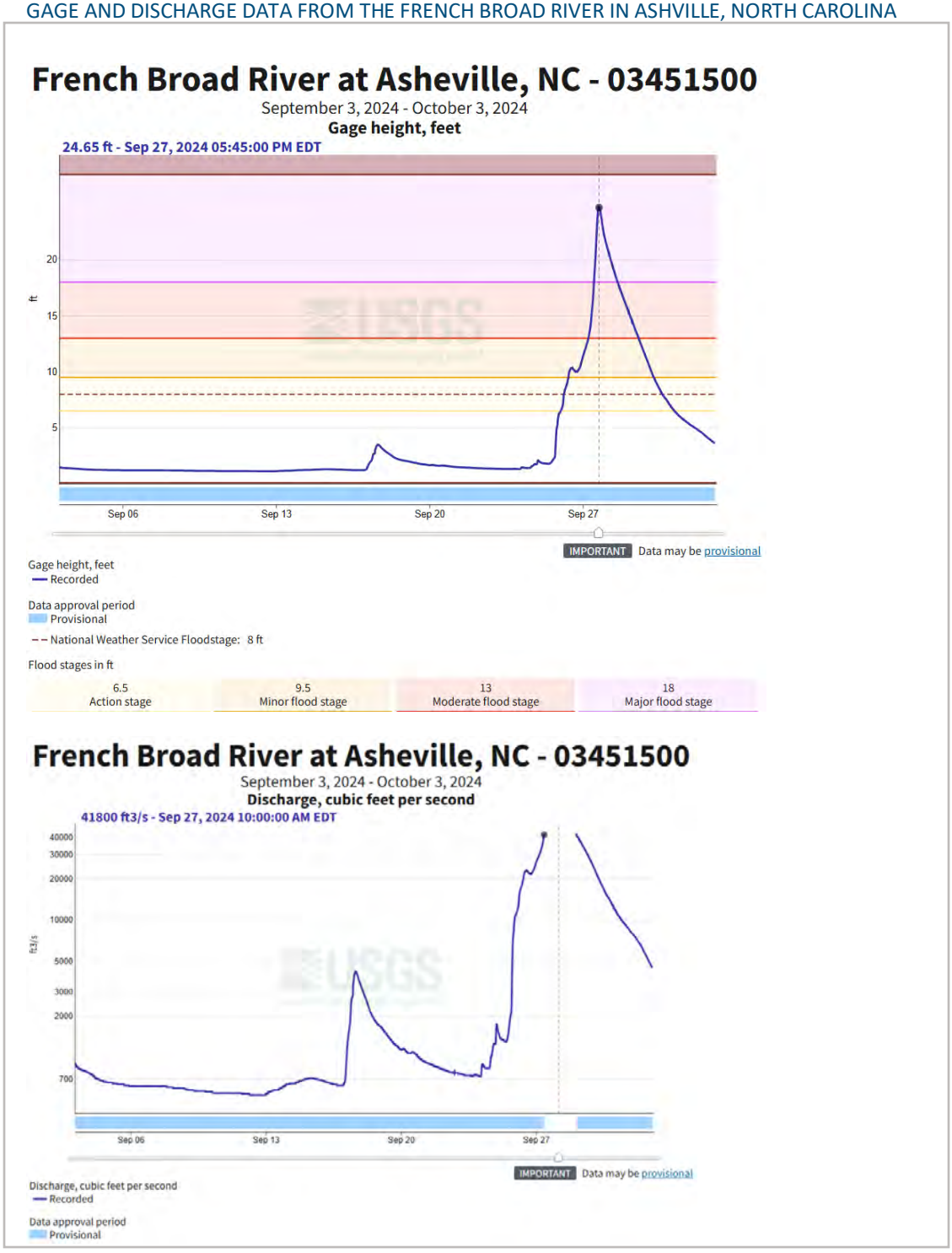
GAGE DATA FROM A SENSOR IN ASHVILLE, NORTH CAROLINA



Graphic accessed from USGS's Water Data site on October 3rd, 2024:
https://waterdata.usgs.gov/monitoring-location/0344878100/#parameterCode=00065&period=P30D&showMedian=false

Figure 6

GAGE AND DISCHARGE DATA FROM THE FRENCH BROAD RIVER IN ASHVILLE, NORTH CAROLINA



Graphic accessed from USGS's Water Data site on October 3rd, 2024:
https://waterdata.usgs.gov/monitoring-location/03451500/#parameterCode=00065&period=P30D&showMedian=false
https://waterdata.usgs.gov/monitoring-location/03451500/#parameterCode=00060&period=P30D&showMedian=false

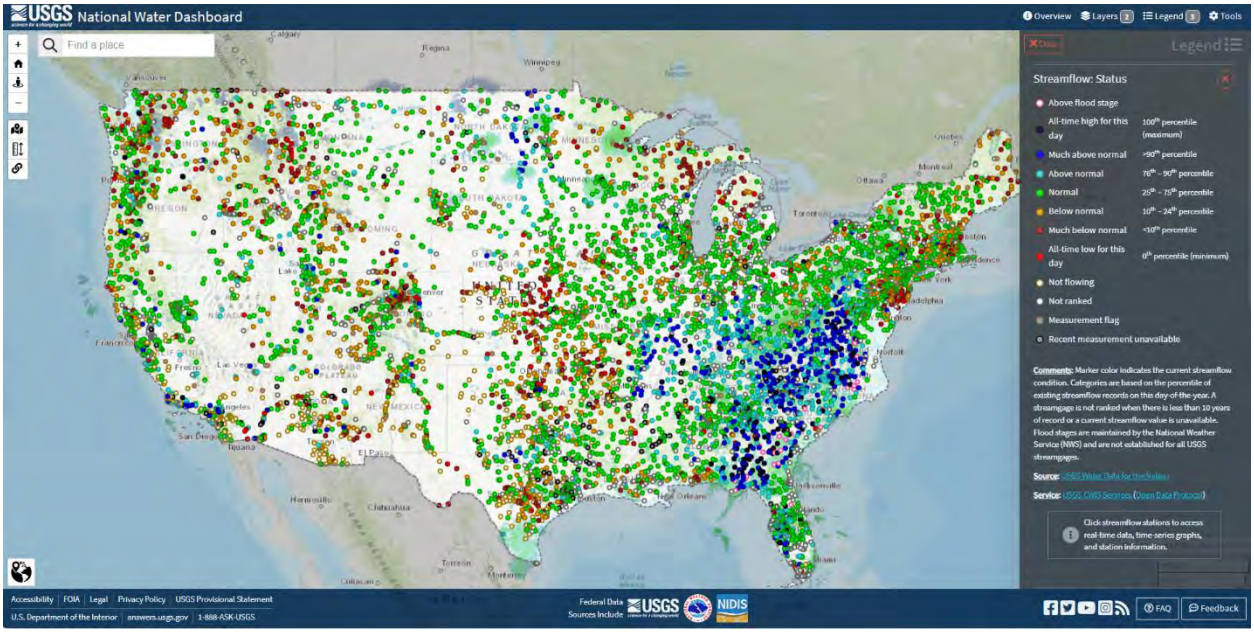
Figure 5 gives the Hominy Creek gage level, while Figure 6 gives the French Broad River gage level and discharge for the 30-day period beginning on September 3rd. The Hominy Creek gage shoots up to nearly 20 ft. before the recordings stop. Similarly, the French Broad River gage increases to over 24 ft, crossing the zones for "action stage", "minor Flood Stage", "moderate flood stage", and "major flood stage." The French Broad River reaches a discharge level of 41,800 ft^3/s before that sensor goes out. To put that into perspective, the Mississippi River at St. Louis had a discharge level of 109,000 ft^3/s at that time.[2] So this river had the flow that was more than one-third the current of the Mississippi River for this normally much smaller river.

Ongoing Flooding

One week after the hurricane made landfall, there was still elevated water levels in the waterways of the southeastern United States. The map below, taken from the USGS's live National Water Dashboard on the morning of October 3rd, shows many sensors with all-time highs or > 90th percentile for their streamflow, meaning that the currents and water levels are still very strong and high, respectively.

Figure 7

USGS NATIONAL WATER DASHBOARD FOR OCTOBER 3, 2024



Graphic accessed from USGS's Water Data site on October 3rd, 2024:
https://dashboard.waterdata.usgs.gov/app/nwd/en/

Figure 7 highlights the unprecedented levels of streamflow in the southeastern United States, with dark blue and blue dots highlighting statistically significant percentiles.

[2] *Mississippi River at St. Louis, MO*. (n.d.). Retrieved October 3, 2024, from https://waterdata.usgs.gov/monitoring-location/07010000/

Economic Impacts

With the deceased still being counted, there are already estimates as to the property damage done by Hurricane Helene. Moody's is estimating property damage of $15 billion to $26 billion,[3] while AccuWeather's preliminary estimate is that the total damage and economic loss will be between $95 billion and $110 billion.[4] If this figure is correct, then Helene will be one of the most expensive storms in modern US history.[5] Included in this damage, the USDA is estimating insurance payouts of $7 billion for crop losses alone.[6] Congress is expected to pass an aid package to cover some of the losses across the region.[7]

[3] Hanrahan, R. (2024, October 2). Hurricane Helene Causes Billions in Ag Damage. *Farm Policy News*. https://farmpolicynews.illinois.edu/2024/10/hurricane-helene-causes-billions-in-ag-damage/
[4] See footnote 4
[5] US southeast faces daunting cleanup from Helene as death toll rises. (2024, September 28). *Reuters*. https://www.reuters.com/business/environment/us-southeast-faces-daunting-task-cleaning-up-helene-death-toll-rises-2024-09-28/
[6] See footnote 4.
[7] See footnote 4.