Hurricane Helene Strategic Wildfire Rapid Risk Assessment

Authors: Ben Gannon (benjamin.gannon@usda.gov), David Quisenberry (david.quisenberry@usda.gov), Rick Stratton (richard.stratton@usda.gov)
Last updated: 03/07/2025

Purpose

Hurricane Helene damaged forests in the Southeastern United States last September. The combination of abundant rainfall and high winds resulted in a range of impacts from defoliation and partial crown damage to snapped boles and uprooted trees. Forests with moderate and high severity disturbance are a concern because of altered fire behavior and suppression difficulty (see safety alert). Fire behavior may be more extreme in hurricane disturbed stands from the increased surface fuels and the reduced canopy cover. The addition of down trees and large branches in hurricane disturbed stands can also impede firefighter mobility, increase the difficulty of line construction, and expose firefighters to additional hazards. This strategic wildfire rapid risk assessment seeks to identify areas where hurricane disturbance may compound existing wildfire risks to inform post-hurricane fuels management priorities and wildfire response strategies.

Methods

Hurricane disturbance

The extent and severity of hurricane disturbance was mapped from two sources based on regional fire and fuels specialist feedback:

- HiForm four class disturbance map for the Southern Appalachians from the USDA Forest Service Southern Research Station, and
- DeltaViewer five class disturbance map for the full hurricane path from the USDA Forest Service Geospatial Technology and Applications Center (GTAC).

Both disturbance maps were created using remote sensing change detection based on Sentinel 10-m resolution satellite imagery.

Local feedback indicated that the HiForm map provided the most accurate depiction of high severity disturbance in the Southern Appalachians, but the map does not cover the full extent of the hurricane path. Therefore, we combined the maps as follows:

- Reprojected both data sources to match the LANDFIRE projection, cell size (30-m), and cell alignment using the majority resampling technique;
- In the Southern Appalachians:
    - Classified the original HiForm values as indicated in **Table 1**;

    - Classified the original DeltaViewer values as indicated in the "Severity for Southern Appalachians" column of **Table 2**;
    - Assigned the final severity as the maximum of the reclassed HiForm and DeltaViewer values.
- For the remainder of the hurricane path:
    - Classified the original DeltaViewer values as indicated in the "Severity for Rest of Path" column of **Table 2**;
- Combined reclassified severity maps for Southern Appalachians and rest of hurricane path; and
- Filtered out any non-forest from the hurricane severity map using the criteria of greater than zero canopy cover as mapped by LANDFIRE 2023 (v2.4.0).

Table 1. HiForm hurricane disturbance values and assigned severity level.

Value	Description	Severity
1	Large gap blowdowns	High (3)
2	Heterogenous areas with severe or mixed damage	Moderate (2)
3	Scattered low severity or broad light impacts that are non-structural	Low (1)
4	No/minor impacts	None (0)

Table 2. DeltaViewer hurricane disturbance values and assigned severity level.

Value	Description	Severity for Southern Appalachians	Severity for Rest of Path
0	No data/clouds	None (0)	None (0)
1	No damage	None (0)	None (0)
2	Slight damage	None (0)	None (0)
3	Moderate damage	Low (1)	Low (1)
4	Severe damage	Moderate (2)	Moderate (2)
5	Catastrophic damage	Moderate (2)	High (3)

The combined map of hurricane severity is shown in **Figure 1**. The area mapped in different severity levels is described in **Table 3**.

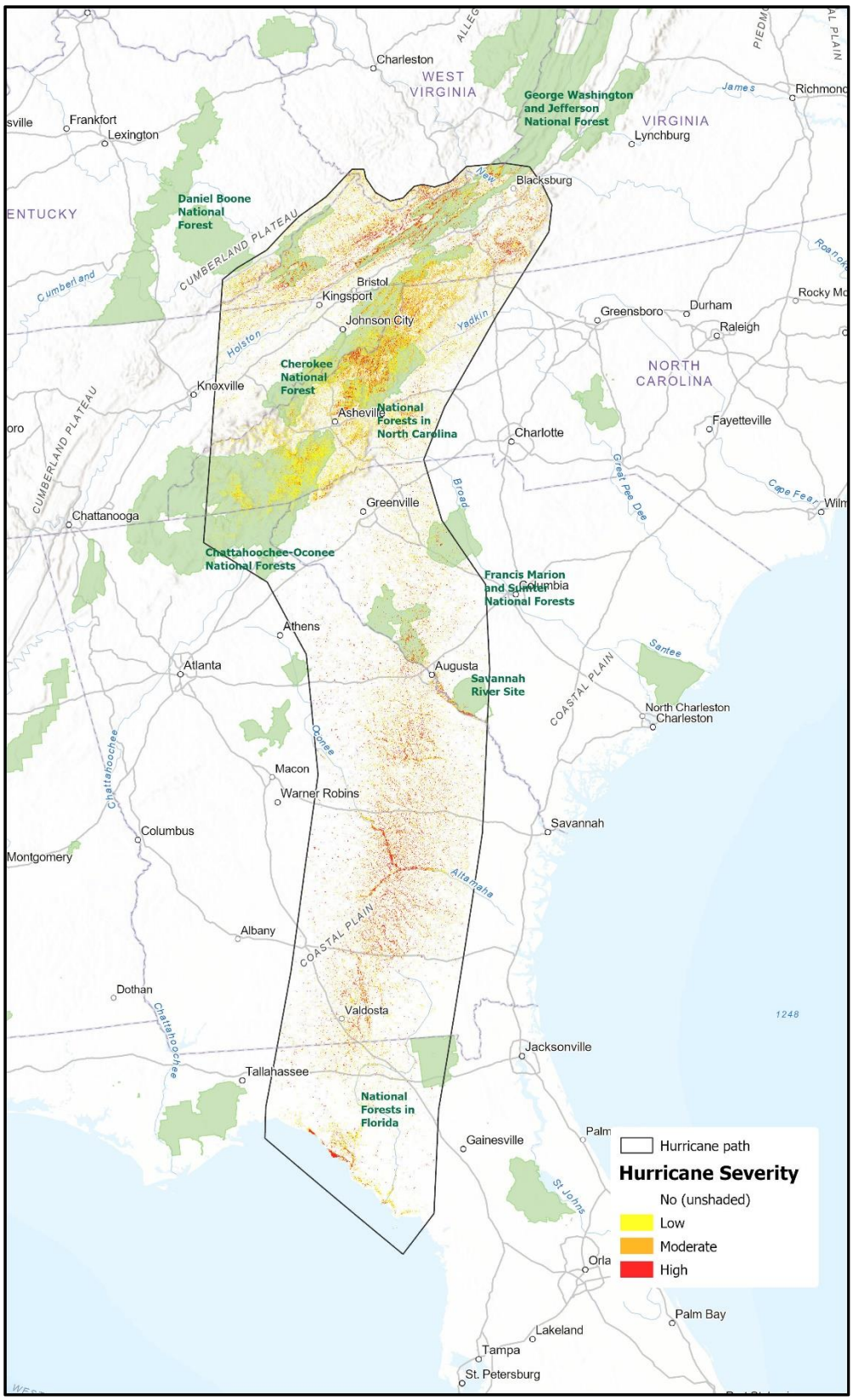

Figure 1. Map of combined hurricane disturbance severity.

Table 3. Area mapped by hurricane severity.

Severity	Area (ac)	Area (%)
No (0)	36,804,690	88.6
Low (1)	2,269,526	5.5
Moderate (2)	1,603,453	3.9
High (3)	872,589	2.1

Wildfire risk

Wildfire risk data came from the Southern Wildfire Risk Assessment (https://www.southernwildfirerisk.com/), also known as SouthWRAP. The current public data distribution for SouthWRAP focuses on wildfire hazard. The latest update also includes a pilot complete wildfire risk assessment accounting for wildfire likelihood, wildfire intensity, highly valued resource and asset (HVRA) presence, HVRA response to fire of different intensity levels, and HVRA relative importance (RMRS-GTR-315, Scott et al. 2013). We used the expected Net Value Change (eNVC) layers for people and property, infrastructure, and drinking water to focus our analysis on the most important values for communities. The eNVC data is intended for pre-fire planning work because it accounts for spatial differences in the probability of fire.

The SouthWRAP wildfire risk values for people and property, infrastructure, and drinking water were summed into a total risk raster. The total risk raster was classified into four levels for our analysis by calculating the 40th, 70th, and 90th percentiles of non-zero pixel values within an analysis area defined using a 30-mi buffer around the approximate hurricane path (**Table 4**; **Figure 2**). The 30-mi buffer was chosen to capture a representative area of the Southeast within the coverage of SouthWRAP, which ends close to the northern edge of the hurricane path.

Table 4. Definition of wildfire risk classes derived from the total SouthWRAP risk layer. Note that more negative eNVC (risk) values indicate higher potential for loss.

Wildfire Risk	Area (ac)	Area (%)	Percentiles	Low	High
Very low (0)	51,904,840	75.5	0-40	-0.0027	0.0000
Low (1)	8,414,182	12.2	40-70	-0.0106	-0.0027
Moderate (2)	5,609,453	8.2	70-90	-0.0399	-0.0106
High (3)	2,804,727	4.1	90-100	-200.0000	-0.0399

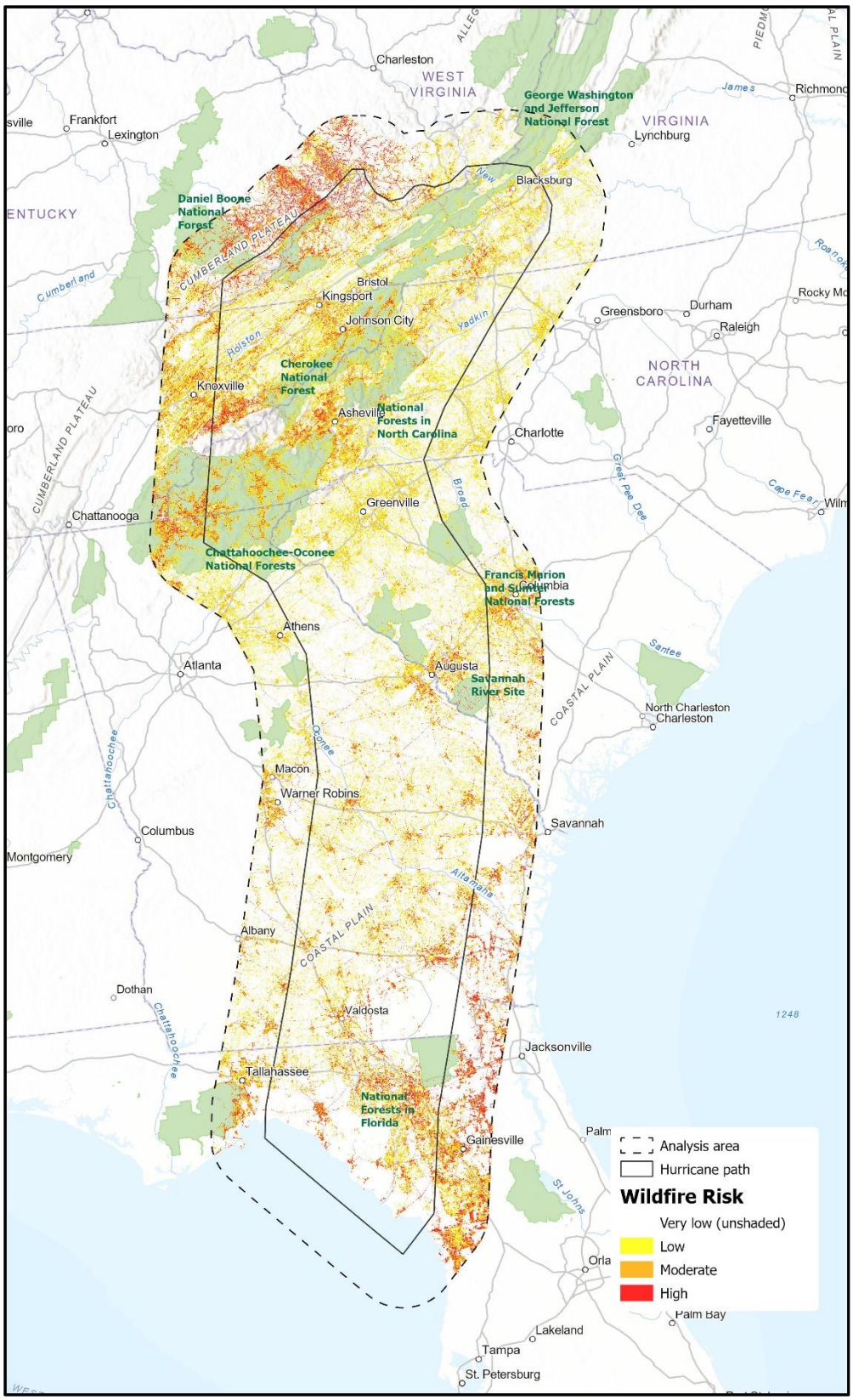

Figure 2. Map of SouthWRAP risk to people and property, infrastructure, and drinking water classified into four levels.

Combined Risk Matrix

To combine the wildfire risk and hurricane severity information into a single rating, we defined a risk matrix (**Table 5**) to depict increasing concern with both increasing wildfire risk and hurricane severity.

Table 5. Combined risk matrix used to combine wildfire risk and hurricane severity information.

	Hurricane Severity			
Wildfire Risk	**No**	**Low**	**Moderate**	**High**
No	0	1	2	3
Low	1	2	3	4
Moderate	2	3	4	5
High	3	4	5	5

Table 6. Area mapped by combined risk values.

Combined risk	Area (ac)	Area (%)
None (0)	27,275,448	66.7
Very low (1)	6,592,766	16.1
Low (2)	4,404,413	10.8
Moderate (3)	2,293,706	5.6
High (4)	242,893	0.6
Extreme (5)	83,624	0.2

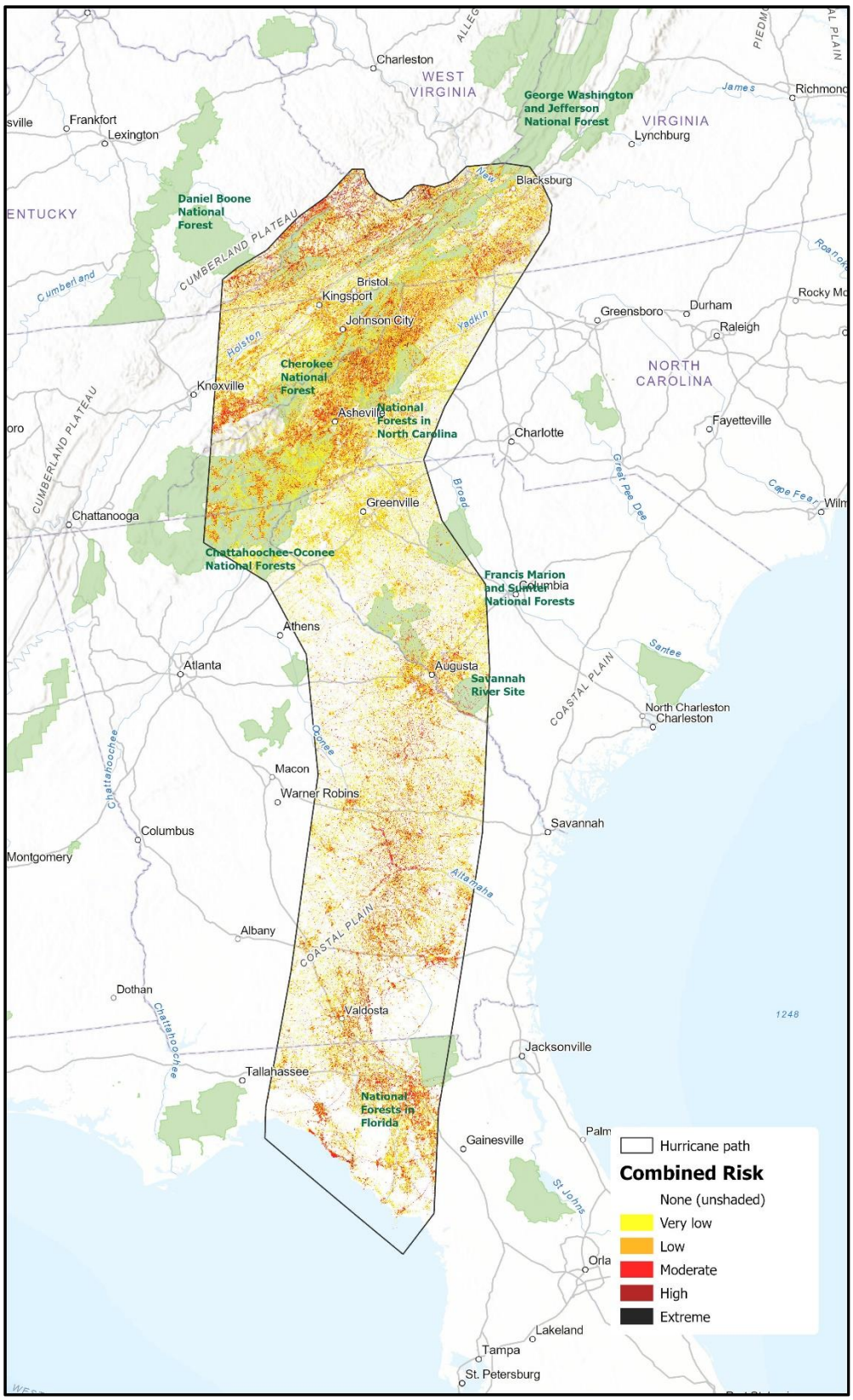

Figure 3. Map of combined risk accounting for both wildfire risk and hurricane severity.

Hexel summaries

We generated 5-km^2 and 10-km^2 hexels across the analysis area to support regional-scale planning. Zonal statistics were used to calculate relevant summary statistics from the original raster products including the mean values for wildfire risk, hurricane severity, and combined risk, as well as the percent of hexel area in the more extreme classes of wildfire risk, hurricane severity, and combined risk (**Table 7**). Additionally, we assigned hexels a percentile (rank) based on the mean combined risk for two analysis sets: 1) all hexels in the hurricane path and 2) only hexels with mapped hurricane disturbance. The recommendation is to rank and visualize the hexels based on either the "Combined risk (mean)", "Combined risk percentile (whole path)", or "Combined risk percentile (hurricane disturbed)" values (for example, see **Figure 4**). The additional "percent of area" attributes are provided to allow end users to experiment with alternative thresholds for rating risk and to loosen the spatial overlap criterion that is inherent in the raster application of the combined risk matrix.

Table 7. Attributes calculated for each hexel.

Name	Alias	Description
UID	UID	Unique identifier for hexel
Risk_m	Wildfire risk (mean)	Mean of wildfire risk assessment classes
Hurr_m	Hurricane severity (mean)	Mean of hurricane severity
CTM_m	Combined risk (mean)	Mean of combined risk matrix
Risk_mhper	Wildfire risk moderate or high (percent area)	Percent of hexel with moderate or high wildfire risk
Risk_hper	Wildfire risk high (percent area)	Percent of hexel with high wildfire risk
Hurr_mhper	Hurricane severity moderate or high (percent area)	Percent of hexel with moderate or high hurricane severity
Hurr_hper	Hurricane severity high (percent area)	Percent of hexel with high hurricane severity
CRM_mhper	Combined risk high or extreme (percent area)	Percent of hexel with high or extreme combined risk matrix
CRM_mper	Combined risk extreme (percent area)	Percent of hexel with extreme combined risk matrix
CRM_m_p	Combined risk percentile (whole path)	Hexel percentile (rank) based on combined risk matrix mean across whole path
CRM_m_p_ih	Combined risk percentile (hurricane disturbed)	Hexel percentile (rank) based on combined risk matrix mean for hurricane disturbed hexels

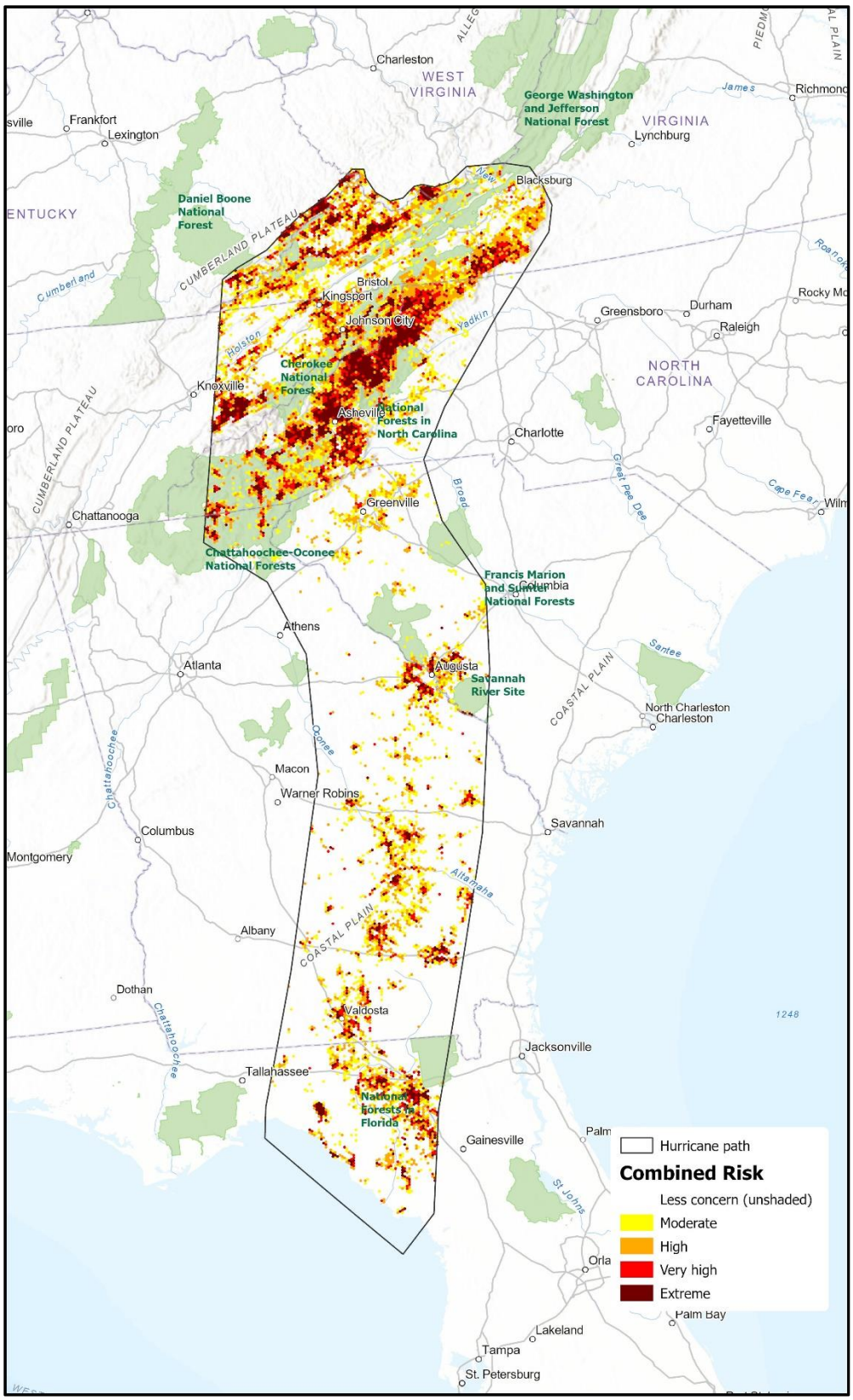

Figure 4. Example of the 5-km^2 hexels symbolized using the combined risk (mean) for hexels with hurricane disturbance.

Products

The products of this assessment (**Table 8**) are available on the USDA Forest Service Enterprise Network Drive ("the T Drive"). Note that rasters have class names and suggested colors for visualization in the attribute tables – use the unique values symbology method to apply them.

Data path: T:\FS\Reference\GIS\wo_spf_fam\RMA\2025_Helene_SRA_v2

Table 8. Product of the analysis.

Data type	Layer	Description
Raster	./Rasters/wildfire_risk_class_masked_rat.tif	Wildfire risk class
	./Rasters/hurricane_severity_masked_rat.tif	Hurricane severity
	./Rasters/combined_risk_matrix_masked_rat.tif	Combined risk matrix
Vector	./Hexel_summaries.gdb/Hexel_summaries_5sqkm	Hexel summaries (5-km^2)
	./Hexel_summaries.gdb/Hexel_summaries_10sqkm	Hexel summaries (10-km^2)

Acknowledgements

Thank you to Curt Stripling from the Texas A&M Forest Service for sharing the SouthWRAP wildfire risk assessment data. For more information on SouthWRAP, see https://www.southernwildfirerisk.com/.