

Supplementary Information

Tropical cyclone hazards and economic losses in coastal North Carolina

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Overview

This supplement presents supporting spatial analyses and vulnerability function details that underpin the results in the main text. Figures [S1–S4](#) display the spatial distribution of hazard occurrence, intensity, and loss severity across eastern North Carolina at both the 250 m grid cell and census block levels. Figures [S5](#) and [S6](#) display the Hazus 7.0 vulnerability functions used to translate hazard intensities into fractional damage ratios.

Spatial Distribution of Damage Probability

Figure [S1](#) maps the extensive margin of hazard risk—the spatial distribution of per-storm damage probability—at two levels of aggregation. Panel A displays the fraction of the 604-storm ensemble producing positive losses at each 250 m grid cell, separately by hazard type. Wind damage probabilities are elevated across the entire eastern North Carolina domain, reflecting the broad spatial reach of tropical cyclone wind fields. Surge and flood damage probabilities, by contrast, are confined to narrow coastal and riverine corridors, respectively. Panel B aggregates these probabilities to the census block level, where a block is considered damaged if at least one building within it sustains positive loss. The block-level view smooths fine-scale heterogeneity while preserving the fundamental spatial contrast between the spatially diffuse wind hazard and the geographically concentrated inundation hazards.

Spatial Distribution of Hazard Intensity

Figure [S2](#) characterizes the physical forcing environment by mapping the distribution of peak hazard intensity at each 250 m grid cell across the ensemble. Wind speeds (Panel A) increase from the interior toward the coast, with median values of 30–50 mph across much of the Coastal Plain and 95th-percentile values exceeding 100 mph along the Outer Banks and Cape Fear region. Flood depths (Panel B) are concentrated along major river corridors—the Roanoke, Neuse, Tar-Pamlico, Cape Fear, and Lumber rivers—with 99th-percentile depths exceeding 15 ft in the most flood-prone reaches. Surge depths (Panel C) are confined to the immediate coastline and Albemarle-Pamlico estuarine system, with extreme values exceeding 15 ft along the southern Outer Banks and behind the barrier islands. The contrast between the broad spatial extent of wind forcing and the narrow, topographically controlled footprints of inundation hazards motivates the compound hazard framework developed in the main text.

Spatial Distribution of Loss Severity

Figures [S3](#) and [S4](#) translate the hazard intensities in Fig. [S2](#) into economic outcomes, displaying conditional loss ratios and absolute dollar losses at the census block level. Figure [S3](#) presents the intensive margin in relative terms: conditional on a hazard producing positive damage, the loss ratio (damage as a fraction of total replacement value) is shown at the median, 95th, and 99th percentiles of the block-level distribution. Wind loss ratios (Panel A) are low at the median but rise sharply in the tail, reflecting the nonlinear character of wind vulnerability functions. Flood and surge loss ratios (Panels B and C) are substantially higher at all percentiles, consistent with the steep depth–damage

relationships for inundation hazards. Panel D shows the total loss ratio under the maximum damage rule, computed unconditionally across all storms.

Figure S4 presents the same information in absolute dollar terms. The spatial pattern of absolute losses reflects both hazard severity and local asset concentration: wind losses (Panel A) are largest in densely built coastal communities where high replacement values coincide with intense wind exposure, while flood and surge losses (Panels B and C) are concentrated in asset-rich low-lying areas along the coast and major river corridors.

Hazus Vulnerability Functions

Figure S5 shows wind damage curves for all building construction types represented in the Hazus inventory, with structural damage (left column) and contents damage (right column) plotted as functions of peak gust wind speed (mph). Curves are grouped by construction material: wood, masonry single-family, masonry commercial, concrete, steel, and manufactured housing. Within each group, individual curves correspond to distinct Hazus archetypes differentiated by building attributes such as number of stories, roof type, and age. Manufactured housing exhibits the steepest damage functions, reaching near-total structural loss at wind speeds below 150 mph, while concrete and steel structures sustain substantially lower damage at equivalent wind speeds. The spread among curves within each construction class reflects the sensitivity of wind vulnerability to building-specific characteristics—particularly roof shape, wall-to-opening ratio, and the presence of shutters or impact-resistant glazing.

Figure S6 shows flood depth–damage curves for residential, commercial, industrial, and other occupancy types. Structural damage (left column) and contents damage (right column) are plotted as functions of inundation depth above the first-floor elevation (ft). Residential depth–damage functions (top row) show rapid initial increases in damage at shallow depths (0–4 ft), followed by a decelerating rate of additional damage at greater depths. Contents damage curves generally exceed structural damage curves at equivalent depths, reflecting the vulnerability of interior furnishings and equipment to even shallow flooding. The variation across occupancy subtypes (RES1–RES6 for residential, COM1–COM9 for commercial) captures differences in building use, typical contents value, and construction standards.

Computational Implementation

The analysis pipeline is implemented in R (v4.3+) using the `data.table` package for memory-efficient manipulation of the 774-million-row building–storm observation matrix. All code is organized into three sequential stages, each of which produces intermediate outputs that feed the next.

Stage 1: Loss calculation. The building inventory is read from the NSI extract and each structure is assigned a Hazus 7.0 archetype code for both wind and flood vulnerability. Wind archetype assignment follows a hierarchical decision tree based on construction material (wood, masonry, concrete, steel, manufactured housing), occupancy class, and number of stories—yielding 30 distinct wind damage codes. Flood archetype assignment maps each occupancy type to its corresponding Hazus depth–damage function identifier for both structural and contents components, with separate treatment for buildings located in FEMA FIRM V-zones (coastal high-hazard areas subject to wave action), where Hazus prescribes distinct depth–damage curves.

Hazard outputs from the ADCIRC/EF5/P-CLIPER model suite are delivered as CSV files partitioned into spatial chunks. Raw hazard intensities undergo two unit conversions before damage function lookup: wind speeds are converted from 10-minute sustained winds (m/s) to 3-second peak gusts (mph) by applying a gust factor of 1.66 and the standard m/s-to-mph conversion (2.237), and inundation depths are converted from meters to feet (3.281). Wind speeds are then rounded to the nearest 5 mph increment and inundation depths to the nearest integer foot to match the discretization of the Hazus damage function tables. Each building–storm pair is matched to the appropriate damage function via a keyed merge on archetype code and discretized intensity, producing hazard-specific fractional damage ratios for structure and contents components separately.

Dollar losses are computed as the product of the fractional damage ratio and the corresponding replacement value (structure or contents). The resulting building–storm–hazard loss matrix is aggregated from the raw building level to the 250 m grid cell $\times$ census block $\times$ storm level by summing structure and contents losses within each spatial unit, retaining both hazard-specific and maximum-rule compound losses.

Stage 2: Extensive margin. The extensive margin analysis operates on the aggregated loss matrix restricted to single-family residential buildings (RES1 occupancy class, $n = 575,453$). Hazard occurrence at each building–storm pair is classified using intensity thresholds: wind damage is considered to occur when peak gust speed exceeds 55 mph (the approximate onset of structural damage for wood-frame residential construction in Hazus), while surge and flood damage are classified as occurring at any positive inundation depth above the first-floor elevation. Each observation is assigned to one of eight mutually exclusive hazard categories (none, three single-hazard, three pairwise-compound, and one triple-compound) based on which thresholds are exceeded.

Cell-level occurrence probabilities are computed as the fraction of the 604-storm ensemble in which each hazard category is realized at each 250 m grid cell. These probabilities are cross-tabulated with building counts, population, and asset values to produce the exposure-by-probability-bin tables reported in the main text and supplementary tables. Because homes are unevenly distributed across grid cells, the per-home occurrence-probability quantiles reported in the main text (Table 1, Panel B) weight each cell’s probability by the number of homes it contains, so that the reported distribution reflects the exposure of the typical home rather than the typical cell. Building-level classification aggregates across storms to determine whether each structure experiences exclusively single-hazard, exclusively compound, or mixed exposure patterns over the full ensemble.

Stage 3: Intensive margin. The intensive margin analysis conditions on positive damage to characterize loss severity. Hazard-specific loss ratios are computed as the ratio of dollar loss to total replacement value at the building–storm level. The compound loss under the maximum damage rule is computed as $\max(\ell^{\text{Wind}}, \ell^{\text{Surge}}, \ell^{\text{Flood}})$ at each building–storm pair; the bounded additive alternative is computed as $\min(\ell^{\text{Wind}} + \ell^{\text{Surge}} + \ell^{\text{Flood}}, v_b)$, where v_b is total building value. Intensity–damage relationships are constructed by binning observations into 10-mph wind speed intervals and 2-ft inundation depth intervals, then computing mean, median, and 95th-percentile loss ratios within each bin conditional on positive damage.

Storm-level aggregates sum building losses across the study area for each of the 604 events, producing the ensemble distribution of per-storm total losses reported in the main text. The hazard contribution analysis decomposes each storm’s total loss into wind, flood, and surge components and identifies the dominant hazard (the one producing the largest loss) at each damaged building–storm pair.

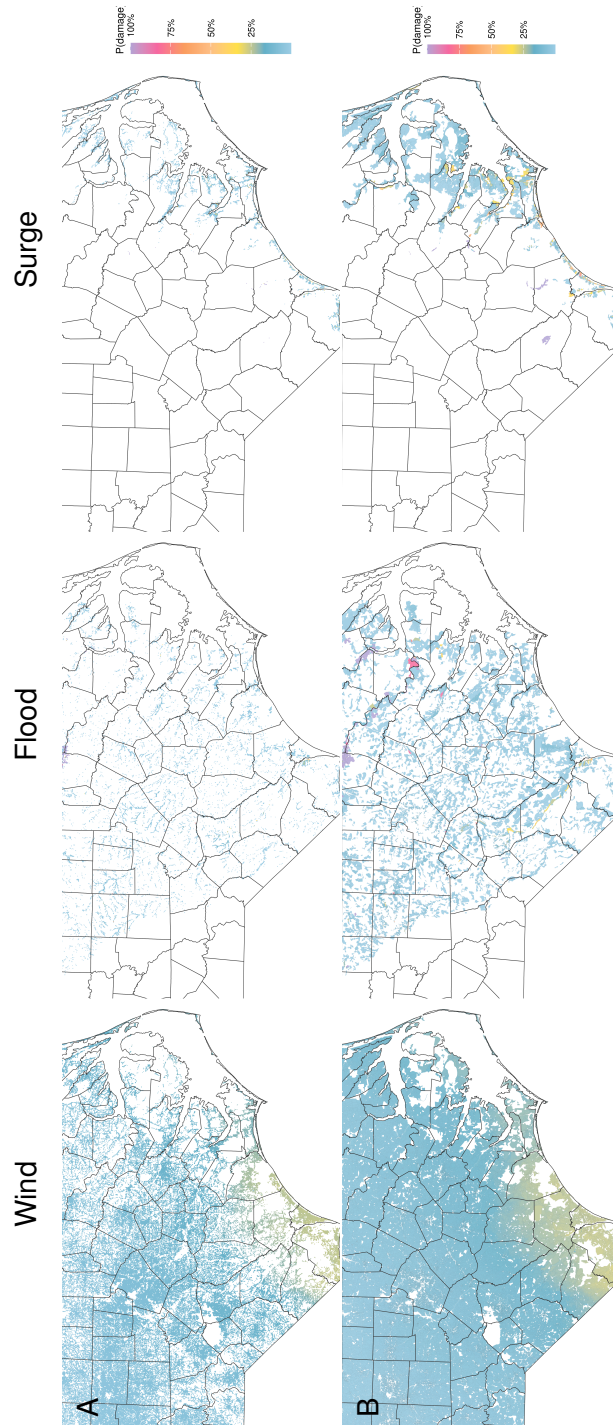


Figure S1. Probability of hazard-specific structural damage across North Carolina residential buildings (RES1), aggregated at the 250 m grid cell and census block levels. A, Fraction of 604 synthetic hurricane tracks producing positive wind, inland flood, or storm surge losses at each 250 m grid cell, mapped separately by hazard type. B, Same damage probability aggregated to the census block level, computed as the share of storms in which at least one building within the block sustains positive losses from each hazard. Both panels reflect the extensive margin of risk—where each hazard is likely to cause any damage at all, irrespective of severity.

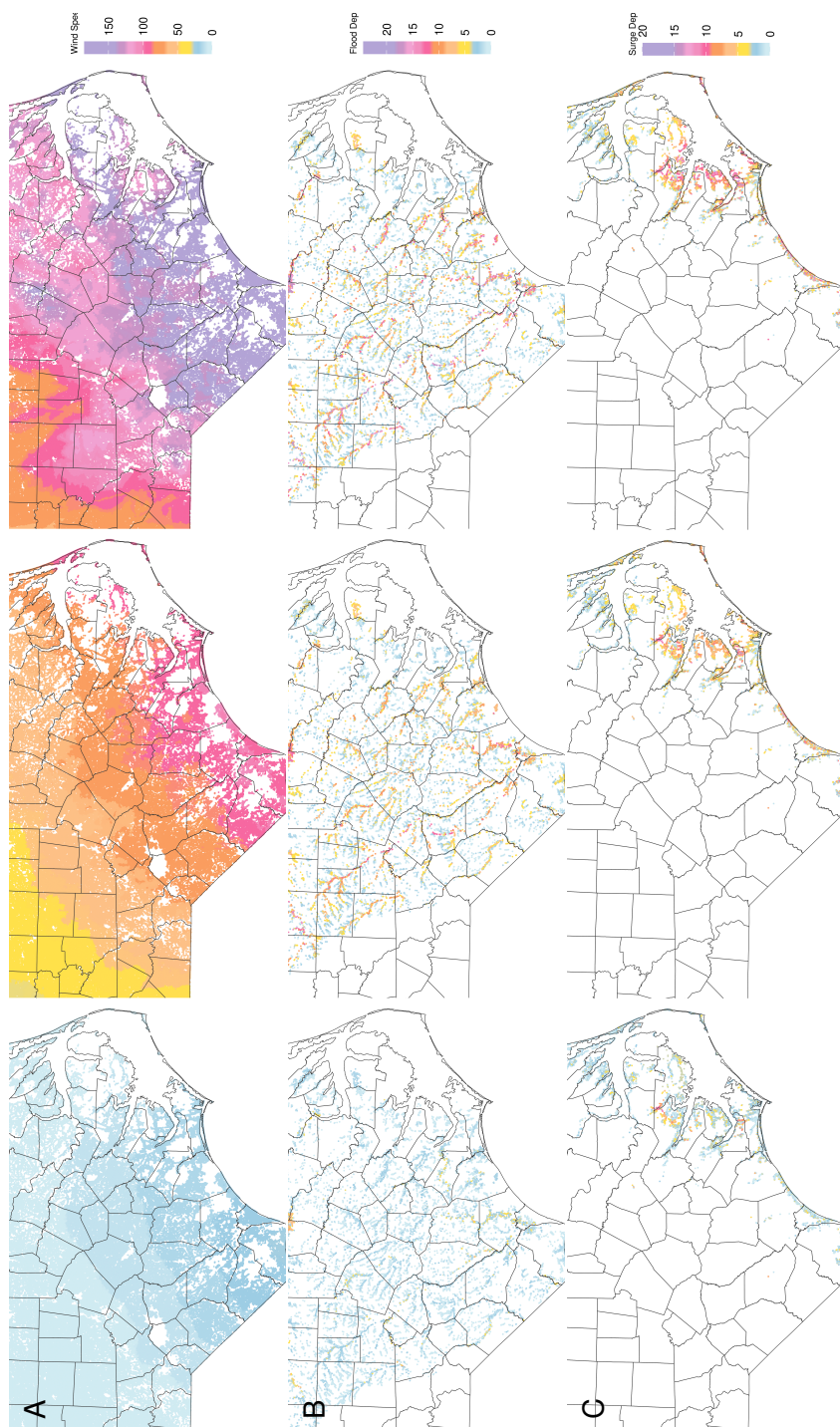


Figure S2. Distribution of peak hazard intensity at the 250 m grid cell level across 604 synthetic hurricane tracks. A, Median, 95th, and 99th percentiles of peak terrain-adjusted wind speed (mph, 3-second gust) at each grid cell. **B,** Same percentile distribution for maximum inland flood inundation depth (ft). **C,** Same percentile distribution for maximum storm surge inundation depth (ft). All statistics are computed unconditionally across all 604 storms, capturing both the typical and extreme physical forcing experienced at each location.

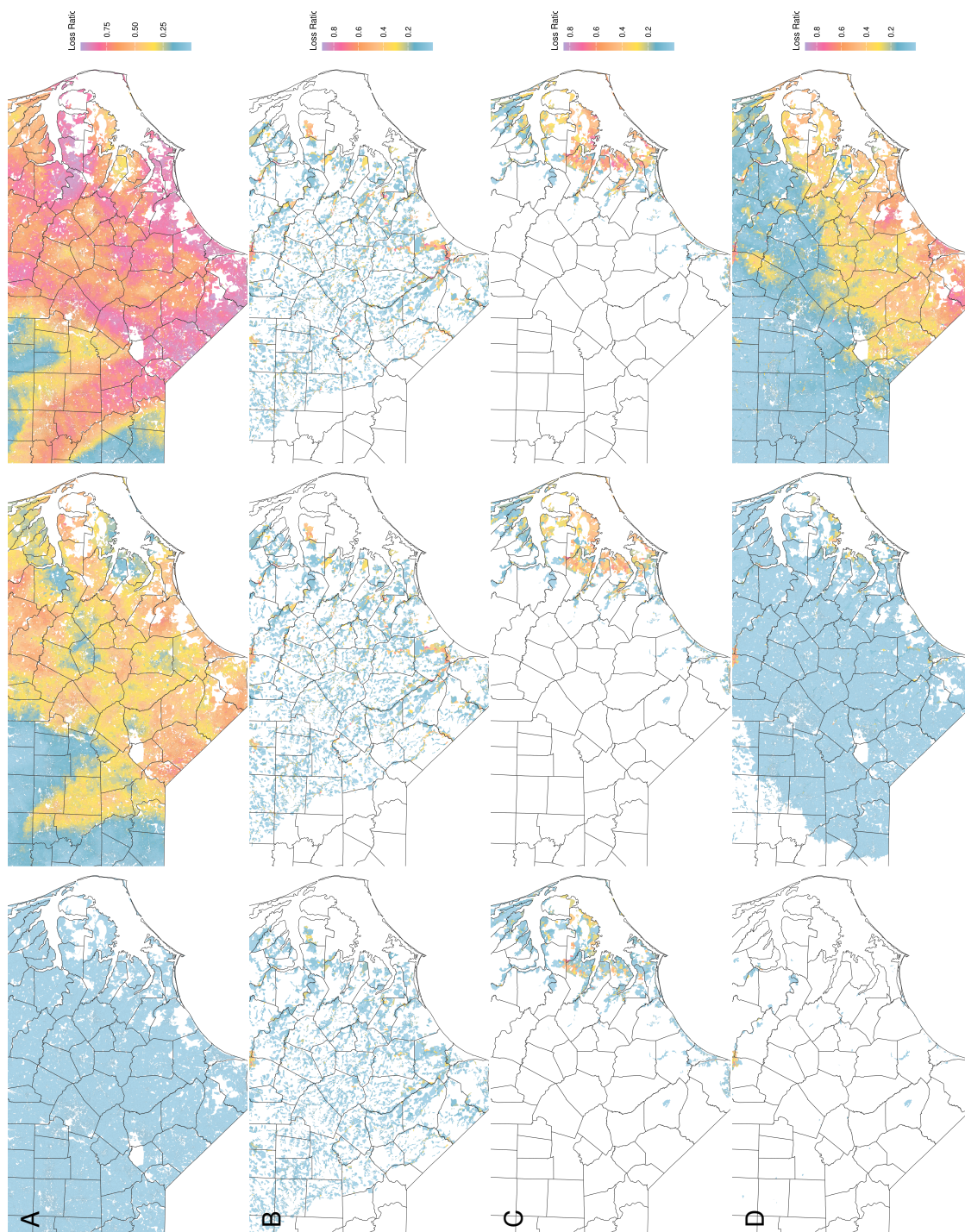


Figure S3. Conditional structural loss ratios at the census block level, shown at the median, 95th, and 99th percentiles. A–C, For wind (A), inland flood (B), and storm surge (C), loss ratios (damage as a fraction of total replacement value) are computed conditional on the hazard producing positive losses in a given storm, then summarized across storms at each block. D, Total loss ratio using the maximum-damage rule across all three hazards, computed unconditionally. Together these panels capture the intensive margin of risk—how severe losses become when a hazard strikes.

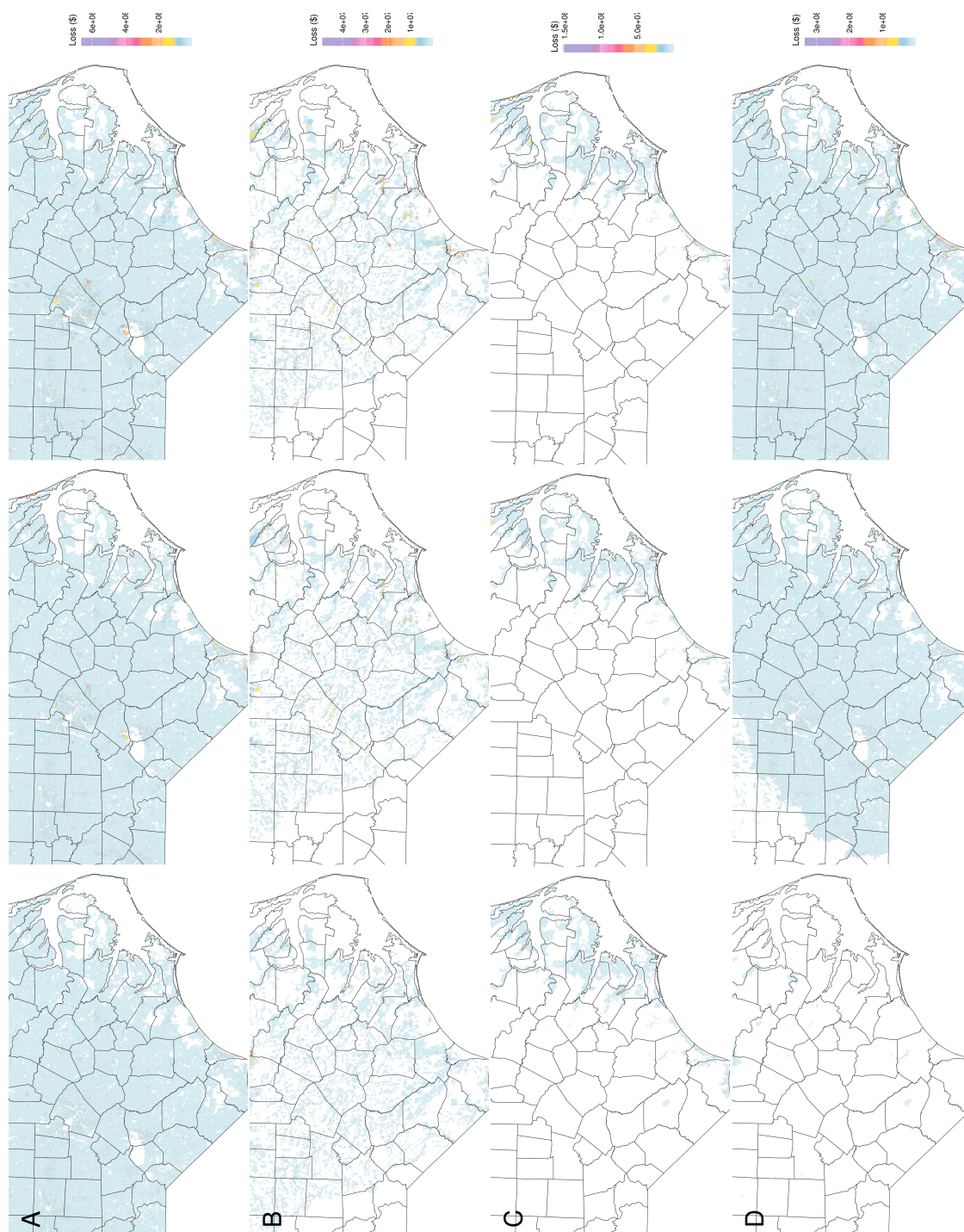


Figure S4. Absolute structural losses (\$) at the census block level, shown at the median, 95th, and 99th percentiles. A–C, For wind (A), inland flood (B), and storm surge (C), dollar losses are computed conditional on the hazard producing positive losses in a given storm, reflecting the typical and tail severity for buildings actually affected. D, Total block-level loss under the maximum-damage rule across all three hazards, computed unconditionally across all storms. Unlike Fig. S3, these panels reflect the combined influence of hazard severity and local asset values, highlighting where high replacement costs amplify absolute monetary exposure.

Wind Damage Curves (Hazus 7) - MPH

Building (left) vs Contents (right)

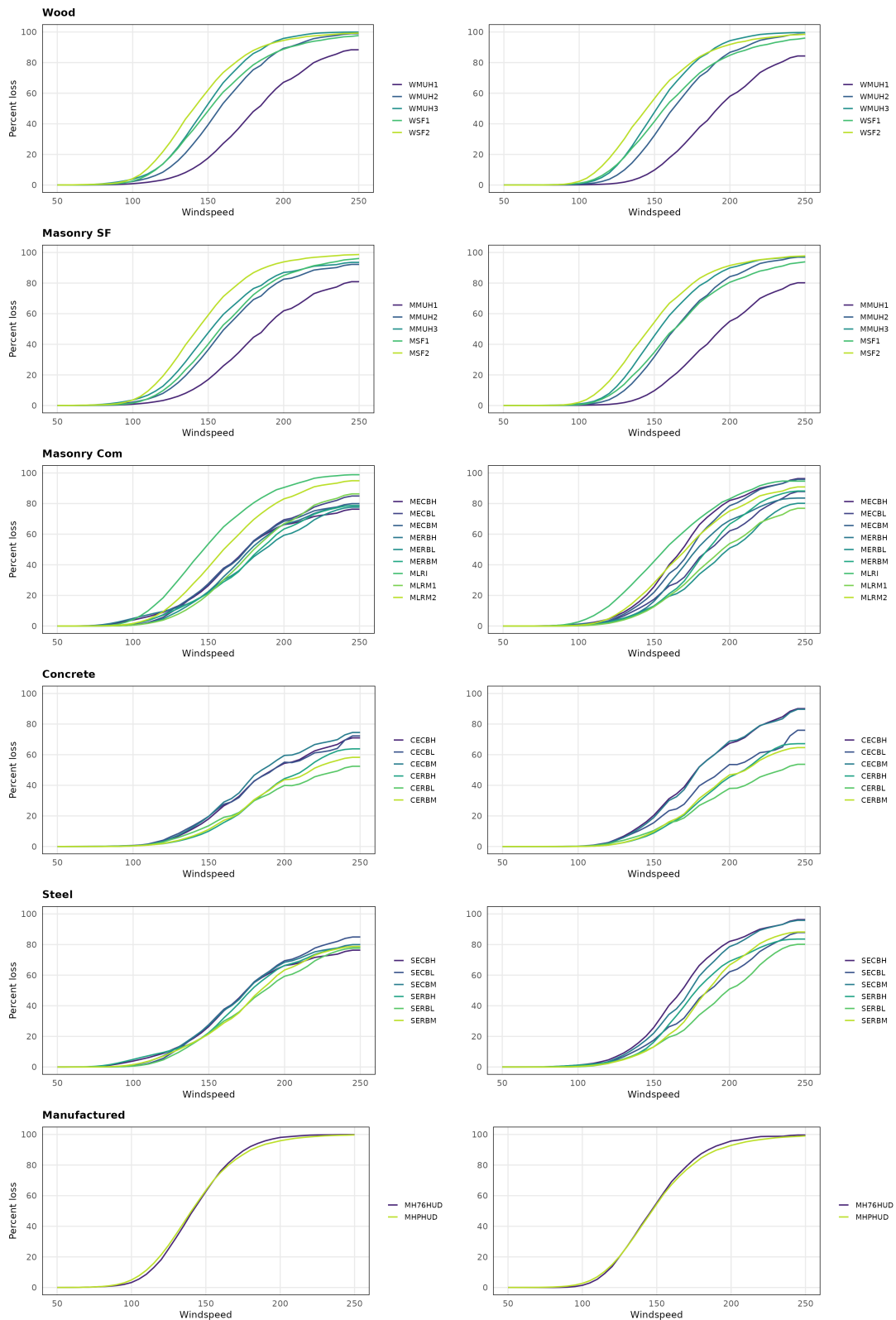


Figure S5. Hazus 7.0 wind damage functions by construction type. Each panel shows the fractional damage ratio as a function of peak gust wind speed (mph) for structural components (left) and building contents (right). Rows correspond to construction material classes: wood frame, masonry single-family, masonry commercial, concrete, steel, and manufactured housing. Individual curves within each panel represent distinct Hazus archetypes differentiated by number of stories, roof geometry, and building age.

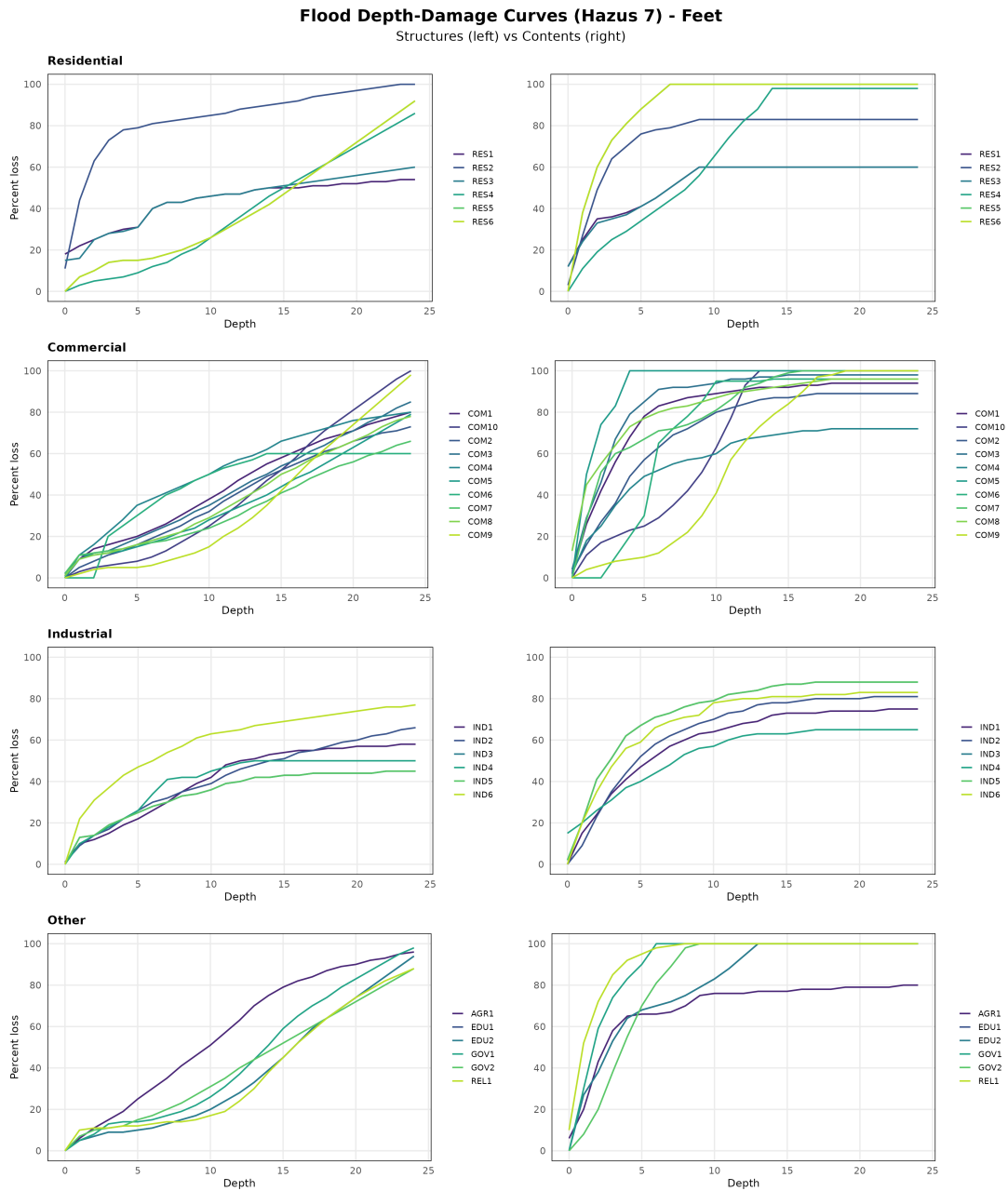


Figure S6. Hazus 7.0 flood depth–damage functions by occupancy type. Each panel shows the fractional damage ratio as a function of inundation depth above first-floor elevation (ft) for structural components (left) and building contents (right). Rows correspond to occupancy classes: residential, commercial, industrial, and other (agricultural, educational, governmental, religious). Individual curves represent distinct Hazus occupancy subtypes within each class.

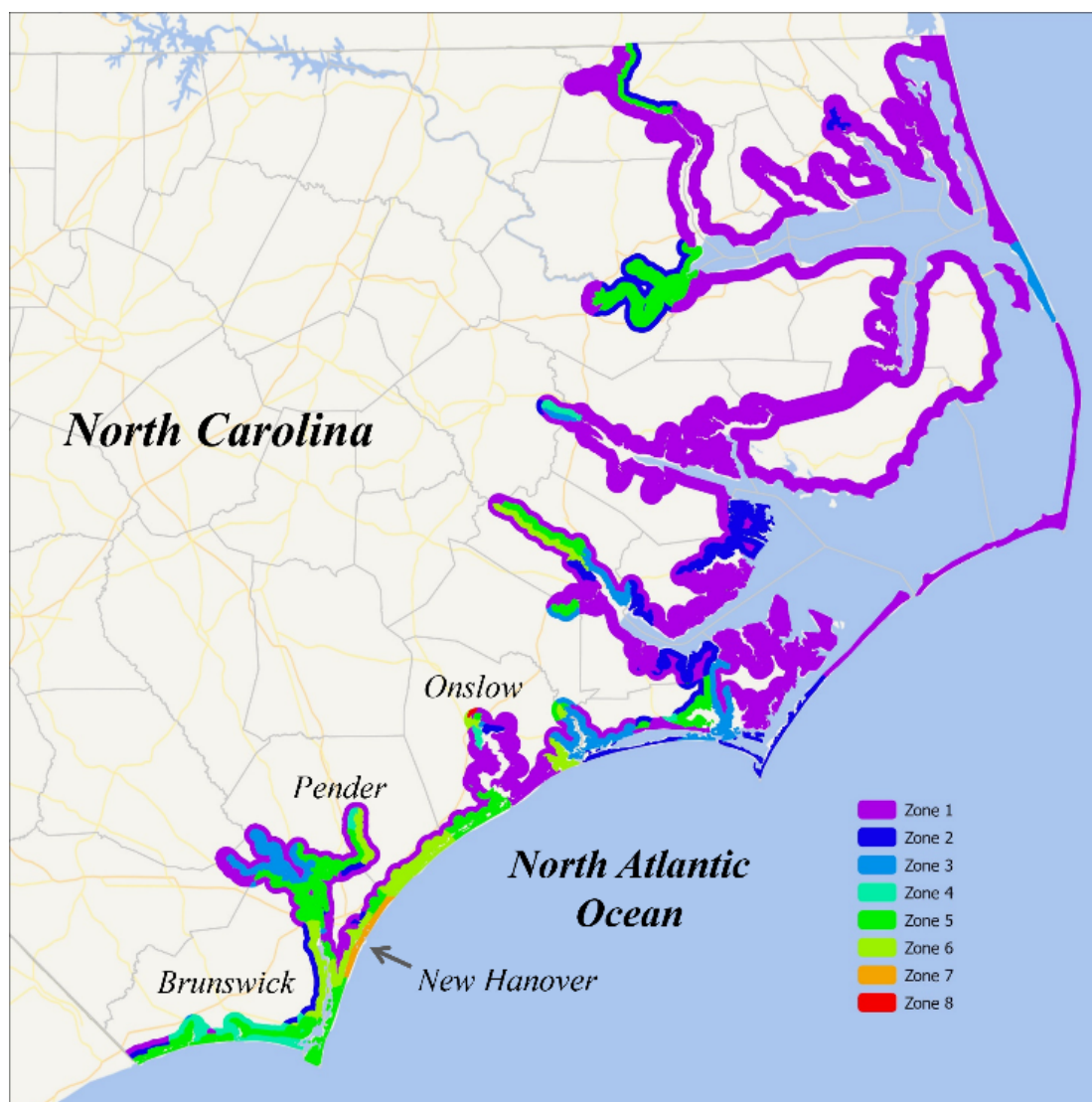


Figure S7. Insurance Zones. Risk-based pricing zones for the insurance model: coastal single-family (RES1) homes grouped by expected hurricane loss per home into eight pricing zones (Zone 1–8), each offered a common risk-based premium.

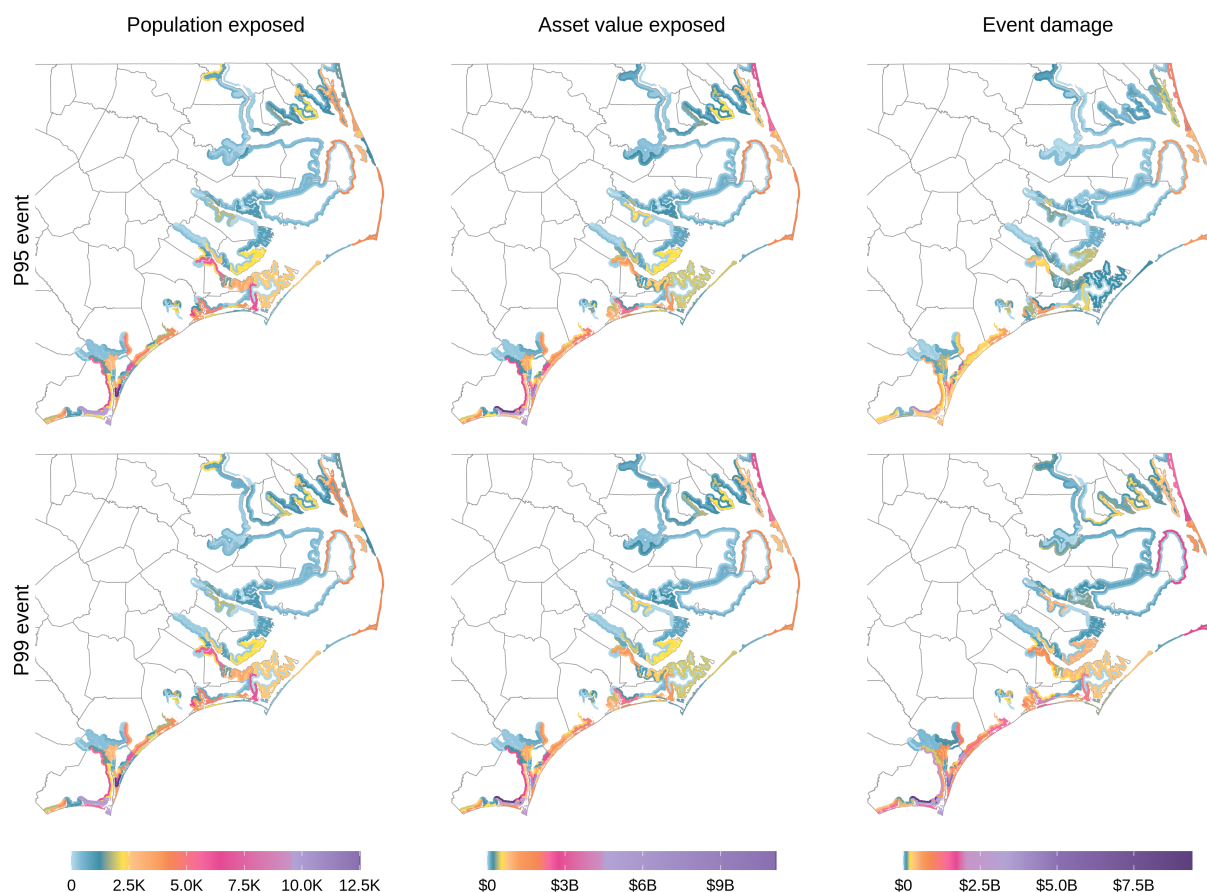


Figure S8. Tail exposure and damage across the coastal insurance pricing zones. For each 1-mile and 1-to-2-mile pricing zone, the ensemble storm nearest the 95th (top row) and 99th (bottom row) percentile of that zone’s aggregate per-event loss is selected. Panels map the population residing in damaged buildings in that event (left), the replacement value of those buildings (centre), and the zone’s total event damage (right). *Notes:* zones are Kevin Nozick’s coastal pricing zones, the same geography used in Fig. S7; the underlying buildings are the 196,619-building priced sample of Table S10. Colour scales are shared within each column, so the P95 and P99 rows are directly comparable, and are anchored at area-weighted quantiles of the pooled zone values because the distributions are strongly right-skewed—a linear scale would render nearly every zone in the lowest colour. Buildings outside the pricing zones contribute to Table S10 but are not shown here.

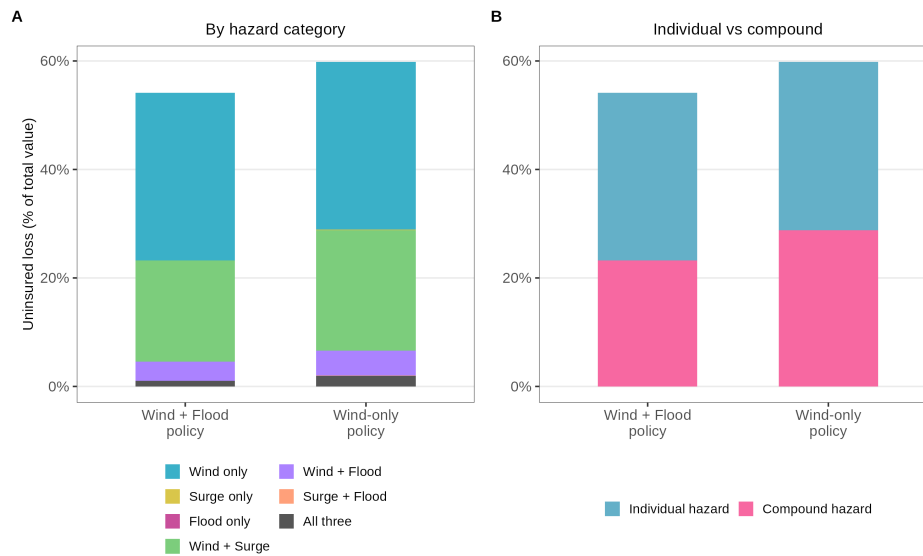


Figure S9. Worst-case uninsured losses by insurer-offered policy. Graphical companion to the worst-case uninsured cross-tab reported in the main text. For each building, the worst-case storm under a given policy is the storm in the 604-storm ensemble producing the largest uninsured loss under that policy’s coverage rules; the loss is attributed to the hazard category of the driving storm and expressed as a share of the total building-plus-contents value of the priced sample (\$57.0 B). *Left:* decomposition by the seven hazard categories. *Right:* the same totals collapsed to individual versus compound hazards. *Notes:* under a *Wind-only* offering, uptakers have wind losses reimbursed and bear surge and flood out-of-pocket, while non-uptakers bear all losses; under a *Wind+Flood* offering, uptakers bear nothing and non-uptakers bear all losses. The broader policy leaves a larger aggregate share uninsured because voluntary flood-coverage uptake is low, so most buildings decline the combined policy and retain their full worst-case loss.

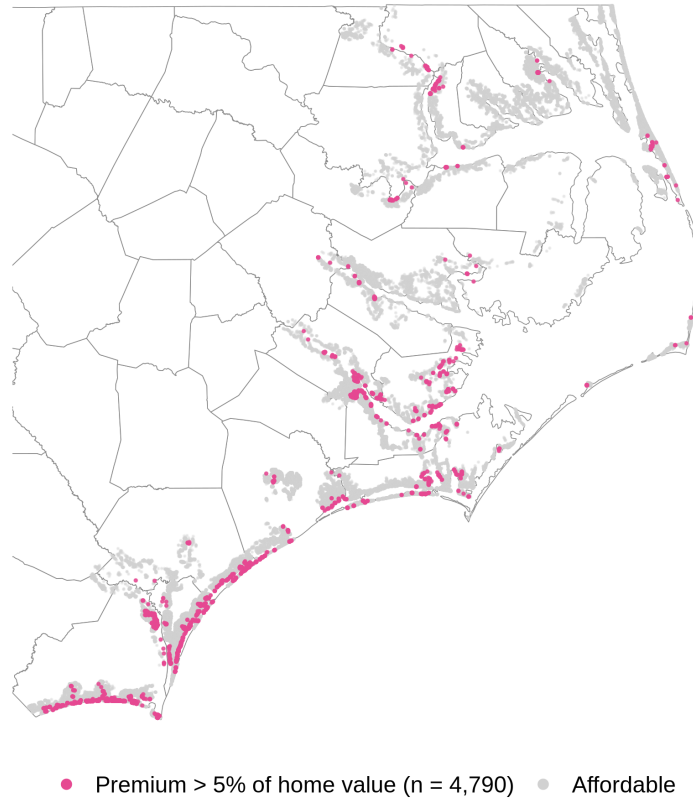


Figure S10. Homes for which the offered full-coverage (wind + flood) premium exceeds 5% of home value under the affordability-constrained equilibrium (Table S8). Of the 196,619 single-family homes in the coastal pricing footprint, 4,790 (pink) cannot afford full coverage at this threshold; grey points are affordable homes. Every unaffordable home is compound-exposed—facing positive expected losses from both wind and at least one water peril—so affordability failure concentrates in the coastal and estuarine zones where multiple perils converge rather than in wind-only or water-only areas.

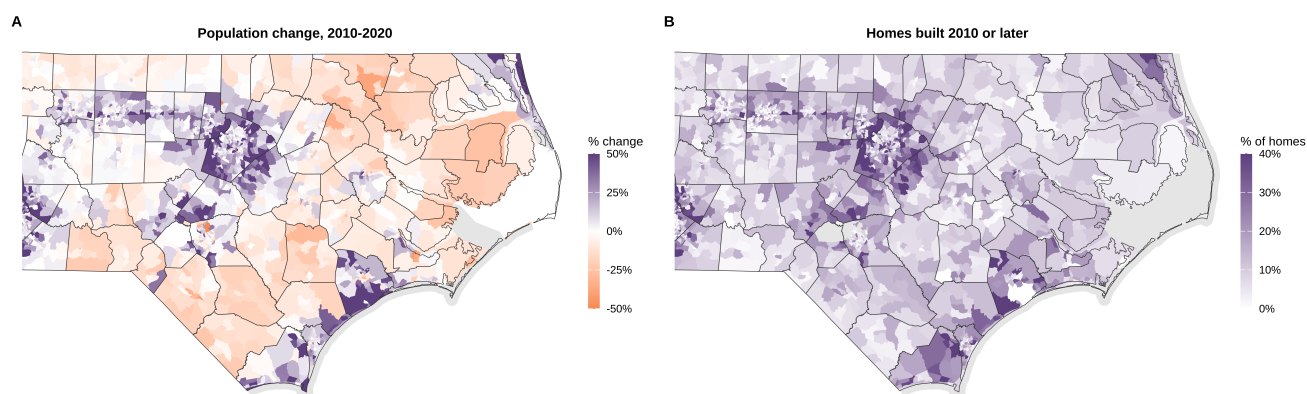


Figure S11. Residential growth in eastern North Carolina relative to the compound-risk coast. Census-tract maps of (A) population change between 2010 and 2020 and (B) the share of housing units built in 2010 or later, a measure of new-construction intensity. *Notes:* both panels are tract-level and cover the same 2010–2020 window. Tract resolution is used deliberately: county averages mask the pattern of interest, in which peri-coastal tracts gain population inside counties that decline overall (Craven County, for example, falls 2.7% in aggregate). Panel B reports housing-stock *age* from the ACS “Year Structure Built” table rather than permit flow, because the Census Building Permits Survey publishes counts only at state, county, and place level — permits are issued by jurisdictions, so no tract-level permit series exists. The two panels therefore measure related but distinct quantities: net population change versus the accumulated share of recently built stock. Sources: Census population counts and ACS table B25034.

Supplementary Tables

Category	Buildings	Value (\$B)	Population	Mean Prob.	% Bldgs	% Value
Single	525,170	405.86	1,588,290	0.135	91.26	91.58
Compound (2)	44,609	33.77	125,636	0.276	7.75	7.62
Compound (3)	3,141	2.01	9,113	0.336	0.55	0.45
Mixed	2,533	1.52	6,672	0.120	0.44	0.34
Total	575,453	443.15	1,729,711	—	100.00	100.00

Table S1. Building classification by dominant hazard exposure pattern across the 604-storm ensemble. Each of the 575,453 unique buildings is assigned to the category reflecting its most frequent hazard exposure. “Mixed” buildings experience both single-hazard and compound events in different storms.

Hazard Type	Prob. Bin	Buildings	Value (\$B)	% of Type
Wind + Surge	0.1–0.5%	5,175	3.63	21.7
	0.5–1%	2,619	2.03	12.2
	1–5%	7,350	5.85	35.0
	5–10%	2,894	2.54	15.2
	10–20%	1,629	1.77	10.6
	20–100%	812	0.86	5.2
Wind + Flood	0.1–0.5%	11,299	6.72	32.4
	0.5–1%	5,088	3.46	16.7
	1–5%	10,392	7.77	37.5
	5–10%	2,050	1.69	8.1
	10–100%	1,069	1.09	5.2
Wind + Flood + Surge	0.1–0.5%	1,630	0.87	43.5
	0.5–1%	742	0.56	28.0
	1–5%	648	0.48	23.8
	5–50%	121	0.10	4.7
Flood + Surge	0.1–0.5%	721	0.41	67.4
	0.5–1%	115	0.08	13.9
	1–50%	157	0.11	18.7

Table S2. Compound hazard exposure by occurrence probability bin. For each compound hazard type, the table reports the number of unique buildings, total replacement value, and share of that category’s total value falling in each probability bin.

Loss Type	Mean (\$B)	Median (\$B)	P95 (\$B)	Max (\$B)	Storms	%
Wind	6.35	0.02	34.77	381.29	450	74.5
Surge	0.47	0.20	1.87	5.13	604	100.0
Flood	0.82	0.45	2.69	16.10	604	100.0
Compound (Max)	7.46	0.75	38.59	382.94	604	100.0

Table S3. Storm-level loss summary across the 604-storm ensemble. “Compound (Max)” reports the total loss per storm computed as the maximum single-hazard loss at each building.

Occurrence Type	Instances	% of Total	Loss (\$B)	% of Loss
None	701,549,982	90.607	0.0	0.0
Wind only	69,462,182	8.971	3,661.2	81.2
Flood only	1,242,563	0.160	337.6	7.5
Wind + Surge	827,809	0.107	244.0	5.4
Wind + Flood	604,264	0.078	166.5	3.7
Surge only	555,422	0.072	86.5	1.9
Wind + Flood + Surge	32,649	0.004	11.0	0.2
Flood + Surge	5,413	<0.001	1.1	<0.1
Total	774,280,284	100.0	4,508.0	100.0

Table S4. Hazard occurrence type frequency and loss contribution across all 774.3 million building–storm observations. “None” indicates no damage; single-hazard rows reflect observations where only one hazard produces positive loss; compound rows reflect co-occurring damage.

Metric	Value
Total individual sum (\$B)	4,611.7
Total maximum (\$B)	4,508.0
Total bounded (\$B)	4,592.3
Mean per-observation: individual	\$5,956
Mean per-observation: maximum	\$5,822
Mean per-observation: bounded	\$5,931
% observations max = sum	99.81%
Mean difference (bounded – max)	\$109

Table S5. Comparison of loss aggregation methods across the 604-storm ensemble. “Individual sum” sums wind, flood, and surge losses at each building–storm pair. “Maximum” takes the largest single-hazard loss. “Bounded” sums individual losses but caps at building replacement value. The high agreement between methods confirms that compound damage at the individual-building level is rare.

Hazard	Intensity Bin	Obs.	Mean LR (%)	Median LR (%)	P95 LR (%)
Wind	40–50 mph	11,696,742	0.02	0.02	0.02
Wind	60–70 mph	11,487,997	0.10	0.09	0.24
Wind	80–90 mph	5,793,404	0.63	0.69	1.12
Wind	100–110 mph	3,159,003	5.26	5.64	9.87
Wind	120–130 mph	1,504,055	21.26	22.04	33.63
Wind	140–150 mph	1,077,563	46.01	46.17	60.20
Wind	160–170 mph	552,506	67.03	67.88	79.81
Wind	180–190 mph	289,710	82.23	82.82	90.79
Flood	0–2 ft	832,528	20.19	20.67	33.33
Flood	2–4 ft	227,272	35.36	38.67	48.67
Flood	4–6 ft	258,311	47.78	51.67	60.67
Flood	8–10 ft	114,748	60.89	63.00	74.00
Flood	12–14 ft	17,132	69.43	75.00	80.00
Flood	16–18 ft	6,039	74.74	81.33	89.33
Surge	0–2 ft	1,066,618	17.44	15.67	33.00
Surge	2–4 ft	206,096	32.78	33.67	46.36
Surge	4–6 ft	79,464	41.97	43.33	59.11
Surge	8–10 ft	17,893	57.45	58.11	72.26
Surge	12–14 ft	3,810	63.03	66.00	79.33
Surge	18–20 ft	264	66.45	75.33	82.00

Table S6. Mean loss ratios by hazard intensity bin. Wind intensity in mph (3-second gust); flood and surge depth in feet above first-floor elevation. Selected bins shown for brevity.

Hazard	0.1–0.5%	0.5–1%	1–5%	5–10%	10–20%	20–50%	50–100%	Total	%
Wind	0.26	0.54	302.27	230.46	85.83	0.11	0.00	619.47	87.5
Wind + Flood	13.17	3.97	9.04	0.49	0.10	0.00	0.00	26.77	3.8
Wind + Surge	8.11	2.97	9.10	2.62	0.73	0.00	0.00	23.53	3.3
Flood	10.18	3.39	5.82	0.66	0.42	0.08	0.73	21.29	3.0
Surge	5.72	1.97	4.32	0.90	0.50	0.30	0.01	13.73	1.9
W + F + S	1.68	0.64	0.28	0.02	0.00	0.00	0.00	2.61	0.4
Flood + Surge	0.64	0.06	0.03	0.01	0.00	0.00	0.00	0.74	0.1
Total	39.76	13.54	330.86	235.16	87.58	0.49	0.74	708.14	100.0

Table S7. Building-instance exposure value (\$B) by hazard category and occurrence probability bin across the 604-storm ensemble.

Panel A: Per-zone insurance outcomes

Zone	No premium limit			Affordability ($\leq 5\%$ of value)		
	Price per \$ loss (\$)	Demand (\$M)	Penetr. (%)	Price per \$ loss (\$)	Demand (\$M)	Penetr. (%)
1	3.03	12.437	30.456	2.72	12.787	32.690
2	4.11	1.650	26.339	2.87	1.885	32.496
3	2.31	2.290	32.991	2.00	2.455	37.633
4	3.26	1.792	33.440	2.88	1.561	34.380
5	2.98	6.737	36.578	2.60	6.113	38.654
6	3.81	4.940	38.464	3.53	4.121	38.413
7	4.01	0.766	36.221	2.40	0.830	47.030
8	3.79	0.031	48.052	4.21	0.028	43.506

Panel B: Portfolio-level reinsurance and region totals

Quantity	No premium limit	Affordability
Reinsurance attachment, A (\$M)	403	312
Reinsurance maximum, M (\$M)	5,954	5,954
Reinsurance premium (\$M)	27.54	31.80
Region total, demand (\$M)	30.64	29.78
Region-wide penetration (%)	32.13	34.57
Region total, profit (\$M)	42.75	26.60

Table S8. Cournot–Nash insurance market equilibrium under two market scenarios. Zone-level and portfolio-level outcomes for an unconstrained equilibrium (*No premium limit*) and an affordability-constrained equilibrium (*Affordability*) in which no household may be charged a premium exceeding 5% of its home value; in both, the insurer’s insolvency probability is constrained below 0.02%. *Notes:* Panel A reports the eight pricing zones. “Price per \$ loss” is the per-dollar price of expected loss, “Demand” is the total dollar value of insured exposure within the zone, and “Penetration” is the share of buildings within the zone that purchase coverage. Panel B reports portfolio-level reinsurance contract terms — attachment A, maximum payout M, and premium — followed by region-wide aggregates: “Region total, demand” is the sum of the Panel A demands, “Region-wide penetration” is the share of all priced buildings purchasing coverage (note this row is a percentage, not a dollar amount), and “Region total, profit” is the insurer’s expected profit. The affordability cap lowers the price in seven of the eight zones, raises penetration in six, and cuts regional profit by roughly 38%. Zones are identified in the building-level file by their distinct price per \$ loss; that file carries a ninth, very low-priced (\$1.35) zone with no policyholders, which is absent from this table. Source: K. Nozick, July 2026 equilibrium runs.

Peril pair	Co-damaged records	Intensity (ρ)	Loss (r)
Wind + Flood	636,913	−0.01	0.30
Wind + Surge	860,458	0.28	0.52
Flood + Surge	38,062	0.00	0.72

Table S9. Pairwise correlation of co-occurring tropical-cyclone hazards. For each peril pair, statistics are computed across all RES1 building–storm records in which both perils produce positive damage. “Intensity (ρ)” is the Spearman rank correlation of peak hazard intensities (wind speed, flood depth, surge depth); “Loss (r)” is the Pearson correlation of the two perils’ dollar losses. Intensities are largely uncorrelated except wind–surge, whereas losses are positively correlated in every pair because co-located structures share exposure to the same storm’s severity.

Hazard type	Homes	Population	Value (\$B)	Damage (\$M/event)			Uninsured	
				Expected	P95	P99	\$M/event	%
Wind only	102,453	120,585	30.61	1,048.5	10,423.6	30,148.9	418.2	39.9
Wind + Inland flood	13,388	18,476	3.49	163.5	744.3	2,533.8	124.9	76.4
Wind + Surge	69,483	64,426	19.92	768.1	4,103.6	9,503.6	590.8	76.9
Wind + Surge + Inland flood	11,198	14,344	3.00	146.8	762.0	2,148.2	107.0	72.9
No modeled damage	97	0	0.00	0.0	—	—	0.0	—
All compound (wind + water)	94,069	97,246	26.42	1,078.3	5,212.3	13,509.3	822.8	76.3
Total	196,619	217,831	57.02	2,126.9	9,893.1	36,299.5	1,241.0	58.3

Table S10. Compound-hazard stratification of the priced insurance sample. Population, assets, expected damage, tail damage, and uninsured losses for the 196,619 coastal-zone buildings in the insurance sample, stratified by the perils that ever damage them across the 604-storm ensemble. *Notes:* categories are the union of damaging perils over all 604 storms, so a building appears in exactly one row; “flood” is inland (fluvial) flooding and “surge” is coastal inundation, and the four wind categories are exhaustive because every building in the priced sample has some wind exposure — the 97 “No modeled damage” homes sustain no loss in any storm, and their tail and share cells are therefore undefined. “Expected damage” is the category’s aggregate loss averaged over all 604 events; P95 and P99 are percentiles of the category’s aggregate per-event loss taken over damaging events only, so they describe the severity of a rare event rather than a per-building tail. “Expected uninsured” is the portion of expected damage left uncovered by the policies actually purchased under the affordability-constrained equilibrium, in which wind policies indemnify wind and flood policies indemnify both flood and surge. Rows sum to the Total; “All compound” aggregates the three wind-plus-water rows. Dollar figures are 2020 replacement values of structure plus contents. Source: 10_stratification_table.R.

Hazard Category	Type	Cells	Buildings	Pop.	Value (\$B)	Mean Prob.
Wind	Single	313,584	2,041,534	2,617,846	619.47	0.065
Surge	Single	7,434	48,947	46,948	13.73	0.027
Flood	Single	13,566	70,711	92,027	21.29	0.048
Wind + Surge	Compound (2)	11,296	83,019	80,021	23.53	0.022
Wind + Flood	Compound (2)	17,356	92,228	120,585	26.77	0.011
Flood + Surge	Compound (2)	601	2,742	3,573	0.74	0.005
Wind + Flood + Surge	Compound (3)	1,813	9,438	11,792	2.61	0.006
<i>All Single</i>		—	2,161,192	2,756,821	654.49	—
<i>All Compound</i>		—	177,989	204,179	51.04	—
<i>All Compound (3)</i>		—	9,438	11,792	2.61	—

Table S11. Extensive-margin exposure summary by hazard category. Spatial extent, exposed population, and exposed asset value for each of the seven mutually exclusive hazard categories across the 604-storm ensemble. *Notes:* “Cells” counts the distinct 250 m grid cells in which the category ever occurs. “Buildings”, “Pop.”, and “Value” are building–storm *instances* — each building is counted once per storm in which that category produces damage — so the totals exceed the 575,453 unique homes and \$443 B of the analysis set, and should be read as exposure-events rather than distinct structures. “Mean Prob.” is the per-cell occurrence frequency (share of the 604 storms producing that category’s damage), averaged over affected cells. The summary rows aggregate the single-hazard and compound categories; “All Compound” includes both two- and three-hazard categories, with the three-hazard subtotal reported separately. Cell counts are not additive across categories — a cell may host several categories in different storms — so no cell total is given. This table gives the absolute counts underlying the fractions reported in Panel A of the main-text extensive-margin table. Sources: RES1_extensive_table2_summary_by_hazard.csv, RES1_extensive_table3_by_category.csv.