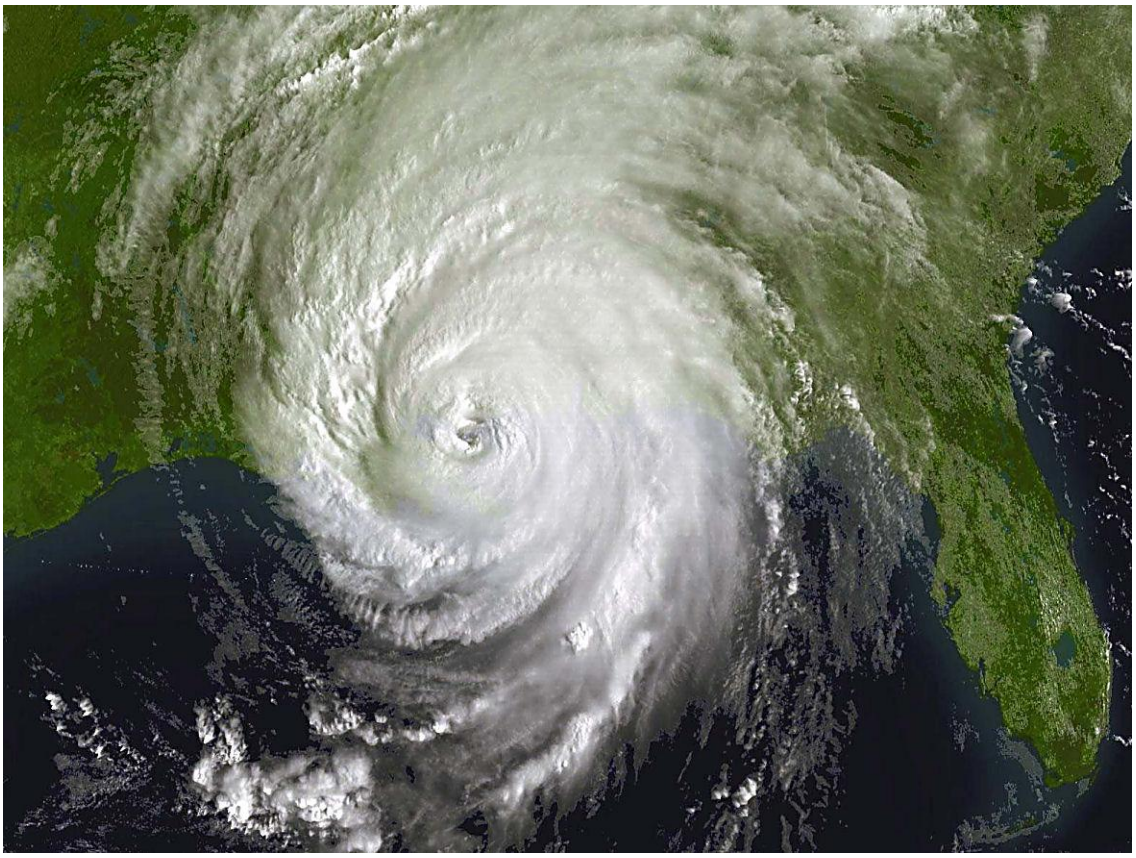
White Paper

Computer Modeling Tames Super-Cat Hurricane Risk



Hurricane Katrina — NOAA Image

By:

Howard Botts, Ph.D.

Proxix Solutions, Inc.
3202 Palm Harbor Blvd.
Palm Harbor, FL 34683
866.781.2662
www.proxix.com

Executive Summary

The length and ferocity of the 2005 Atlantic hurricane season—the most catastrophic ever recorded—changed the way the insurance industry conducts business.

In still-evolving court cases insurers argued that they were not liable for property lost to storm surge. The courts, however, directed companies to pay claims when they could not prove that losses were caused by water alone. Faced with these staggering costs and the prospect of global climate changes, insurers began abandoning coastal property markets.

Increasing population density in high-value coastal areas and insurers' reluctance to insure these properties, has created a unique market opportunity. Companies that accurately identify low-risk coastal properties can provide a valuable service while reaping handsome profits. But how can insurers reliably determine the risk of catastrophic hurricane loss?

Underwriters tried various rule-of-thumb techniques. Properties could be excluded from coverage if they were

- within some fixed distance of the coast,
- within a fixed distance of the coast and below a given elevation, or
- within a known flood zone.

These rules all suffer from the same problem: they wrongly **exclude** low-risk properties and wrongly **include** high-risk ones. Clearly, a very accurate rating technique is needed.

GIS experts at Proxix Solutions developed state of the art storm-surge modeling software that generates storm-surge inundation polygons for all counties along the Gulf and Atlantic Coasts. Accounting for changes in coastal elevations and barriers to inland movement of surge waters, the model produces risk polygons identifying five zones of storm-surge risk, from low to extreme.

Using our product called CATUM (kay´ t'm), underwriters input an address or latitude and longitude and receive a detailed risk score for a specific property or location. With CATUM's very accurate parcel-based geocoding technology, carriers can outperform rule-of-thumb rating techniques that expose them to catastrophic loss.

Proxix's sophisticated tools help carriers identify properties that generate high premiums but are less susceptible to storm-surge damage, allowing them to mine the coastal insurance market.

Super-Cat: The Atlantic hurricane season of 2005

Super catastrophes are rare, but when they occur, they seem to change the world in which we live. The 2005 season had 28 named storms; the average is 11. Of the 28, 15 named storms became hurricanes, five were Category 4 strength; another four were Category 5. When Hurricane Katrina hit the Gulf Coast on August 23, its storm surge was a wall of water thirty-feet high that destroyed much of New Orleans and most of the coastal property in Mississippi. Altogether, 2005's storms caused almost 3,000 deaths and several hundred billion dollars worth of economic damage.[1]

In the aftermath of the 2005 hurricane season and because of the possibility of climate change, insurers radically changed the way they viewed coastal properties. Rating agencies tightened coverage criteria and computer modelers began assuming a higher frequency and severity of storms.

Broussard v. State Farm Fire and Casualty Co.

Retired insurance agent Norman Broussard and his wife Genevieve lived at 154 Brady Drive in Biloxi, Mississippi. Their house, which they built in the 1960s, was just a short stroll to the picturesque Mississippi Sound. When Hurricane Katrina hit, they sought refuge with their daughter, but when they returned, there was nothing left but the concrete slab.[2]

They filed a claim with State Farm, arguing that their home and its contents were destroyed by the hurricane-force winds. State Farm, Mississippi's largest insurer, denied the claim, asserting that the house had been destroyed by the storm surge, or flood, for which coverage was excluded. The Broussards sued.

This was the first of the so-called "slab suits" to go to trial. The court's decision, rendered on January 17, 2007, was a warning to all carriers handling coastal property. In a directed verdict, Judge L. T. Senter awarded the Broussards the full value of their policy. His reasoning was simple: The insurer could not prove what portion of the loss was due to flooding and what portion to wind. He then sent the question of punitive damages to the jury, which promptly awarded the plaintiffs $2.5 million (later reduced to $1 million).

Although State Farm announced that they will appeal, the impact of the award forced them into negotiations with 640 other litigants in a class action suit. The initial settlement offer of $80 million plus a reserve of at least $50 million for claimants who did not sue was rejected by Judge Senter. He is seeking more information before deciding a case that will affect 35,000 policy holders.[3]

The apparently increasing severity of storms and these troubling court decisions have reinsurers demanding more sophisticated risk-assessment tools. Many carriers are taking the "dry road"—refusing to write insurance in the coastal regions. Clearly, companies that insure properties in hurricane-prone regions risk their organization's profitability every time they make an underwriting decision.

A riskier market with real profit potential

Warren Buffett is one of the world's shrewdest and richest businessmen. In his 2006 letter to Berkshire-Hathaway shareholders he wrote:

> The big unknown is super-cat insurance. Were the terrible hurricane seasons of 2004–05 aberrations? Or were they our planet's first warning that the climate of the 21st century will differ materially from what we've seen in the past? If the answer to the second question is yes, 2006 will soon be perceived as a misleading period of calm preceding a series of devastating storms. These could rock the insurance industry. …
>
> Don't think, however, that we have lost our taste for risk. We remain prepared to lose $6 billion in a single event, *if* we have been paid appropriately for assuming that risk.[4]

Obviously, Buffett believes he can make money in an era of super-cats, but the risk must be understood at a very sophisticated level.

Companies tried various underwriting rules of thumb. Properties would be excluded from coverage if they were within some fixed distance of the coast, or within a fixed distance of the coast **and** below a given elevation, or if they fell within a known flood zone. But these rules all suffer from the same problem: they wrongly **exclude** low-risk properties and wrongly **include** high-risk ones. Clearly, a more accurate technique is needed.

Proxix Solutions

Proxix's Coastal Surge Risk™ Model

Proxix has utilized its GIS expertise to provide a solution to this problem. They developed a comprehensive computer model that outputs maximum storm-surge water elevations by considering on- and offshore variables and storm heights derived from past hurricanes. It generates detailed geocoded polygons defining five surge-risk zones, from low to extreme.

Offshore variables

A hurricane's wind and forward speeds both contribute to its power. The angle at which it strikes the shore is also critical; the more perpendicular the track is to the shore, the greater the surge produced. The tidal stage also must be considered; the storm surge is essentially added onto the tide height. Finally, near-shore water depth and topography greatly affects the surge height, with shallower water intensifying the surge.

Onshore variables

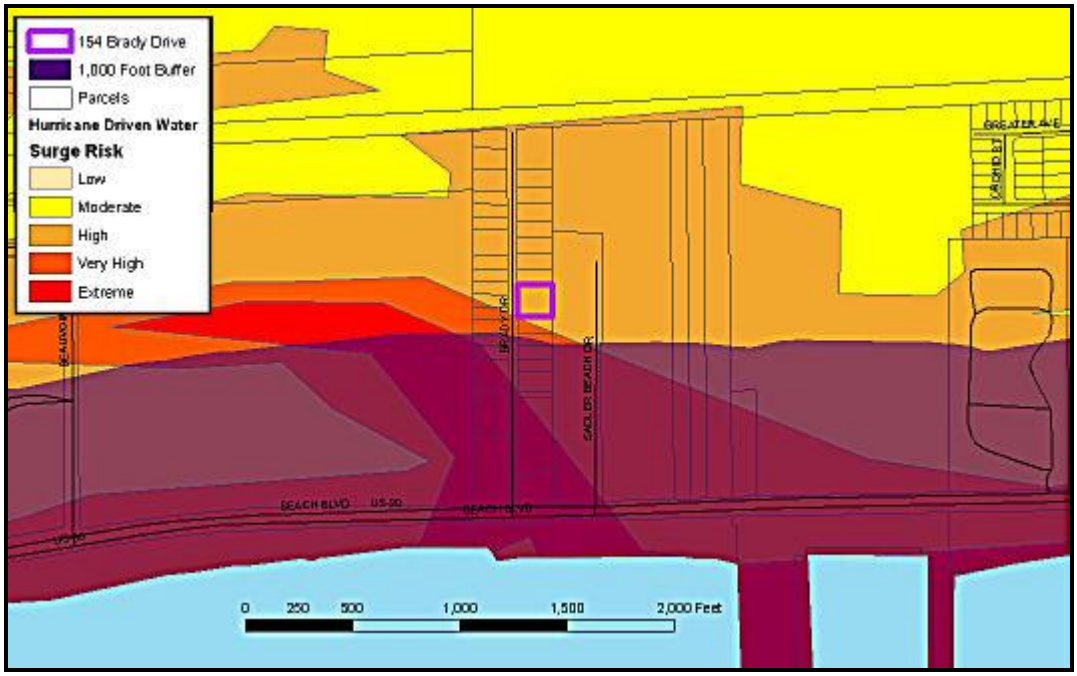
Barriers, both natural and man-made, serve as deterrents to the surge. Their size and sturdiness must be considered. And finally, the elevation of a property is crucial in determining its risk.

Introducing CATUM™, a parcel-level underwriting tool

Proxix's CATUM provides the human interface to our coastal surge-risk database. Underwriters input a parcel address or latitude and longitude and receive a detailed risk analysis of the property or location under consideration.

CATUM analyzes the Broussard property

Figure 1 shows CATUM's output when run on the address of the Brussard property on Brady Drive in Biloxi. CATUM determined that the property is located within a zone with a high risk of loss from a storm surge. Notice also that the property is located 1,162 feet from the Mississippi Sound. So, the 1,000 foot rule of thumb would not have prevented an underwriter from insuring this home.



Geocode

Latitude	30.394467
Longitude	-88.966967
Address Line	154 BRADY DR
City/State Zip	BILOXI MS 39531
Quality Code	R0000
PxPoint Data Set	NAVTEQ

Mainland Determination & Distance to Water Feature

Distance to Seaward Water Feature	1,162 feet
Direction to Seaward Water Feature	SouthSouthEast (SSE) -- 158 Degrees
Seaward Water Feature Name	Mississippi Sound
Distance to Coastal Water Feature	1,162 feet
Direction to Coastal Water Feature	SouthSouthEast (SSE) -- 158 Degrees
Water Feature Name	Mississippi Sound
Mainland: Yes or No	Yes

Coastal Storm Surge

Risk Value	3
Risk Level	High

Figure 1. CATUM analysis for the Broussard property

The inadequacy of rule-of-thumb risk assessment

Now that we've seen how CATUM performs for a single property, it's time to apply it to an entire region at risk for a super-cat hurricane, Nassau County, New York.

We think of the lower Atlantic and Gulf states as being the most vulnerable to tropical storms. But some climate experts think the northeast is overdue for a catastrophic storm. Few now remember the "Long Island Express," a Category 3 hurricane that made landfall in 1938. It had an eye 50 miles across and sustained winds in excess of 100 miles an hour. It was moving at 60 miles an hour when it hit the Nassau County coast, and the impact registered on seismographs in Alaska. It wrought havoc all the way to Quebec and left a brutal legacy: 690 dead and $400 million (1938 dollars) in damage.[5]

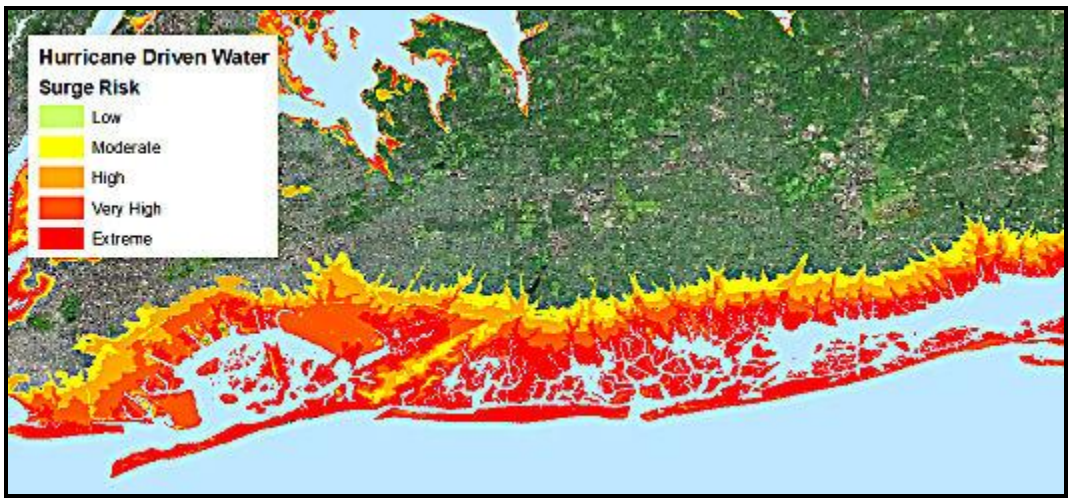


Figure 2. Storm-Surge Zones for Southern Long Island, NY

Figure 2, generated from CATUM's database, illustrates the storm-surge zones along the Long Island coast. Discussion in this section focuses on Nassau County, which includes the central portion of Long Island. The National Household Database contained 596,741 records for Nassau County. CATUM's database has geocodings for 92.9 percent of the total records and 97.6 percent of the single-family dwellings.

Our analysis provided the following results

Surge-risk zone	Number of households
Extreme	69,670
Very High	37,905
High	42,918
Moderate	32,954
Low	0
Total	183,447

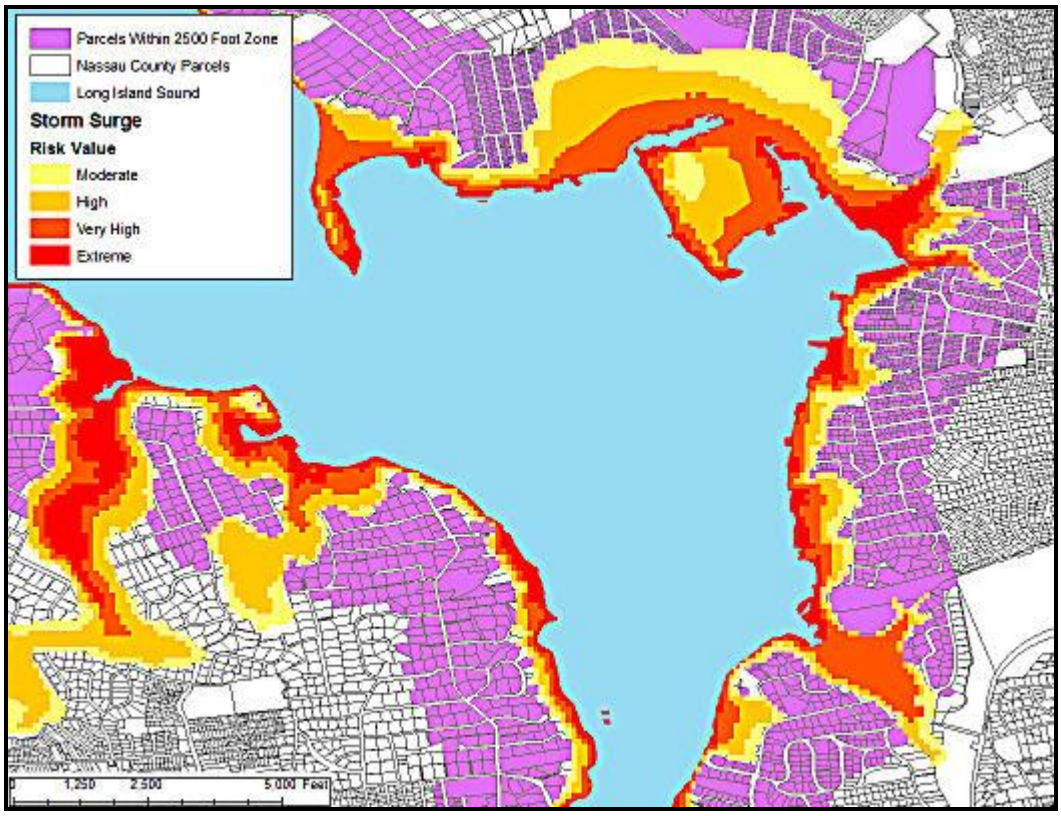


Figure 3. Parcels within 2,500 feet of the ocean but **not** in a surge-risk zone

Distance-from-coast rule

The easiest underwriting rule of thumb to implement is distance from coast. Properties are excluded from coverage if they lie within some fixed distance of the coast; 1,000 feet is often used or, more conservatively, 2,500 feet. Figure 3 illustrates the first problem with the distance rule of thumb: false exclusion. Properties (in purple) are within 2,500 feet of the coast but are outside of a storm-surge risk zone. In other words, **these properties could have been insured**, but were wrongly excluded.

Our analysis showed that

- 20,962 households with a total value of $22 billion would have been wrongly excluded by the 2,500 foot rule of thumb, and

- 5,238 households with a total value of $7 billion would have been wrongly excluded by the more conservative 1,000 foot rule of thumb (no graphic shown).

Whichever distance rule is used, these wrongly excluded properties represent a tremendous loss of premiums for insurers.

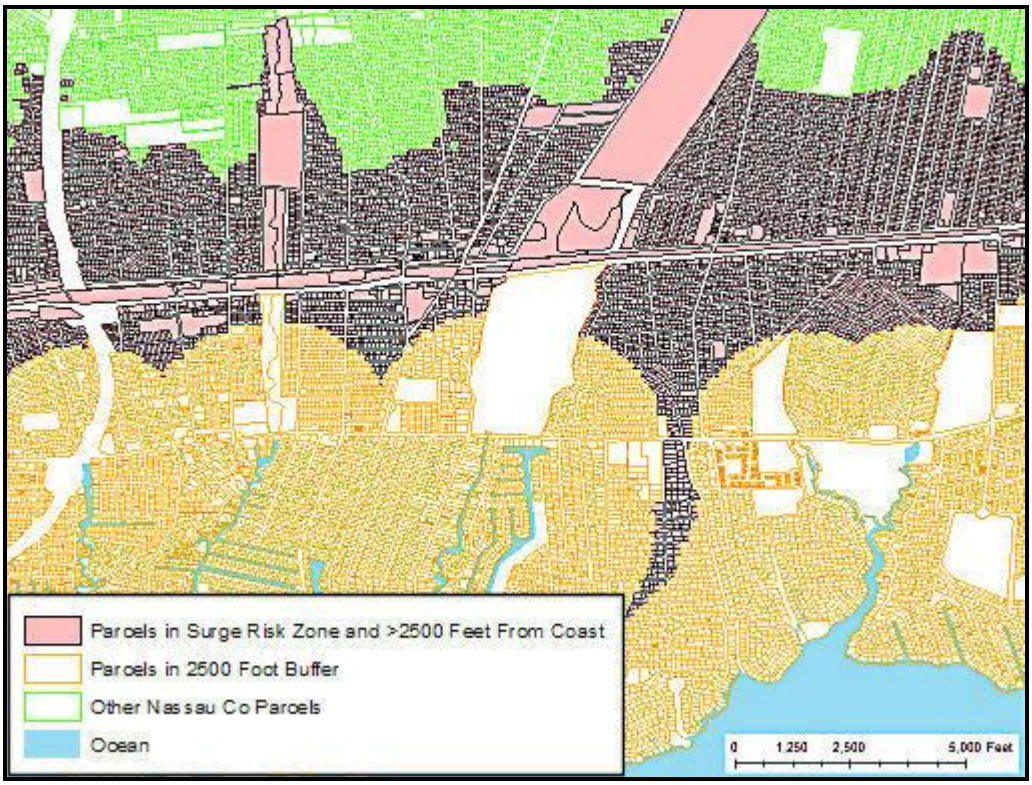


Figure 4. Parcels more than 2,500 feet from the ocean but still in a surge-risk zone

Figure 4 illustrates the opposite problem with the distance rule of thumb: false inclusion. Properties (in rose) are more than 2,500 feet of the coast but are within a storm surge risk zone. In other words, **these are properties that should not have been insured**, but were wrongly included by the distance rule.

Our analysis showed that

- 47,486 households with a total value of $49 billion would have been wrongly included by the 2,500 foot rule of thumb, and

- 67,088 households with a total value of $74 billion would have been wrongly included by the more conservative 1,000 foot rule of thumb (no graphic shown).

Whichever distance rule is used, these wrongly-included properties represent enormous exposure to catastrophic loss for insurers.

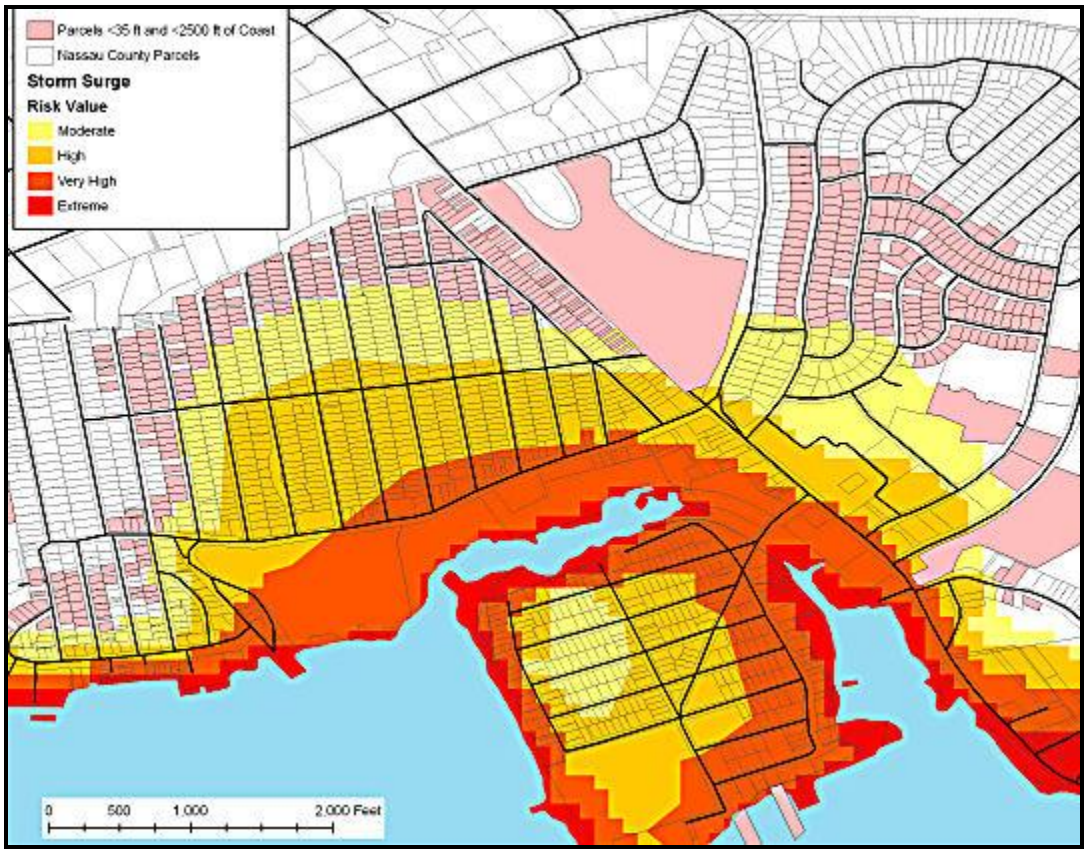


Figure 5. Parcels within 2,500 feet of the coast and less than 36 feet above sea level but **not** in a surge-risk zone

Distance from coast plus elevation

A slightly more discriminating underwriting rule of thumb is distance to coast plus elevation. Properties are excluded from coverage if they lie within some fixed distance of the coast and below a given elevation. Often 1,000 feet or, more conservatively, 2,500 feet is used as the distance, and 36 feet for the elevation, since storm surges rarely exceed 30 feet. Figure 5 illustrates the false exclusion problem with this rule of thumb: Properties (in rose) are within 2,500 feet of the coast and less than 36 feet elevation, but are outside of a storm-surge risk zone. In other words, **these are properties that could have been insured**, but were wrongly excluded.

Our analysis showed that

- 3,902 households would have been wrongly excluded by the 2,500-foot distance plus 36-foot elevation rule of thumb.

When the distance plus elevation rule is used, these wrongly-excluded properties represent a tremendous loss of premiums for insurers.

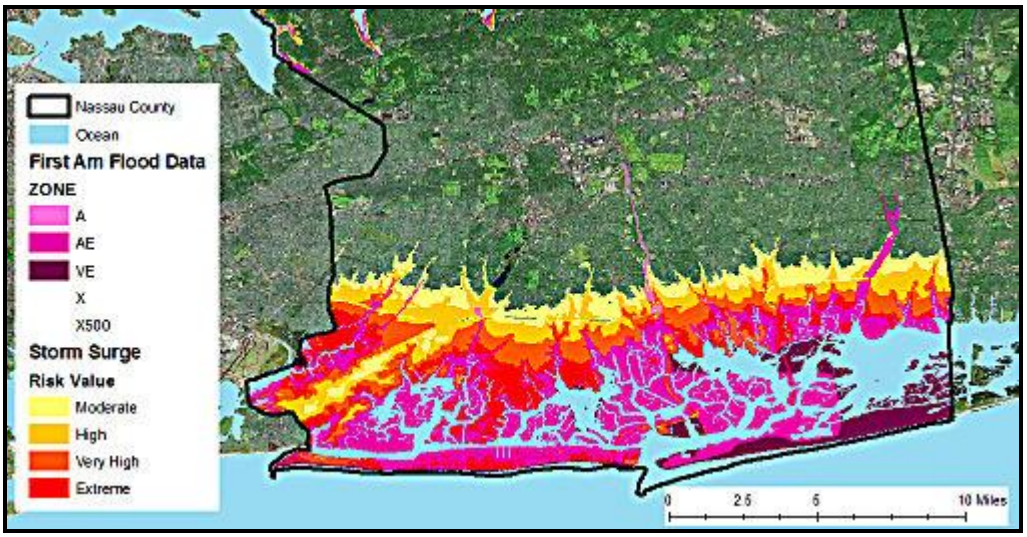


Figure 6. Superimposed flood- and surge-risk zones. Flood zones (shades of purple) are layered on top of storm-surge risk zones (red, yellow and orange).

Flood Zones

Since homeowners insurance policies exclude damage caused by flood waters, insurers argued that these clauses indemnified them against losses caused by Hurricane Katrina's storm surge. As we saw above, however, courts have held insurers liable in these cases. This might tempt carriers to exclude coverage based on a parcel's inclusion in a flood zone. Figure 6 shows, however, that the storm-surge risk zones in Nassau County cover a much larger geographic area than do the flood zones. This is typical for all coastal regions we have studied.

Our analysis considered properties in FEMA flood zones designated A, AE or VE.[6] We determined the following

Risk zone	Number of households
Flood Zone Only	251
Surge Zone Only	148,243
Flood or surge zone	183,698
Flood and surge zone	35,204

Figure 7 (following page) illustrates parcels located in a storm-surge risk zone only, and parcels located in both a surge zone and a flood zone. Properties (rose) are within a surge-risk zone, but are outside of a flood zone. In other words, **these are properties that should have not been insured**, but were wrongly included.

When flood zones alone are considered, these wrongly-included properties represent an enormous exposure to catastrophic loss. Clearly, insurers need to analyze both flood- and storm-surge risk for each property under consideration.

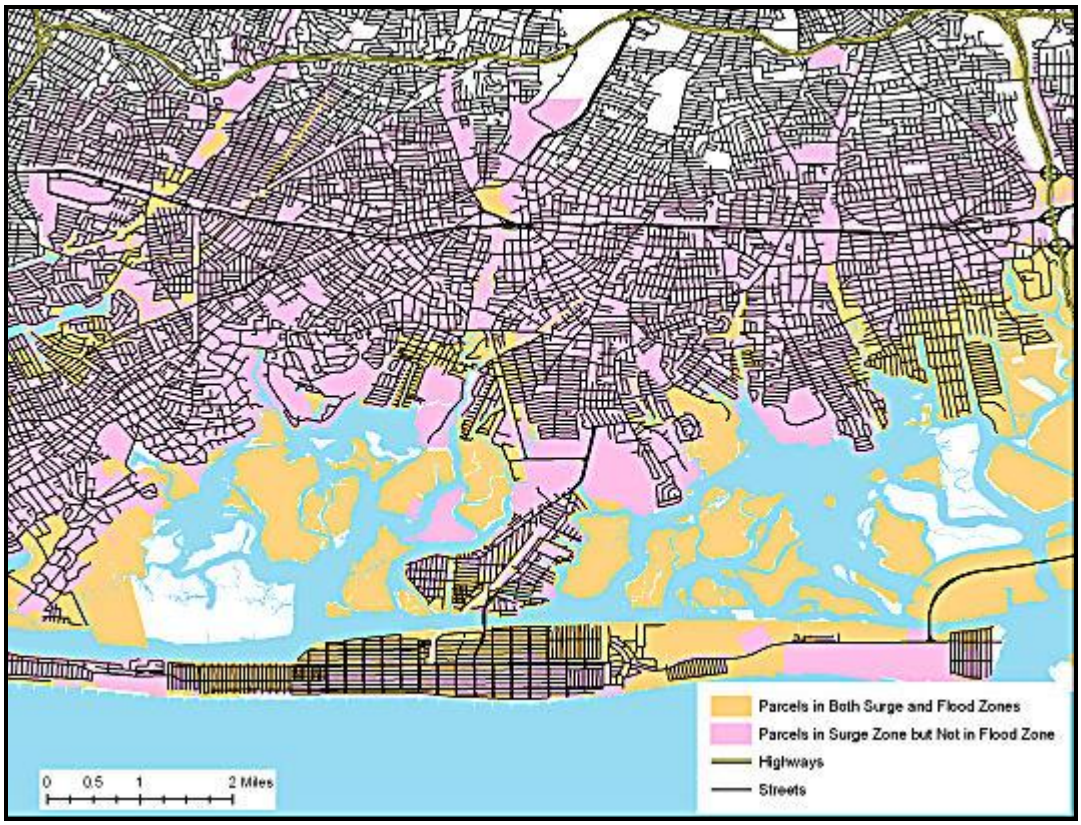


Figure 7. Parcels (in rose) that are located in a surge risk zone only and parcels (in tan) that are located in both surge- and flood-risk zones

Conclusion

The coastal market is being largely abandoned by traditional insurers. Yet as coastal population density continues to grow, so will the need for insurance coverage.

Proxix has developed a sophisticated approach to underwriting that allows carriers to make sound underwriting decisions and mine this growing insurance market.

Additional Modules

In addition to its coastal risk module, CATUM also evaluates the risks from Florida sinkholes, tornadoes, hail storms, and wildfires.

Biographical Data

Howard Botts, PhD. has over 30 years of experience developing spatial databases and in computer cartography and Geographic Information Systems (GIS). He holds a doctorate (1983) in geography from the University of Wisconsin-Madison. In addition to being a founder of Proxix, he is a professor of geography at the University of Wisconsin-Whitewater. His former students work for insurance companies in underwriting, claims,

actuarial, market research, GIS, and IT departments throughout North America. Dr. Botts has published extensively and has made hundreds of presentations to business and professional organizations on a variety of topics including hazard database development, new approaches to rating territory creation and assignment, automating risk assignment in underwriting, agent placement and market potential models, and geographically based market analysis.

Dr. Botts heads Proxix's Madison, Wisconsin database development office overseeing a team of GIS professionals developing and maintaining hazard databases for the insurance industry. Proxix's hazard databases include Brushfire Risk, FIREbreak+ (wild land / urban interface and housing density database), Coastline and Mainland Determination files, Coastal Storm Surge Risk Model, Earthquake Risk Model, Florida Sinkhole Risk Model, Hail Risk, and Tornado Risk. They are considered "the industry standard" and are used by many major U.S. insurance companies.

Data Sources

A. Flood Zone Data - First American Flood Data Services (www.floodcert.com)

B. National Household Database - KnowledgeBase Marketing (http://www2.kbm1.com)

C. Parcel Boundary Database - NAVTEQ (http://www.navteq.com)

D. Property Value Estimates - First American Real Estate Tax Service (http://www.firstam.com/tax/services.html)

E. Street Database - NAVTEQ (http://www.navteq.com)

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[1] "2005: A Record Atlantic Hurricane Season", from http://www.islandnet.com/~see/weather/history/2005hurricanes.htm.

[2] "First witness in insurance slab cases offers tearful testimony", Anita Lee , Biloxi, *MS Sun Herald*, 2007-01-09.

[3] "Federal Judge Rules Against State Farm in Katrina Case", Rick Silver, University of Mississippi Law School, at http://www.olemiss.edu/orgs/SGLC/National/SandBar/6.1statefarm.htm

[4] Warren Buffett, letter to shareholders, 2006 available at http://www.berkshirehathaway.com/letters/2006ltr.pdf

[5] "The Most Overlooked Risks", Matthew Brodsky, at http://www.riskandinsurance.com/070501specreport_2.asp

[6] Definitions of FEMA flood zone designations is available at http://fafds.floodcert.com/images/main/Flood%20Zone%20Designations%20-%20Lenders.pdf

