



# MANGROVES AND MARSHES: A SHIELD AGAINST CATASTROPHE?

## THE ROLE OF WETLANDS IN INSURANCE INDUSTRY RISK MODELS: WHEN IS \$600M A LOT OF MONEY?

**Paul Wilson**  
**Risk Management Solutions**  
**&**  
**Mike Beck, TNC & UCSC**



**TERCENTENARY  
RESEARCH  
FOUNDATION**



**UC SANTA CRUZ**

The Nature  
Conservancy



# Who are Risk Management Solutions?

- RMS produces models used to quantify & manage **catastrophe risk**
- Work with most major insurance and reinsurance companies in **US & Europe**
- **\$2 trillion** worth of insurance and capital markets transactions based on RMS risk models
- Trusted by regulators and rating agencies for **over 20 years**
- Collaborate with **public-sector** institutions to help them understand their exposure to risk
- **1,200 employees**, over **200** in model development across London, California, Zurich and India

# How do insurers / reinsurers use risk models?

- Establish **pricing guidelines** for different perils
- Determine **risk drivers** to their portfolios
- Develop **location-specific** view of risk
  - “what’s the annual likelihood of a property at (x,y) being flooded?”
- ...and **portfolio-specific** view of risk
  - “what’s the annual likelihood of incurring \$500M+ losses?”
- Determine **reinsurance** needs
- Estimate **post-event** losses

# WORLDWIDE CATASTROPHE RISK MANAGEMENT

*From earthquakes, hurricanes, and floods to terrorism and infectious diseases, RMS helps financial institutions and public agencies understand, quantify, and manage risk*



# How do wetlands come into this?

Key question:

Can we estimate how much “nature-based” defences are mitigating coastal flooding risks in the USA?

**Can we put a price on the risk reduction benefit of wetlands?**

This work is supported by the Lloyd’s Tercentenary Research Foundation project “The Role of Coastal Habitats in Managing Natural Hazards and Risk Reduction”.  
[www.lloyds.com/coastalresilience](http://www.lloyds.com/coastalresilience)

Narayan, S., Beck, M.W., Wilson, P., et al. 2016. Coastal Wetlands and Flood Damage Reduction: Using Risk Industry-based Models to Assess Natural Defenses in the Northeastern USA. Lloyd’s Tercentenary Research Foundation, London.

---

# HOW DO WE MODEL US HURRICANE STORM SURGE?

# MODELLING US HURRICANE STORM SURGE

- Tropical cyclone-driven storm surges are amongst the **costliest natural catastrophes** on Earth
- In the USA, **4 of the top 5 costliest natural catastrophes** have involved storm surge

## Hurricane Sandy

Image: Master Sgt. Mark C. Olsen, U.S. Air Force



## Typhoon Haiyan

Image: Noel Celis, AFP





# US HURRICANE MODEL FRAMEWORK



## Define Hurricane

Stochastic Event Module

Generate set of ~50,000 synthetic hurricane events

## Assess Wind & Wave Hazard

Hazard Module

Run deterministic wind & flood models for every event

## Apply Exposure

Geocoding/ Exposure Module

Associate hazard risk to every property in portfolio

## Calculate Damage

Vulnerability Module

Relate wind speed/surge height to property damage

## Quantify Financial Loss

Financial Analysis Module

Calculate financial loss for portfolio of properties

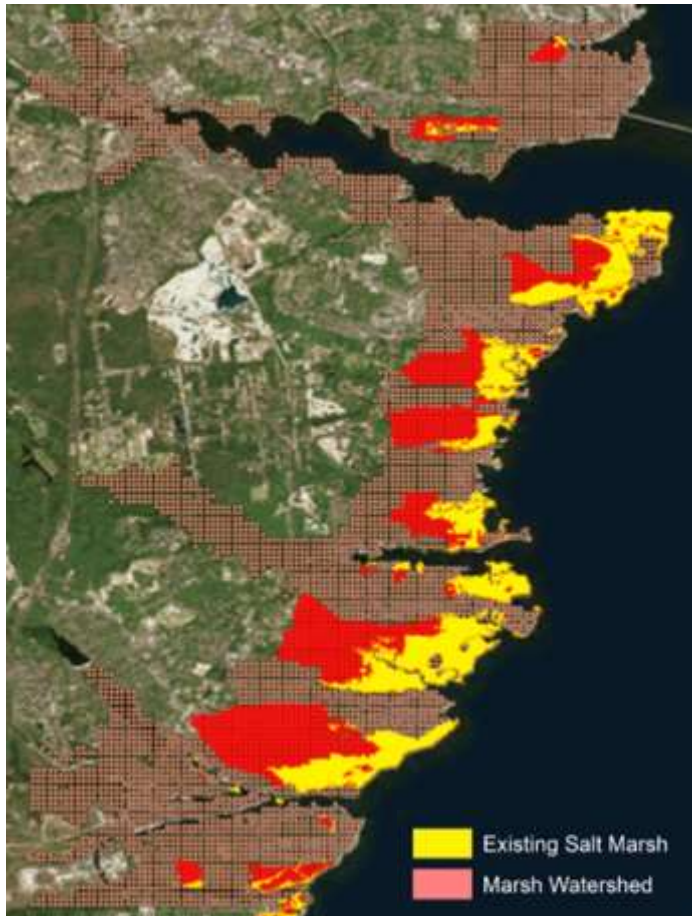


---

# QUANTIFYING THE ROLE OF WETLANDS IN STORM SURGE RISK

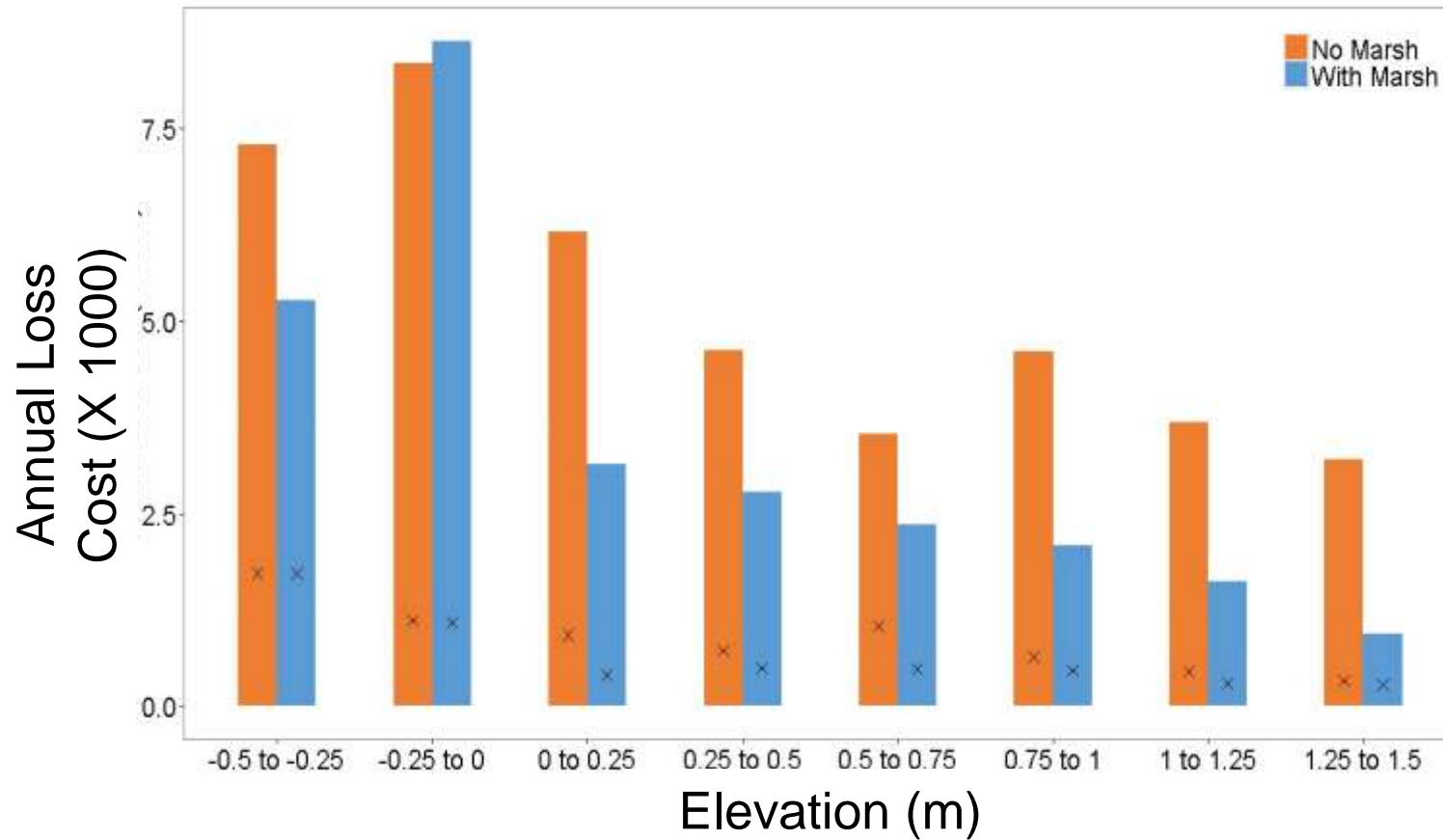
# CASE STUDY #1: OCEAN COUNTY

Do wetlands protect properties from annual storm surge damage in Ocean County (NJ)?



- Looked at ~2,000 synthetic storms
- Assume uniform grid of properties in the area
- Estimated annual flood losses for every property
- Wetlands and their watersheds delineated by Shepard et al. using GIS
- **Are average annual losses different in areas protected by wetlands versus areas not protected?**

# DO WETLANDS PROTECT PROPERTIES FROM ANNUAL FLOOD DAMAGES IN OCEAN COUNTY?



Average annual losses from storm surge are greater in areas not protected by wetlands

# CASE STUDY #2: HURRICANE SANDY

- Hurricane Sandy: 2<sup>nd</sup> costliest in US history
- Surge reached **9ft** above astronomical tide in NY

**Did wetlands reduce/increase economic losses during Hurricane Sandy?**



## Scenario-based analysis

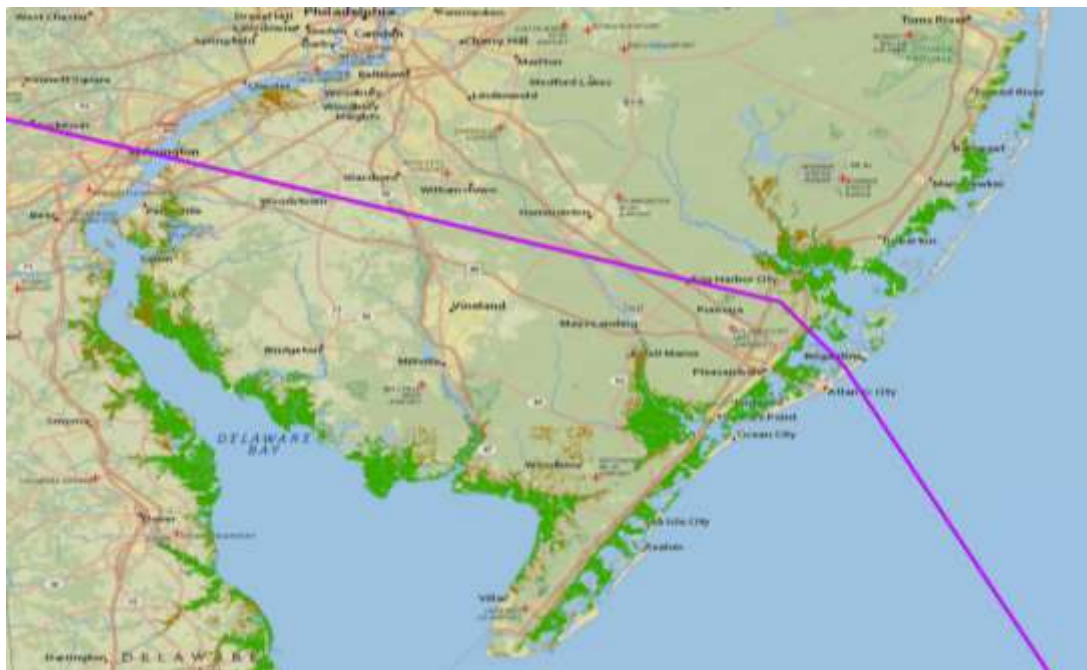
Run the surge model for Hurricane Sandy:

- 1) With wetlands as they are today
- 2) Assuming all wetlands are lost



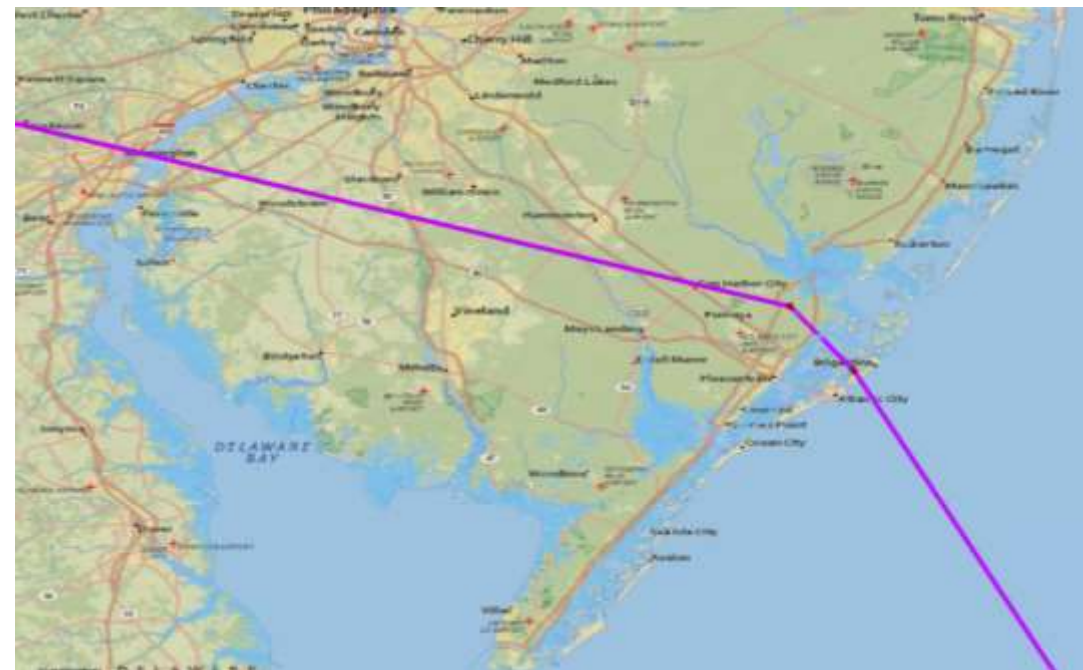
# HURRICANE SANDY: WETLANDS LOSS STUDY

**SCENARIO 1:  
PRESENT-DAY WETLANDS (GREEN)**



Wetlands roughness coefficients: 0.04 – 0.1

**SCENARIO 2:  
WETLAND LOSS TO OPEN WATER (BLUE)**



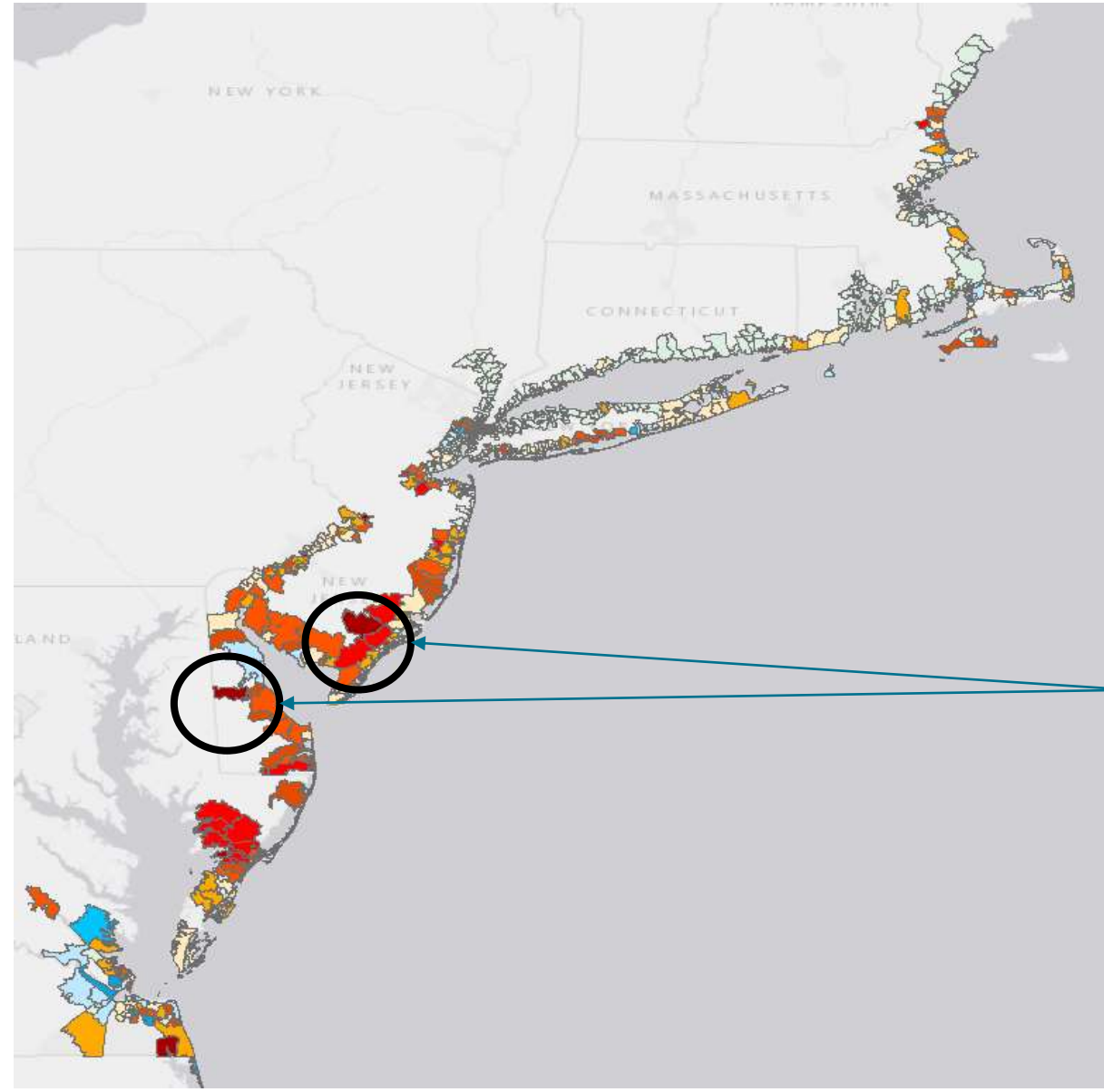
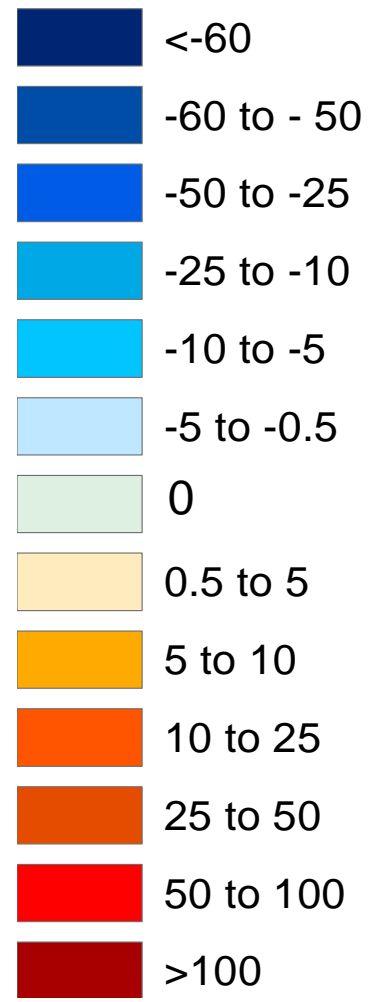
Wetlands' roughness coefficient: 0.02 (=sandy bed)

Surface roughness of wetlands was reduced to simulate wetland loss to open water



# DIFFERENCE IN DAMAGES BETWEEN BOTH SCENARIOS

## Difference in Losses (%)



Removing wetlands caused **an increase in losses** in most locations

Areas with **higher wetland cover** saw biggest relative loss increase

Removing wetlands increases losses by >100% in some areas...

... but what does this mean for absolute losses?



# DIFFERENCE IN DAMAGES BETWEEN BOTH SCENARIOS

State	At Present (\$M)	With Wetland Loss (\$M)	Absolute Difference (\$M)	Relative Difference (%)
Connecticut	2 181	2 181	+0.4	+0.1
Delaware	228	252	+24	+10.4
Massachusetts	1 452	1 459	+6	+0.4
Maryland	16	20	+5	+29.0
Maine	18	18	0	+0.0
North Carolina	10	9	-1	-6.5
New Hampshire	30	31	+1	+3.0
New Jersey	14 015	14 443	+429	+3.1
New York	32 315	32 453	+138	+0.4
Pennsylvania	174	188	+14	+7.9
Rhode Island	72	72	+0	+0.4
Virginia	195	205	+10	+5.1
<b>TOTAL</b>	<b>50 705</b>	<b>51 330</b>	<b>+625</b>	<b>+1.2</b>

Highest relative savings in states with extensive wetlands

Highest absolute savings in NJ & NY – states hardest hit

**Total absolute saving: \$625M**

Figures give total economic loss from storm surge only

# SO – IS \$625M A LOT OF MONEY?

It depends on who you ask...

- **“NO”:**
  - Fairly insignificant compared to total Sandy surge losses (\$50.7Bn)
- **“YES”:**
  - If the benefits are focused on specific communities, organisations or stakeholders
    - In US, homeowners’ flood insurance is often through NFIP (federal agency)
    - Industrial facilities generally insured for wind & water damage, but often have localised flood defences

# SUMMARY

- The effect of wetlands on **attenuating storm surge** for major hurricanes can be significant
- ... and some of these effects can be accounted for in **risk models used by the insurance industry** to manage & price risk
- Who gains most from wetlands' surge attenuation? Risk models can be used to gain further insights.
  
- RMS is committed to a 2-year partnership with The Nature Conservancy to explore this work further, extend the case studies to other habitats and expand the quantification throughout the US.
- [www.lloyds.com/coastalresilience](http://www.lloyds.com/coastalresilience)



## Authors

Siddharth Narayan, UCSC  
Michael Beck, TNC, UCSC  
Paul Wilson, RMS  
Christopher Thomas, RMS  
Alexandra Guerrero, RMS  
Christine Shepard, TNC  
Borja G. Reguero, UCSC  
Guillermo Franco, GC  
Jane Carter Ingram, WCS  
Dania Trespalacios, TNC

# Coastal Wetlands and Flood Damage Reduction: Using Risk Industry-based models to Assess Natural Defenses in the Northeast US

[www.lloyds.com/coastalresilience](http://www.lloyds.com/coastalresilience)





# ABOUT RMS

RMS is the world's leading provider of products, services, and expertise for the quantification and management of catastrophe risk. More than 400 leading insurers, reinsurers, trading companies, and other financial institutions rely on RMS models to quantify, manage, and transfer risk. As an established provider of risk modeling to companies across all market segments, RMS provides solutions that can be trusted as reliable benchmarks for strategic pricing, risk management, and risk transfer decisions.

©2014 Risk Management Solutions, Inc. RMS and the RMS logo are registered trademarks of Risk Management Solutions, Inc. All other trademarks are property of their respective owners.