Did Beach Nourishment Save the Jersey Shore During Sandy?

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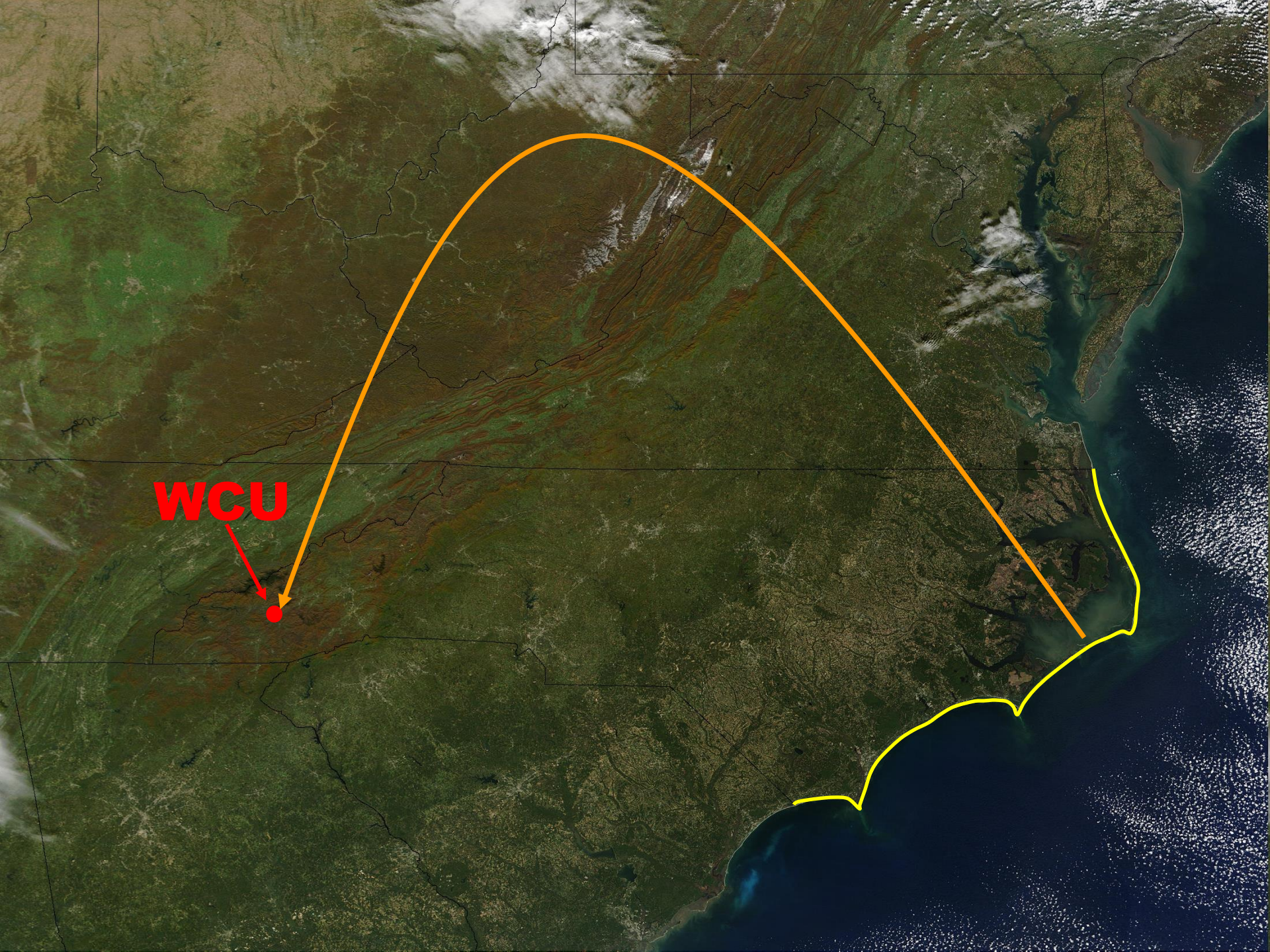
Program for the Study of Developed Shorelines
Western Carolina University

Program for the Study of Developed Shorelines (PSDS):

- Applied research center at Western Carolina University involved in the development and implementation of responsible, science-based coastal management strategies that promote the long-term sustainability of our nation's developed shorelines.
- Established in 1985 at Duke University
- Moved to WCU in 2006


WCU

WITH GLOBAL WARMING WE'LL SOON BE BEACH FRONT
SLANE

Marvin's

Beach Nourishment

Since 1922…

• 2,100 episodes
• 1,400,000,000 yds³
• 117,000,000 dump trucks (12 cy)
• 439,560 Olympic-sized swimming pools (3,185 cy)
• 364 Dallas Cowboys Stadiums (3,851,851cy)
• $6,200,000,000 (2012 dollars)

Beach Nourishment Viewer

Program for the Study of Developed Shorelines @ Western Carolina University

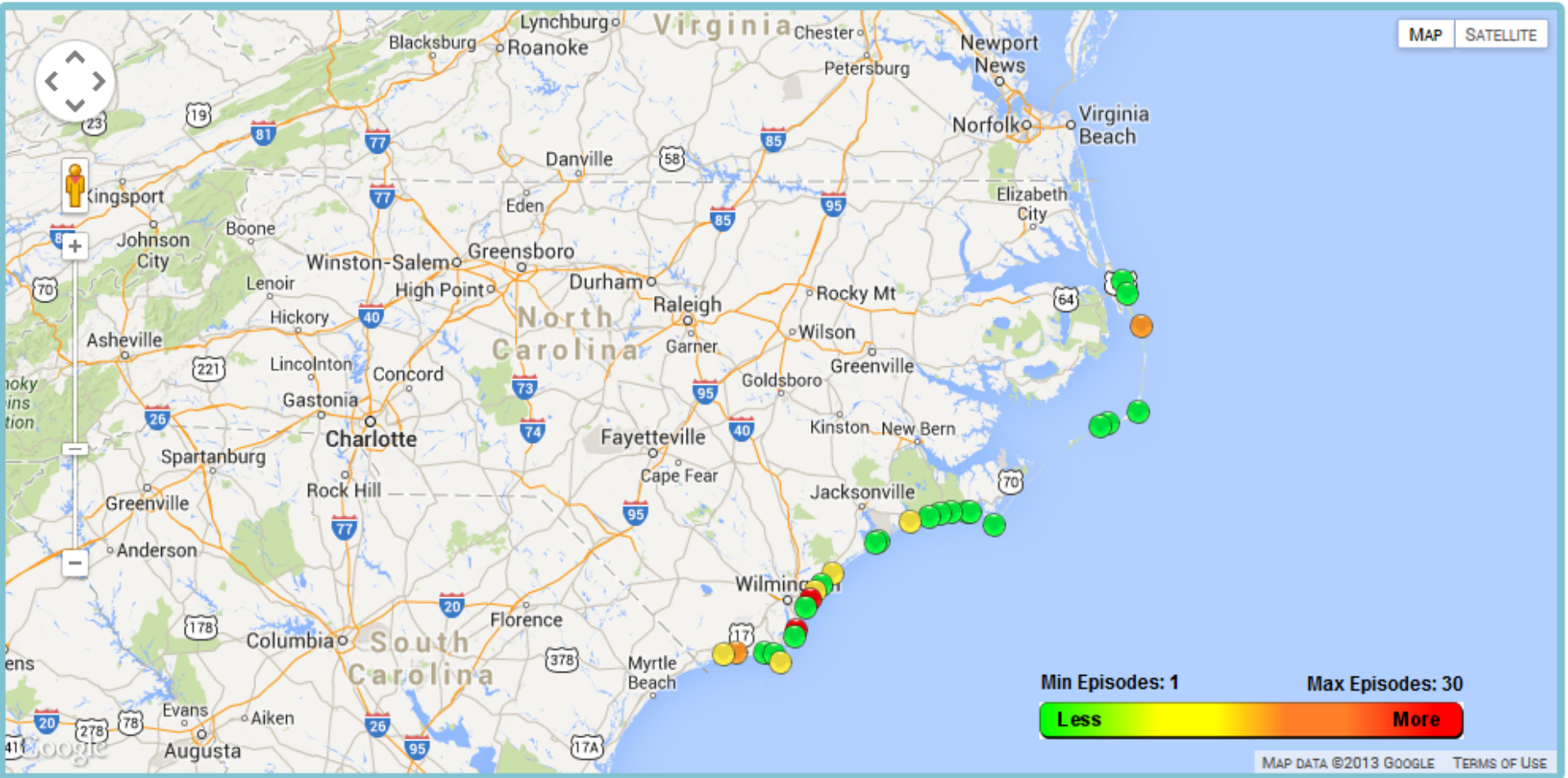
North Carolina

Select a beach

Select another state

State Totals:

Episodes:	215
Cost:	$455,846,981
Cost (in 2012 dollars):	$613,269,809
Volume (cubic yards):	107,377,507
Length (feet):	1,132,463



Beach Nourishment Viewer

Program for the Study of Developed Shorelines @ Western Carolina University

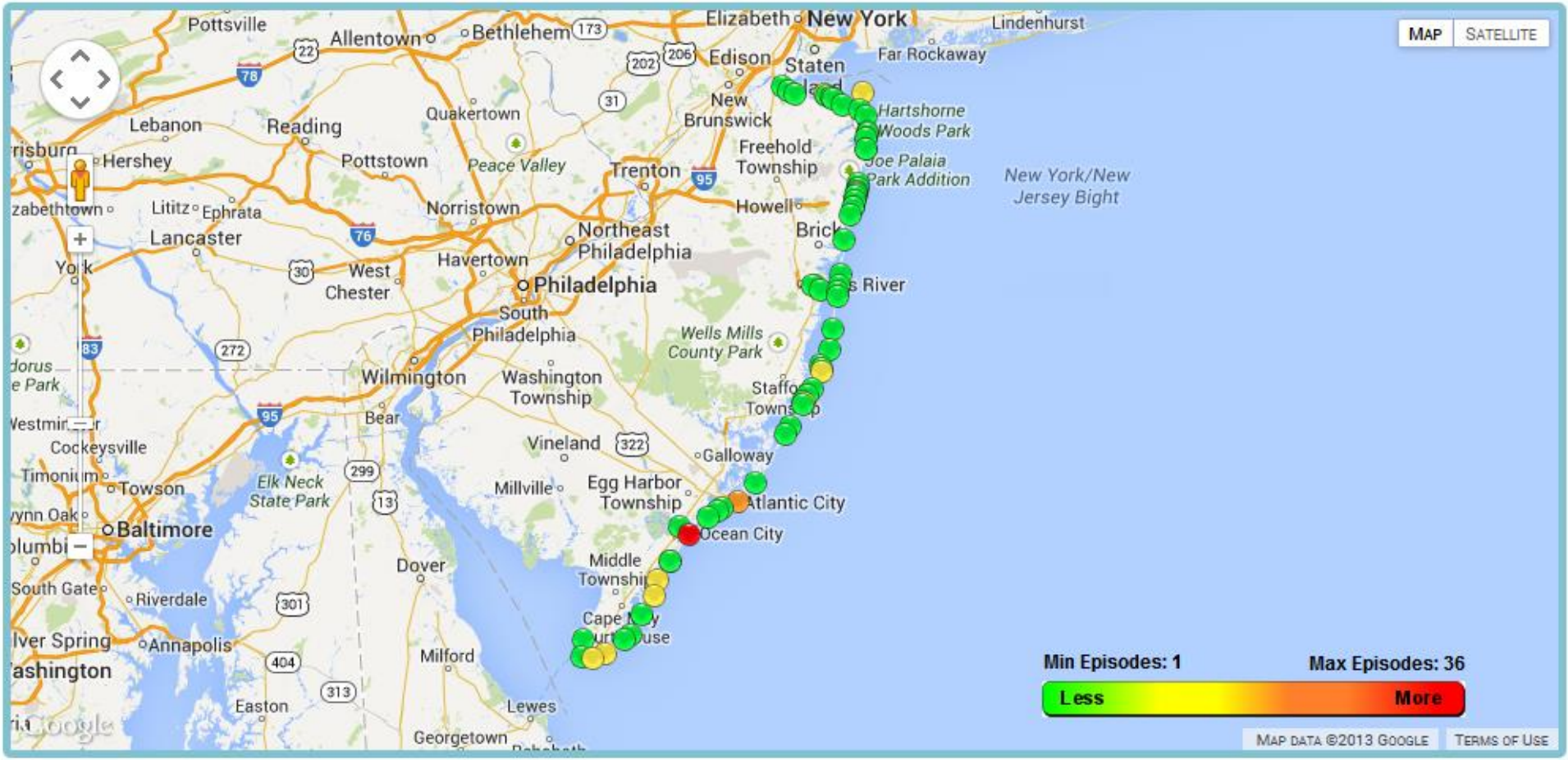
New Jersey

Select a beach

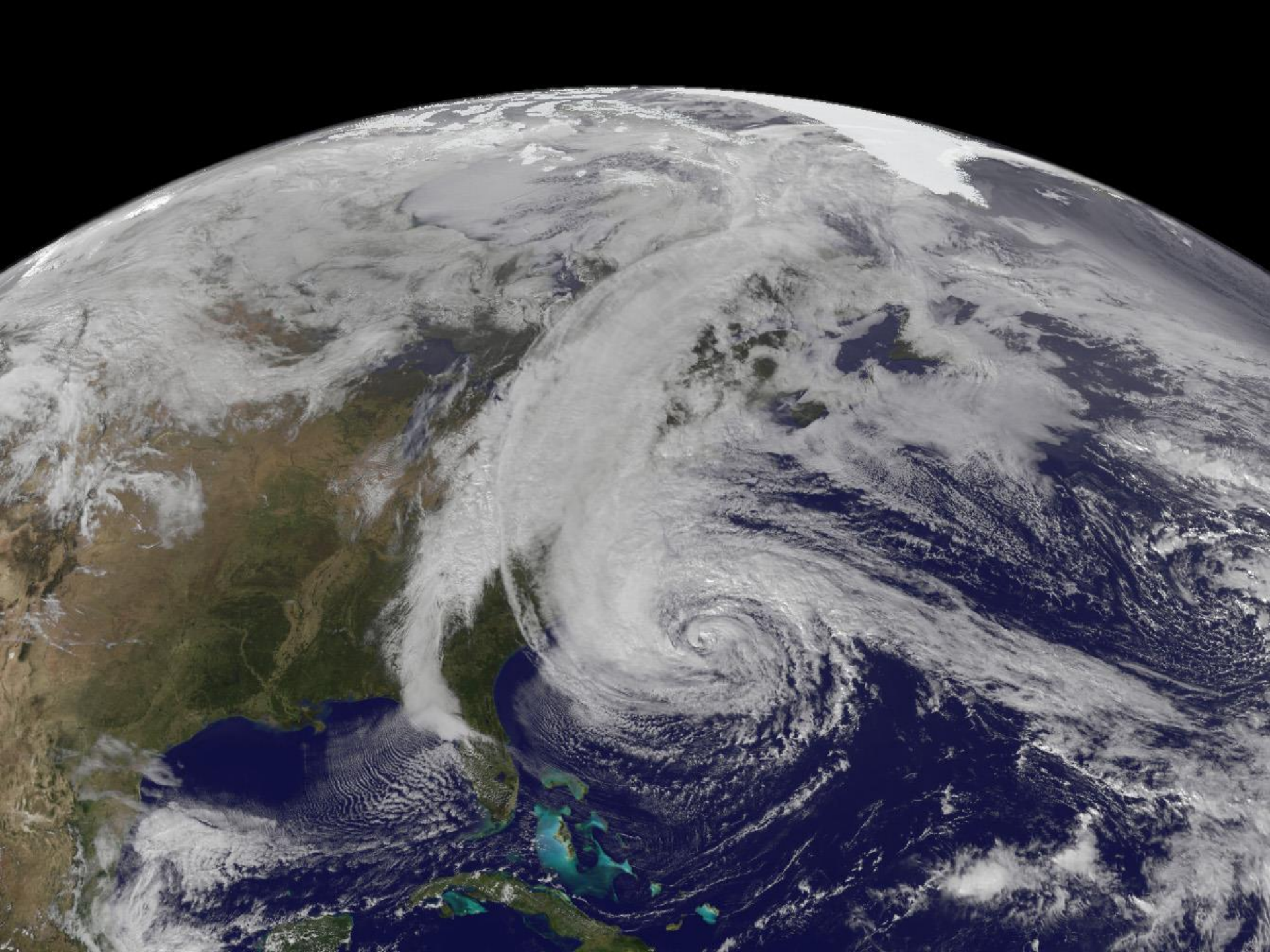
Select another state

State Totals:

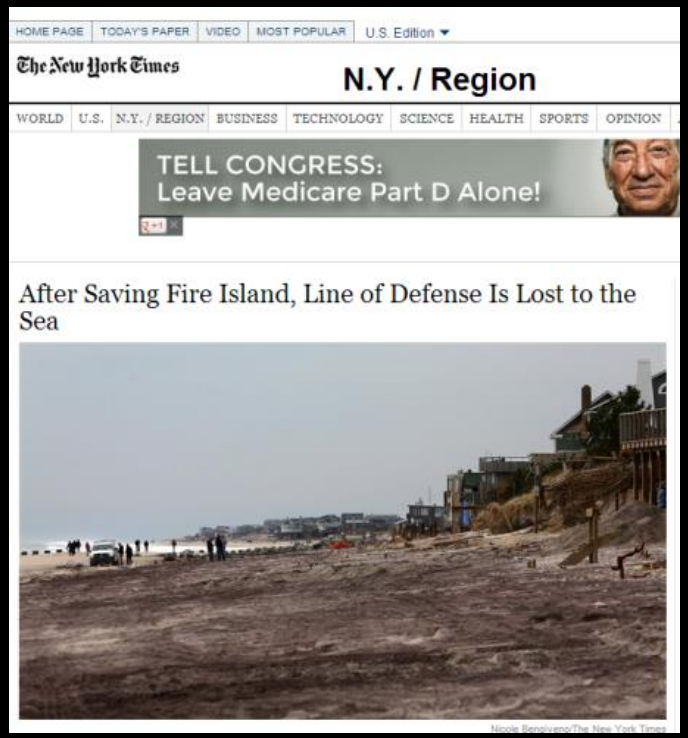
Episodes:	310
Cost:	$851,565,897
Cost (in 2012 dollars):	$1,222,134,321
Volume (cubic yards):	158,380,422
Length (feet):	880,484



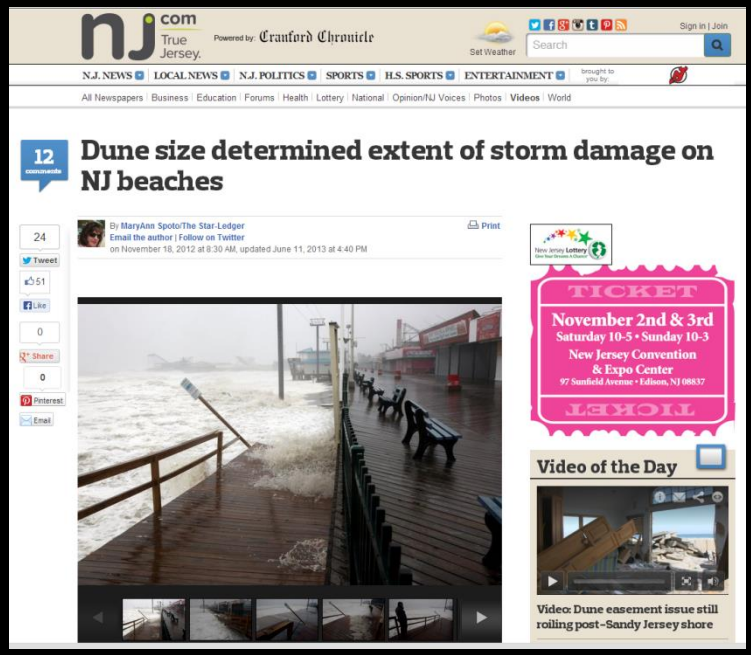
Sort by: (•) Episodes ( ) Cost ( ) Volume (cubic yards)



REPORTING AFTER SANDY



"If you look at the towns that have had engineered beaches, up and down the state, those are the towns whose damage was minimal." Other towns that didn't, the damage was much greater. I think that's a lesson for us as we move forward." – NJ Gov. Chris Christie



One thing is clear: Communities that were protected by a federally constructed beach project fared much better during the storm than their non-project counterparts.

— JOHN HARMS, ASBPA Government Affairs Advisor

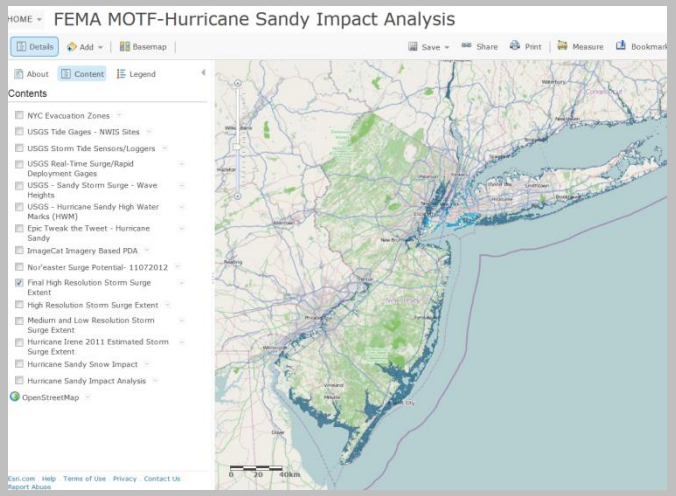
HOW LIKELY IS IT THAT AN INUNDATED HOME WAS LOCATED BEHIND A NOURISHED BEACH?

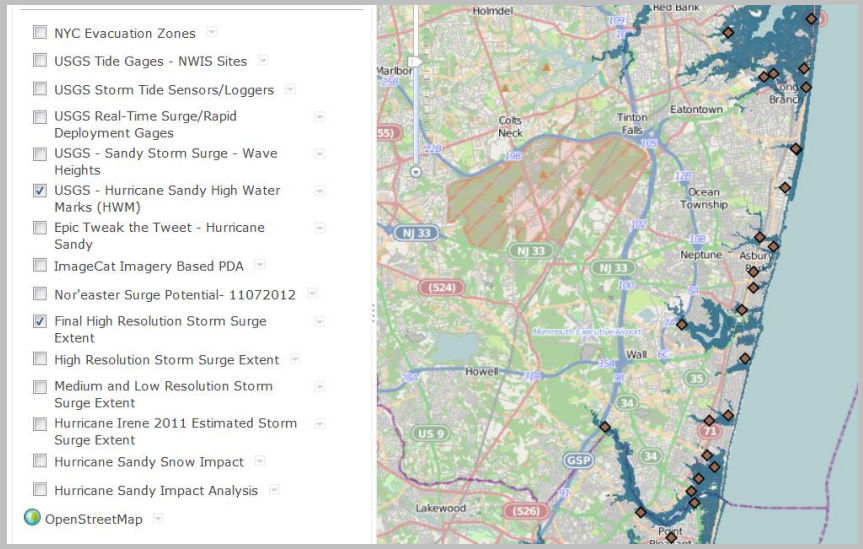
DATA SOURCES

Data Type	Data Source
NJ Coastline	NJ Dept. of GIS
Damage	FEMA-MOTF v 28
Inundation	FEMA/USGS
Beach width	Richard Stockton College
Dune height	ACOE Pre-Sandy LiDAR (2010)
Nourishment	PSDS
Elevation	ACOE Pre-Sandy LiDAR (2010)

DATA: FEMA-MOTF

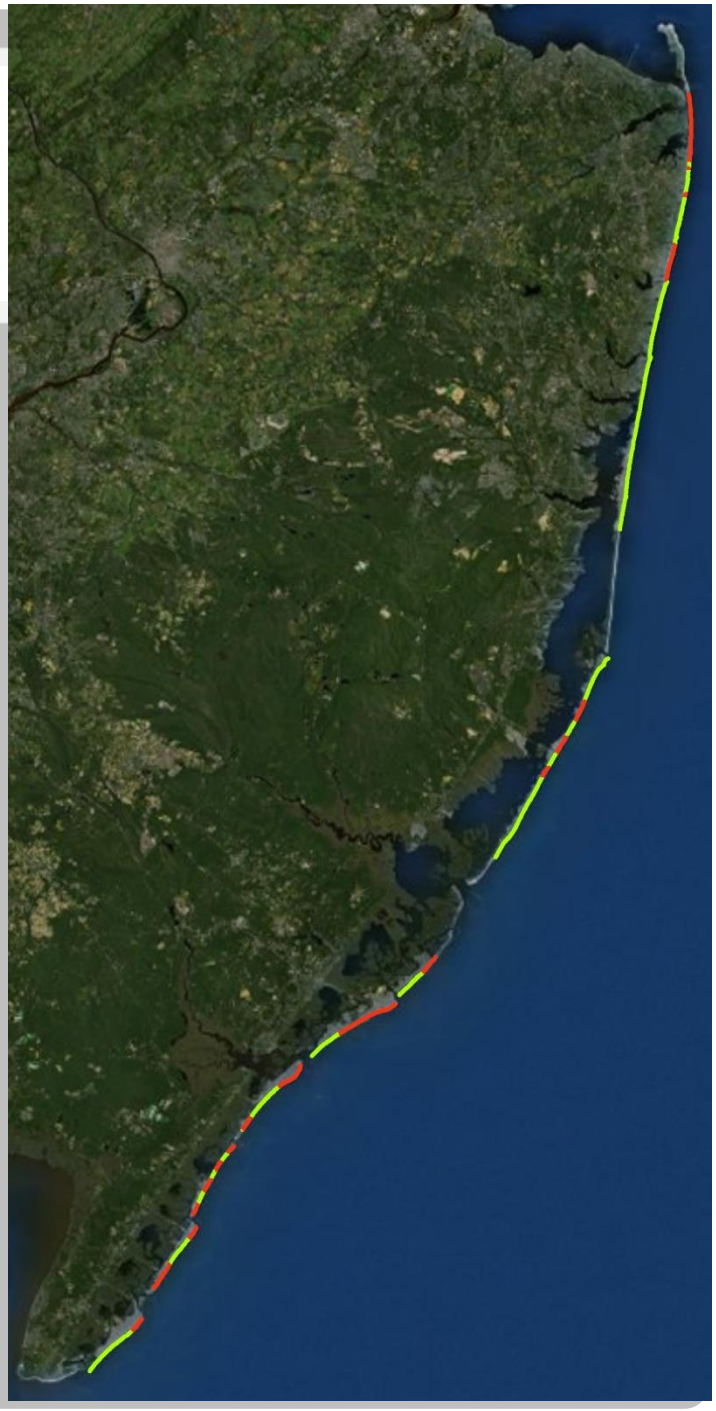
- Individual damages to homes based on remote sensed data (v 28)
  - Categories: Affected, major, minor, and destroyed
  - Some ground truthing
- Surge inundation levels based on models USGS/FEMA high water marks
  - Less than 1% error





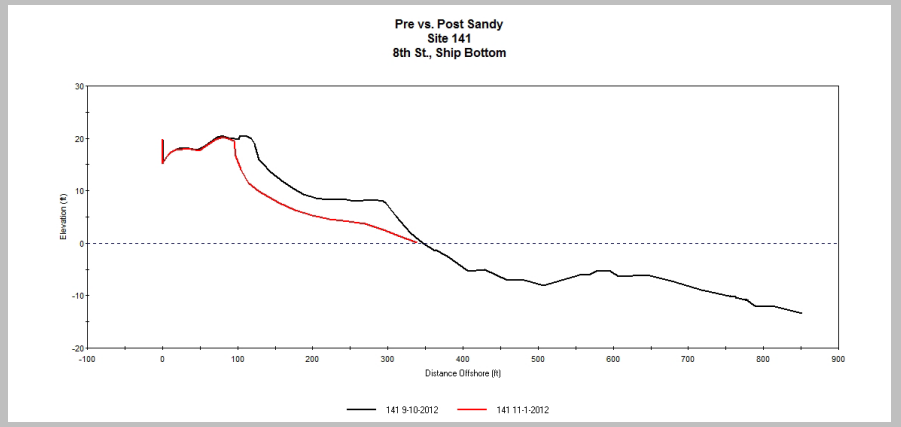
DATA: NOURISHMENT

- Program for the Study of Developed Shorelines dataset
- Only one of its kind



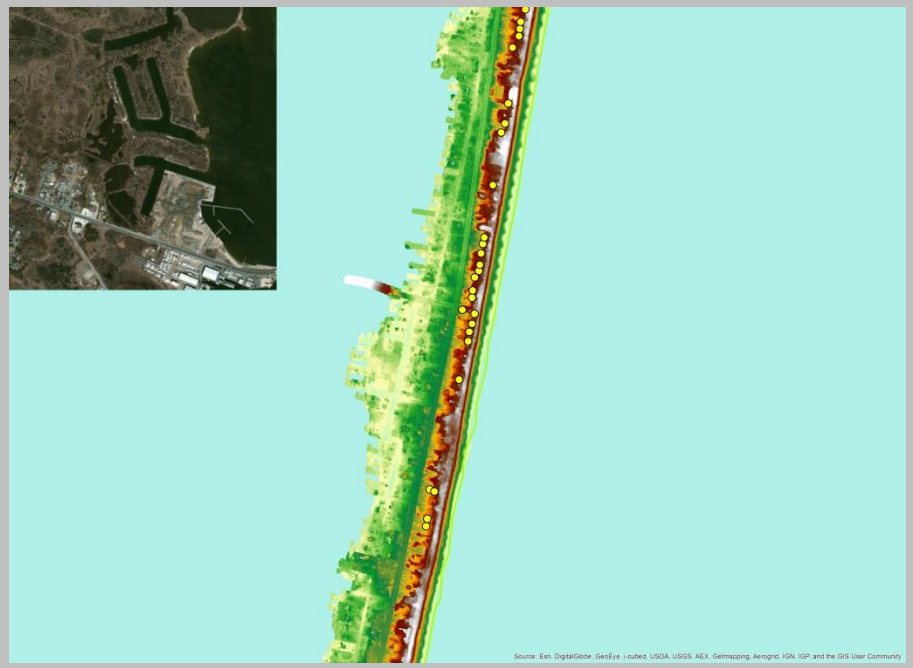
DATA: BEACH CHARACTERISTICS

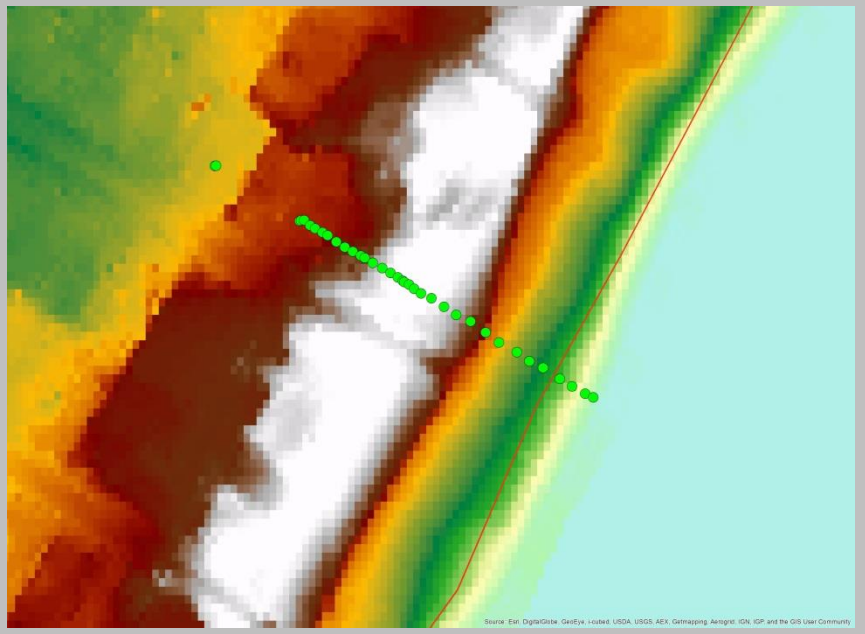
- Richard Stockton College Beach Profile Network
  - Pre and post storm high resolution beach profiles
  - Beach width
  - Dune height



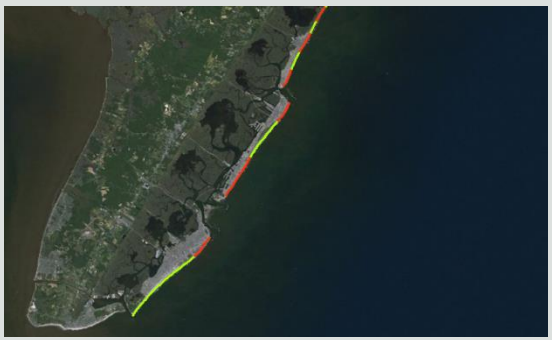
DATA: ELEVATION

- 2010 Army Corps of Engineers LiDAR based DEM





APPROACH

Action	Rationale	Image
Use damage from seaward most structure for coast of New Jersey	Seaward most structure most likely to benefit from nourishment	
Cut houses at inlets out of analyses	Inlet geomorphology too complex	
Use only beaches nourished since 2000 in analyses	Sand is transient and likely does not last 12 years in many places in NJ	

LIMITATIONS

- Front row of development
- Increased error in inundation model from sampling only front row structures
- Inundation based on model
- FEMA damage estimates lack resolution – Y or N "affected" carries same weight as "minor" carries same weight as "destroyed" home

DATA - OVERVIEW

First row method

	total	non-nourished	nourished
Affected		2125	1157
Destroyed		112	18
Major		62	53
Minor		144	117
	3788	2443	1345

- 18/130 = 14% of destroyed homes behind nourished beaches
- **Expected value = 37%**

1000 foot buffer

	total	non-nourished	nourished
Affected		8792	4500
Destroyed		354	21
Major		216	73
Minor		1872	528
	16356	11234	5122

21/375 = 5.6% of destroyed homes behind nourished beaches

LOGISTIC REGRESSION

- Dependent variables from FEMA-MOTF data:
  - Inundation – Y or N - 1% error, prior to sampling
  - Damage – Y or N - remote damage assessments with some ground truthing
  - Y = affected, minor, major, destroyed categories

- Independent variables:
  - Beach width, dune height, structure elevation, structure distance from MHW

RESULTS – INUNDATION AS DEPENDENT VARIABLE

Coefficients:					
	Estimate	Std.	Error	value	Pr(>|z|)
(Intercept)	4.077	0.179	22.749	2.00E-16	***
Beach Width	-0.003	0.000	-8.448	2.00E-16	***
Structure Elevation	-0.020	0.010	-2.124	0.0336	*
Structure Distance	-0.003	0.000	-21.799	2.00E-16	***
Nourished1	-0.436	0.081	-5.367	8.02E-08	***

- Intuition prevails!
- Homes behind nourished beaches were LESS likely to be inundated.
- Homes on wider beaches, higher ground, and far from coast were also LESS likely to be inundated.

RESULTS – DAMAGE AS DEPENDENT VARIABLE – DESTROYED AND MAJOR DAMAGE

Coefficients:					
Estimate	Std.	Error	z	value	Pr(>|z|)
(Intercept)	4.170	0.448	9.309	2.00E-16	***
BeachWidth	-0.012	0.001	-9.546	2.00E-16	***
StructureE	-0.071	0.019	-3.757	0.000172	***
StructDist	-0.004	0.000	-8.001	1.24E-15	***
Nourished1	-1.608	0.210	-7.645	2.09E-14	***

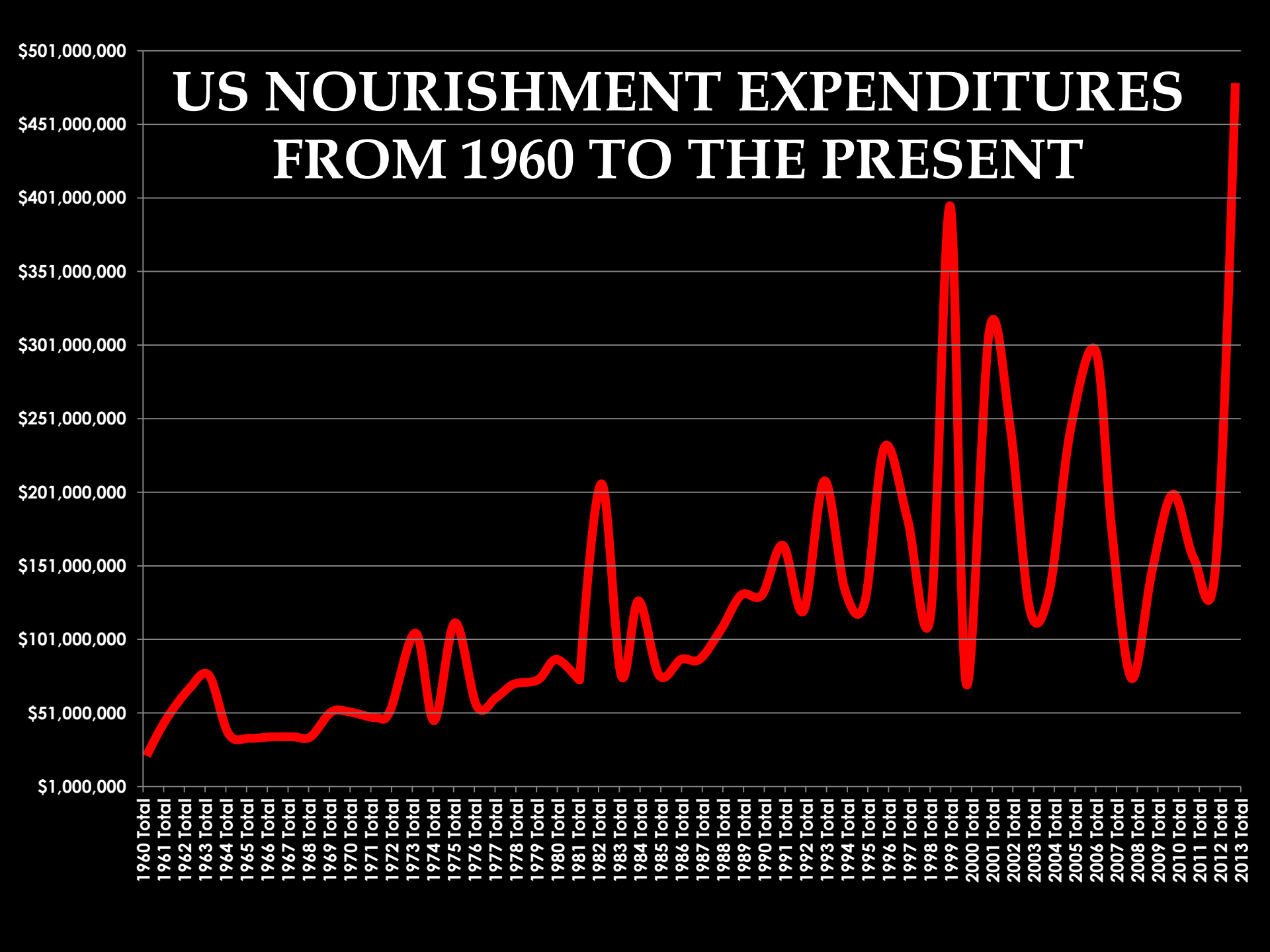
- Intuition prevails again!
- Homes on the front row were MORE likely to be damaged IF they were at a LOWER elevation.
- Nourishment highly correlated with damage field.

NEXT STEPS

- Power analysis
  - n~5000
- Analyze New York (Long Island) data the same way

- So what?
  - Like all models, these numbers should be approached with caution, BUT I think the results are real.
  - Engineer the entire coast of NJ?*

***Although we are not promoting beach nourishment as a solution to beach erosion/storm damage reduction…**


US NOURISHMENT EXPENDITURES FROM 1960 TO THE PRESENT
$501,000,000
$451,000,000
$401,000,000
$351,000,000
$301,000,000
$251,000,000
$201,000,000
$151,000,000
$101,000,000
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