HAZUS 2014

7th Annual Conference

USC Dornsife
Spatial Sciences Institute

VALIDATING THE HAZUS COASTAL SURGE MODEL FOR SUPERSTORM SANDY

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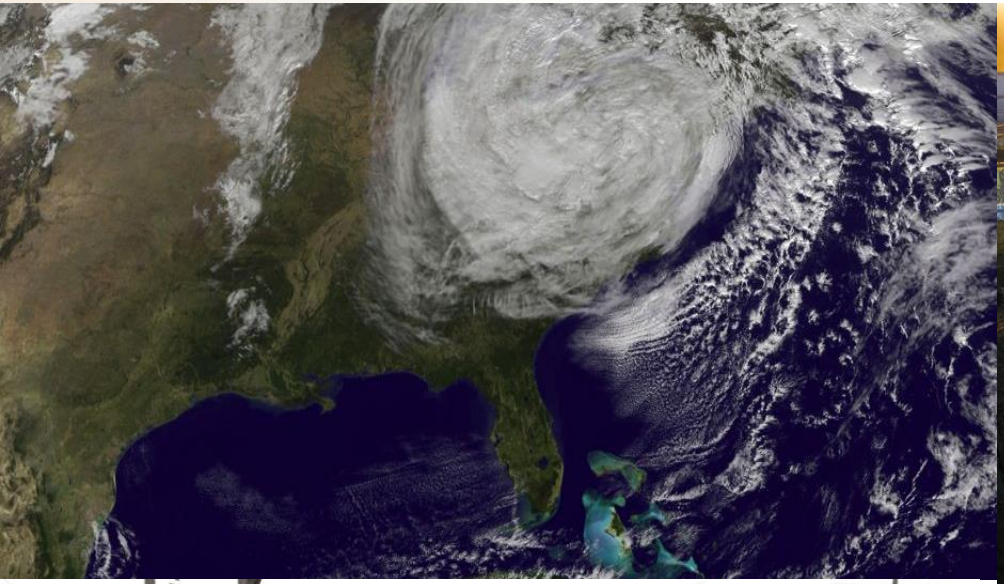
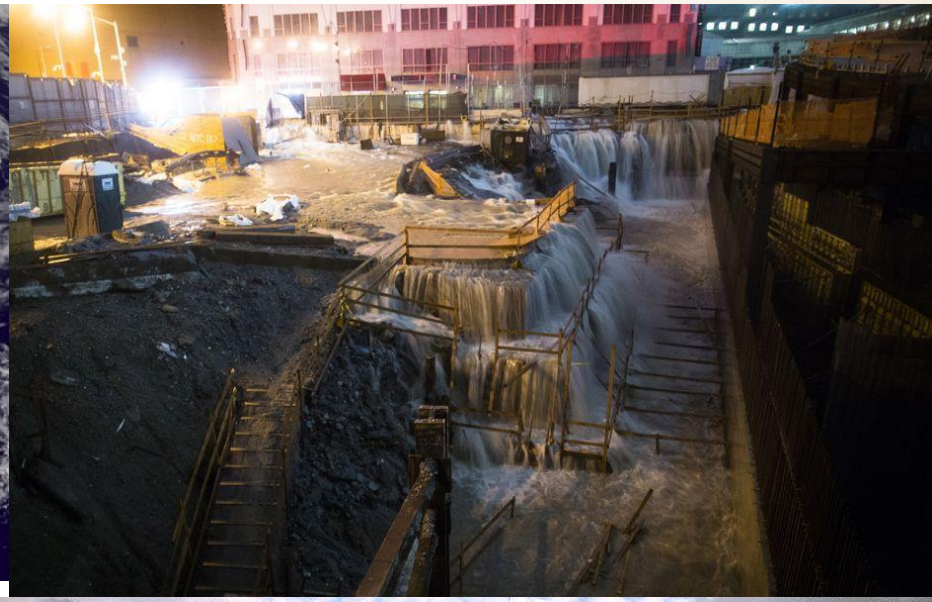
Superstorm Sandy, Oct’12



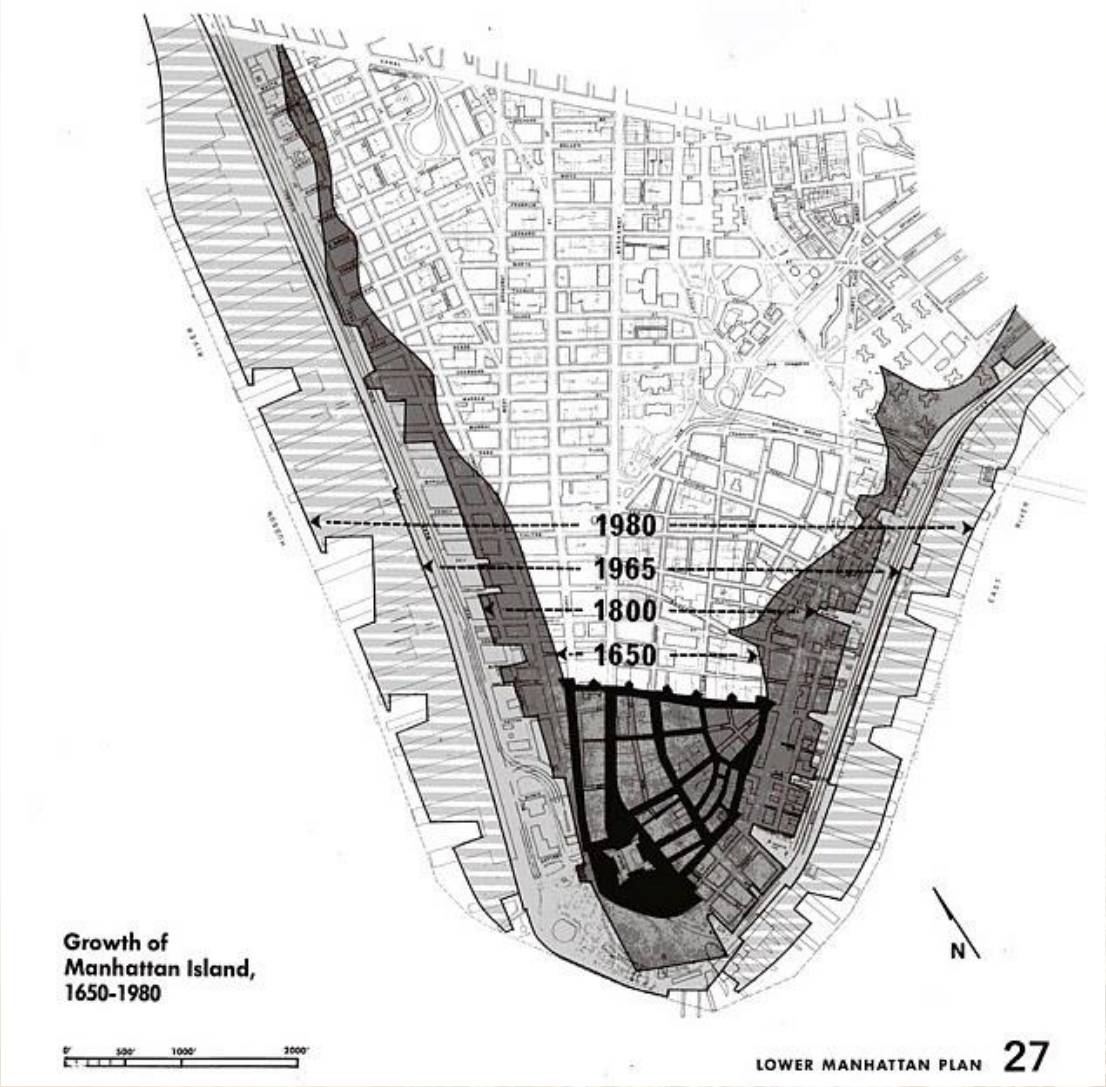


NYC Geography

Five Boroughs

- Manhattan, Brooklyn, Queens, Staten Island, and Bronx.

NYC Development, 400+ years



Quick Facts:
Lower Manhattan

40 ac West side fill

24 ac East side fill

1.2 M cuyd ex-WTC

400,000 residents

68,000 living on fill =flood plain

Courtesy:
www.lowermanhattan.info

NYC Airports

John F. Kennedy (JFK) International Airport

- 50+ million passengers annually, 19th busiest
- Located in basin SE of Brooklyn & Queens
- 2,598 flights canceled during Sandy

La Guardia (LGA) Airport

- 27 million passengers annually
- Located in Northern Queen, built out into bay
- 3,667 flights canceled

Introduction

Major Hurricane flooding along Eastern seaboard

- Katrina (2005)
- Irene (2011)
- Sandy (2012)

Storm Surge is major factor; can be ~predicted

- SLOSH (NOAA) Statistical
- HAZUS (FEMA) Dynamic Modeling

  - Coastal Surge Model (CSM)

Sandy Storm Surge actually measured

- FEMA Modeling Task Force (MOTF)

NOAA SLOSH

Sea, Lake & Overland Surges from Hurricanes

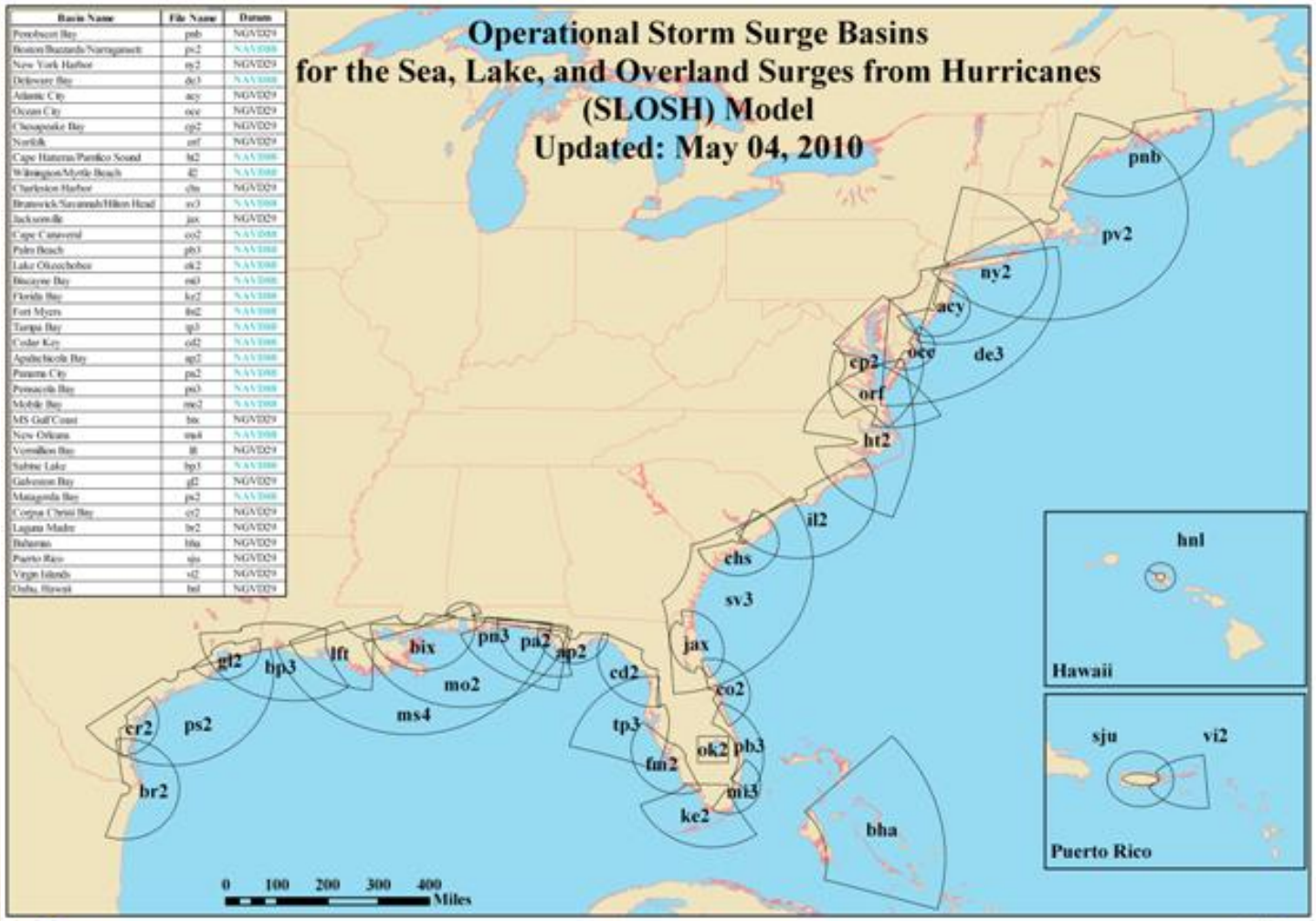
- Fundamentally, a statistical approach
- Historical and hypothetical scenarios
- Refined for 27 basins along Eastern seaboard
- Wind field model creates coastal surge
- Grid presentation – finer near center, coarser outer
  - ~500 x 500m to 1 x 1km

NOAA SLOSH

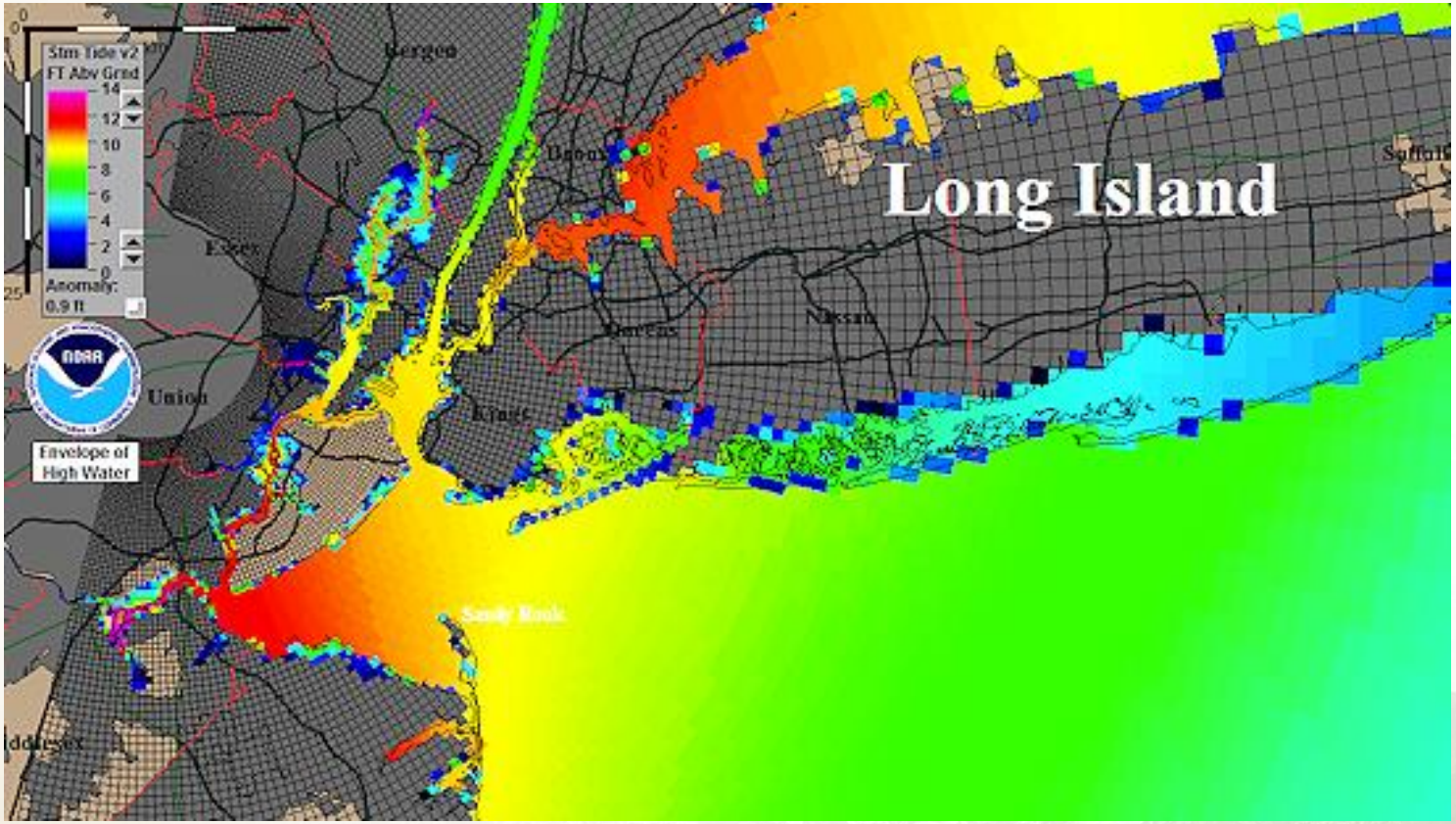
Basin name:

New York Harbor

- ny2
- ny3 (new)



NOAA SLOSH



SLOSH simulation of the storm tide for Hurricane Sandy

FEMA/HAZUS

Three basic hazard types

1. Earthquake
2. Hurricane
3. Flood

Plus…

4. Coastal Surge Model

- Dual-hazard: Hurricane (HU) and Flood (FL)

HAZUS Coastal Surge Model

1. Hurricane Model

Relies on Storm-track/winds (Hurrevac, NOAA)

Produces

A. Rain/wind damages
B. Storm Surge, with 3 options
   1 No Waves
   2 Near Shore
   3 Deep Water & Near Shore

which generates a depth-grid, relayed to

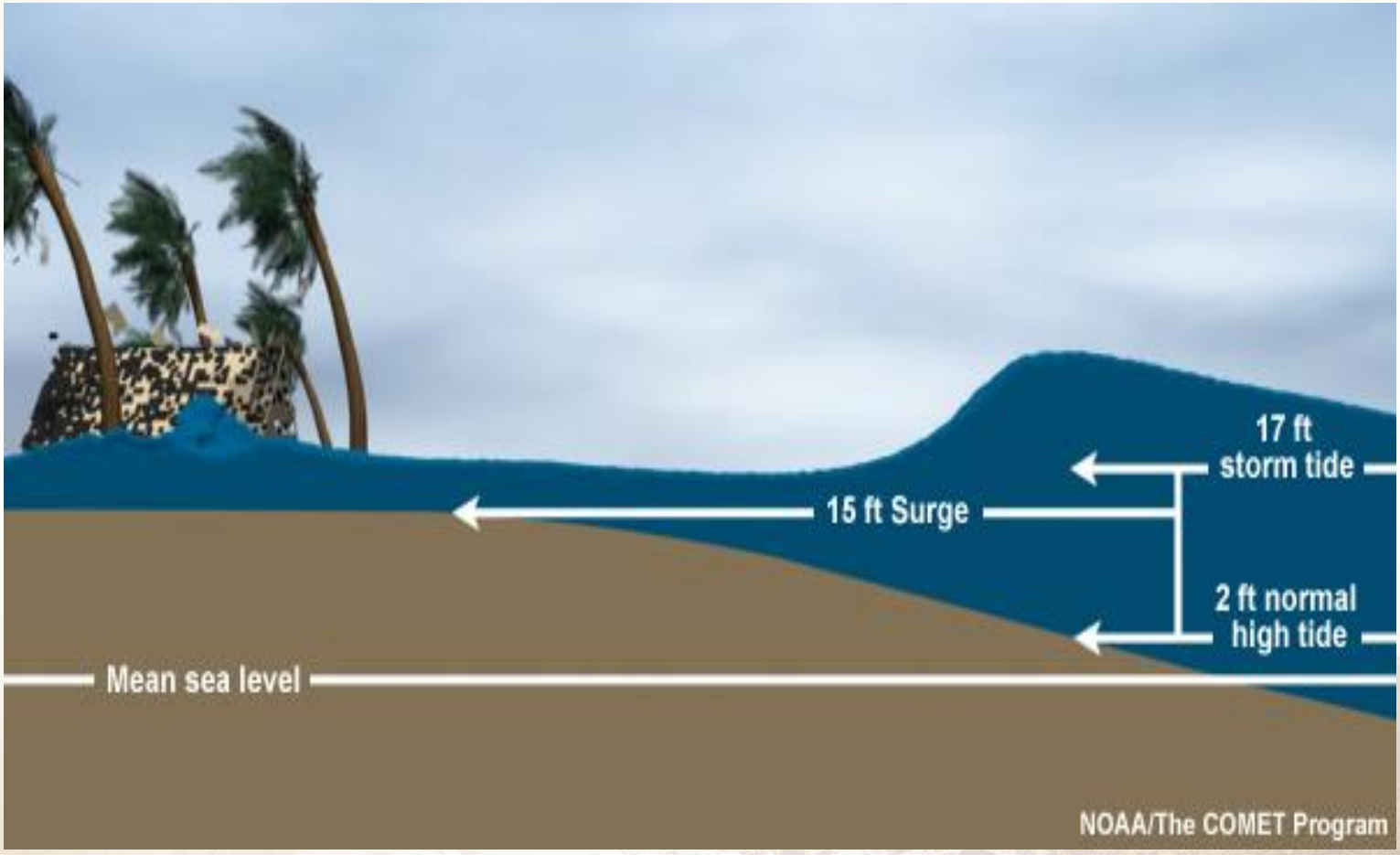
2. Flood Model

TU Delft SWAN

Simulating WAves Nearshore

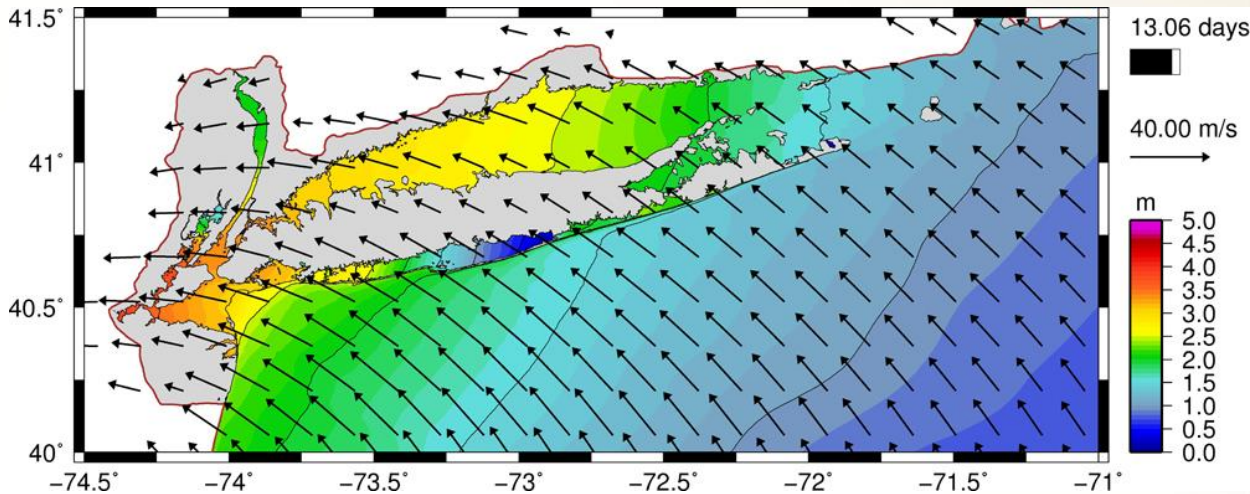
- Like HAZUS, a modeling approach
- Like SLOSH, based on storm-track / wind field
- Also focused on coastal regions and inland waters
- Models random, short-crested, wind-generated waves which “pile up” on top of tidal surge

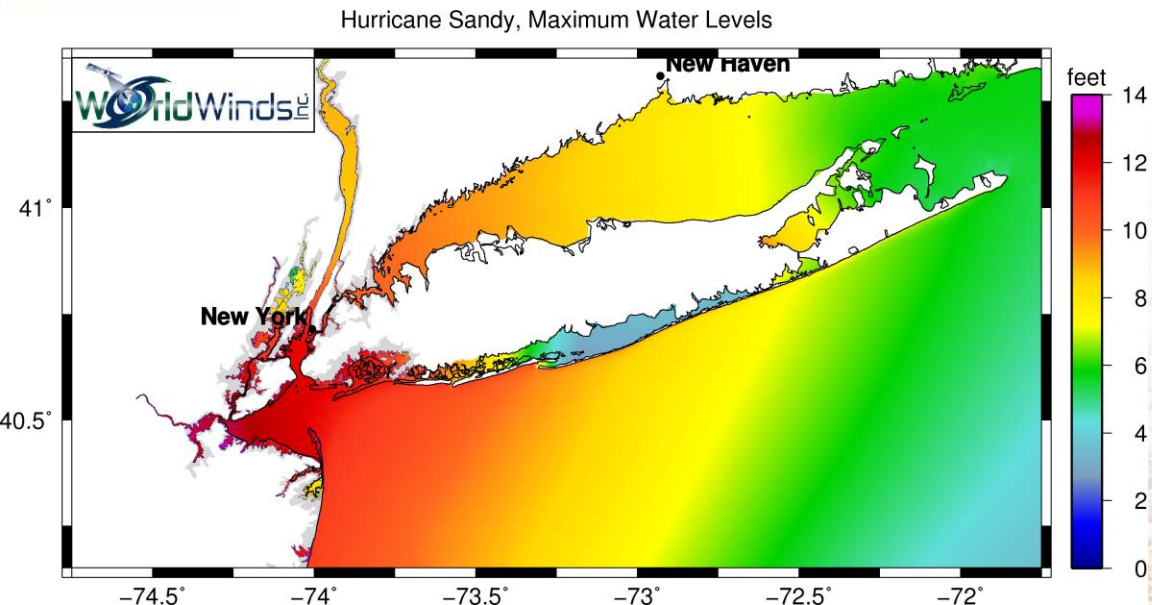
Storm Surge


17 ft
storm tide
15 ft Surge
2 ft normal
high tide
Mean sea level
NOAA/The COMET Program

TUDelft SWAN

Development of a Wave and Circulation Model





Hurricane Sandy Impact Analysis (HSIA)

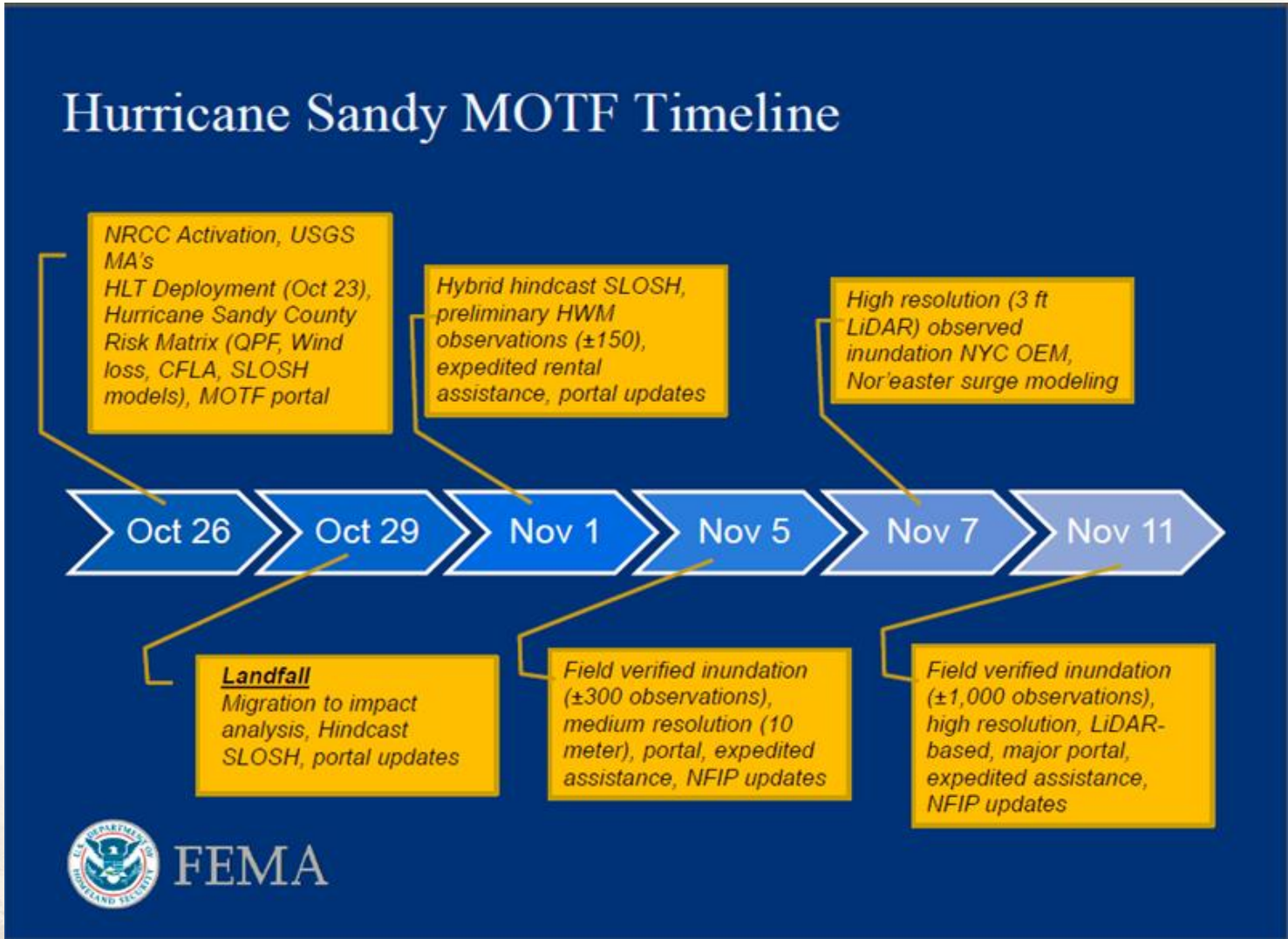
Ground-truth in this case!

FEMA Modeling Task Force (MOTF)

- USGS field-verified HWMs
- Sensor data
- LIDAR

Interpolated Depth Grid

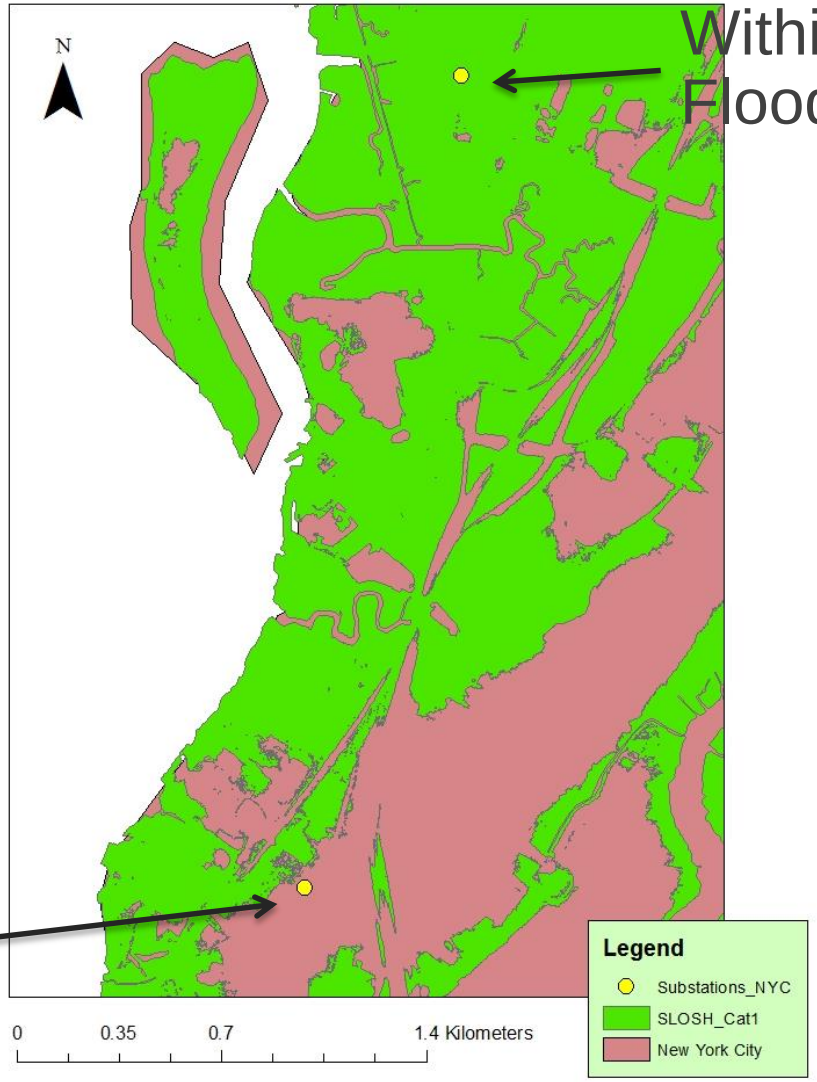
- Inverse Distance Weighted (IDW)



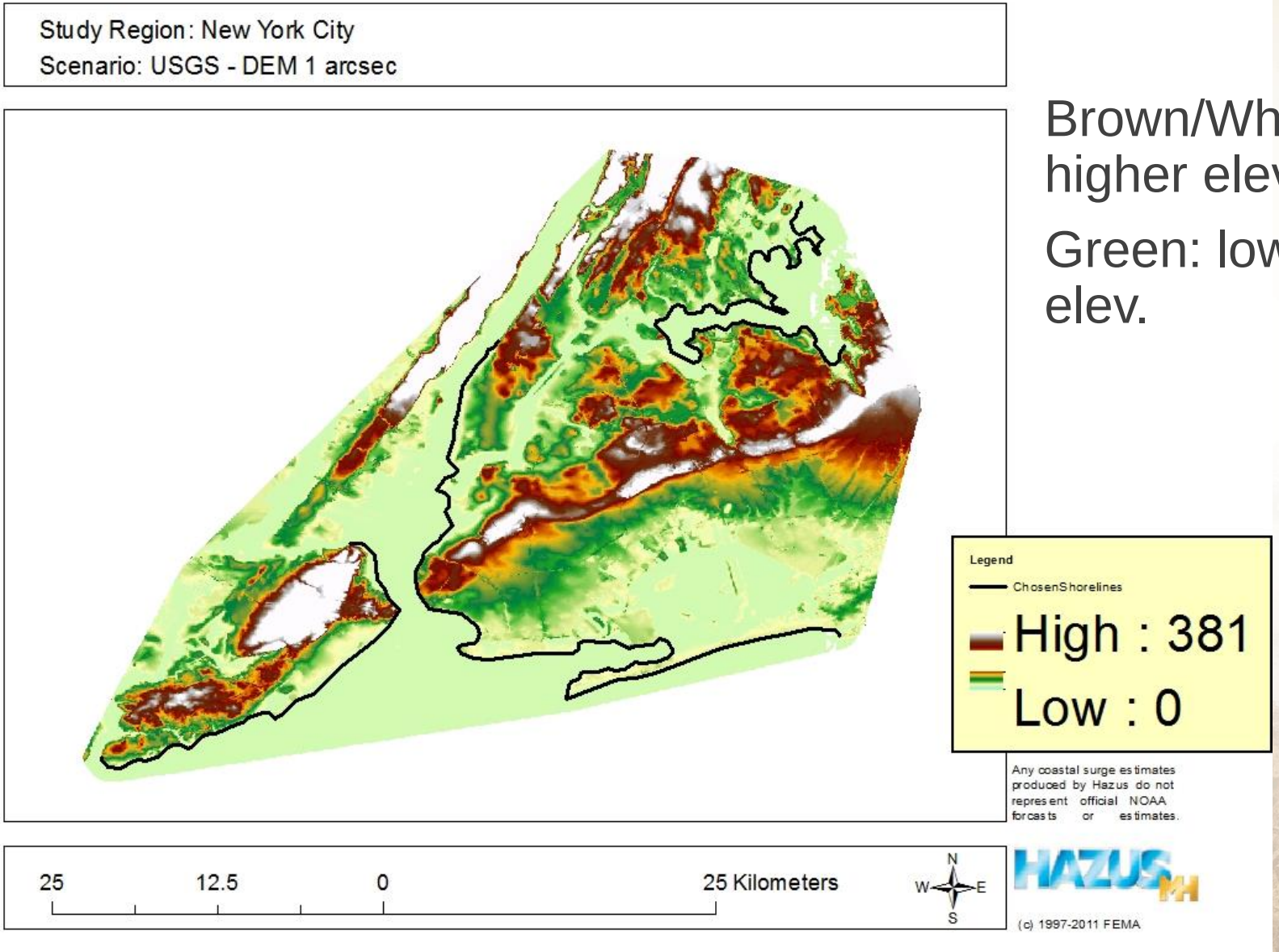
Con Ed Facilities

More ground-truth.

Method	S/S Count
Con Ed Count	11
FEMA MOTF (observed)	9
SLOSH	10



Runs



Brown/White: higher elev.

Green: lower elev.

Hazus Runs

Whole NYC - No Waves (HU/CSM)

- 1 arcsec DEM (30 meter)
- 1/3 arcsec DEM (10 meter)

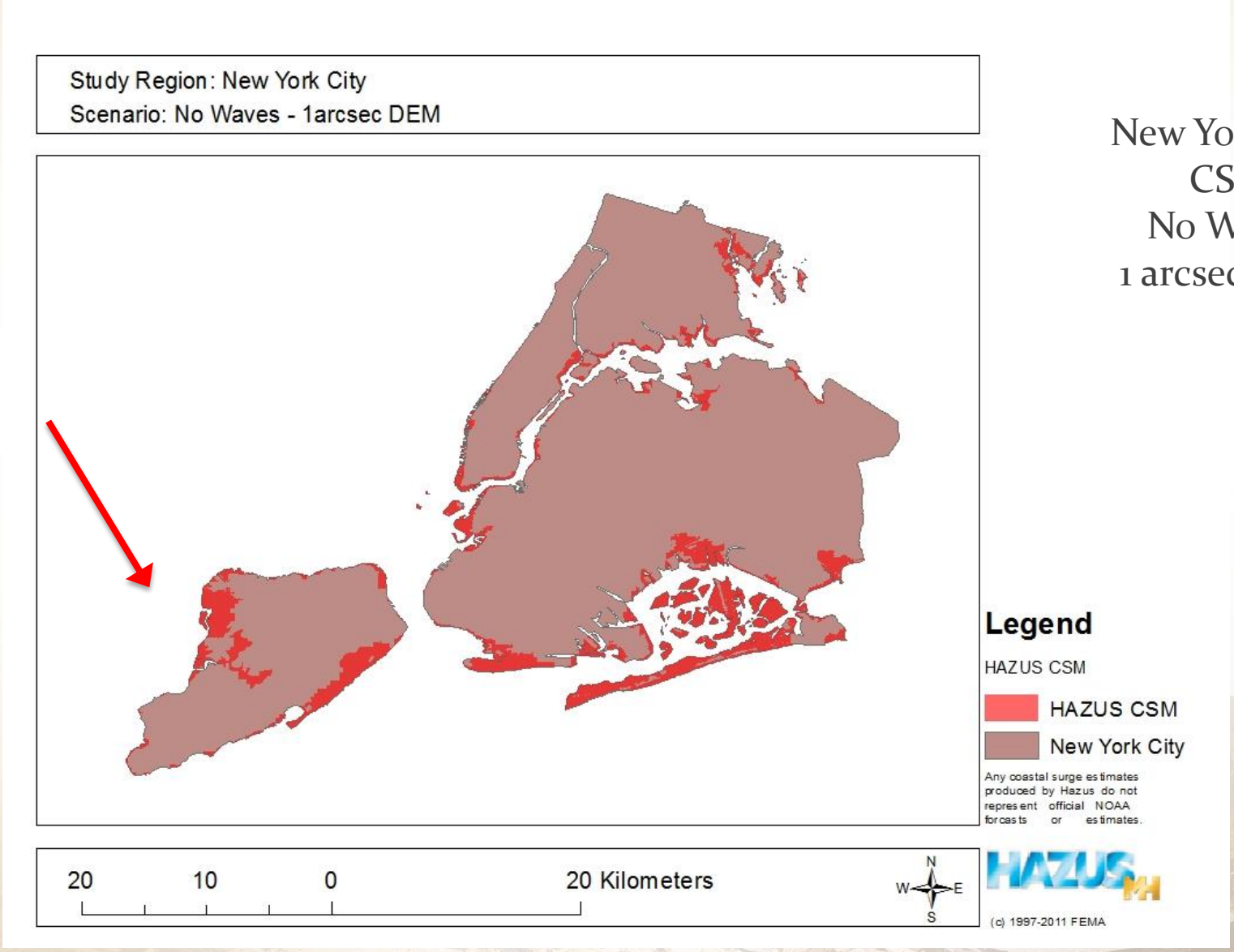
Five Boroughs Individually - With Waves

- 1/3 arcsec DEM - Near Shore
- 1/3 arcsec DEM - Deep Water & Near Shore

FEMA MOTF Depth Grid

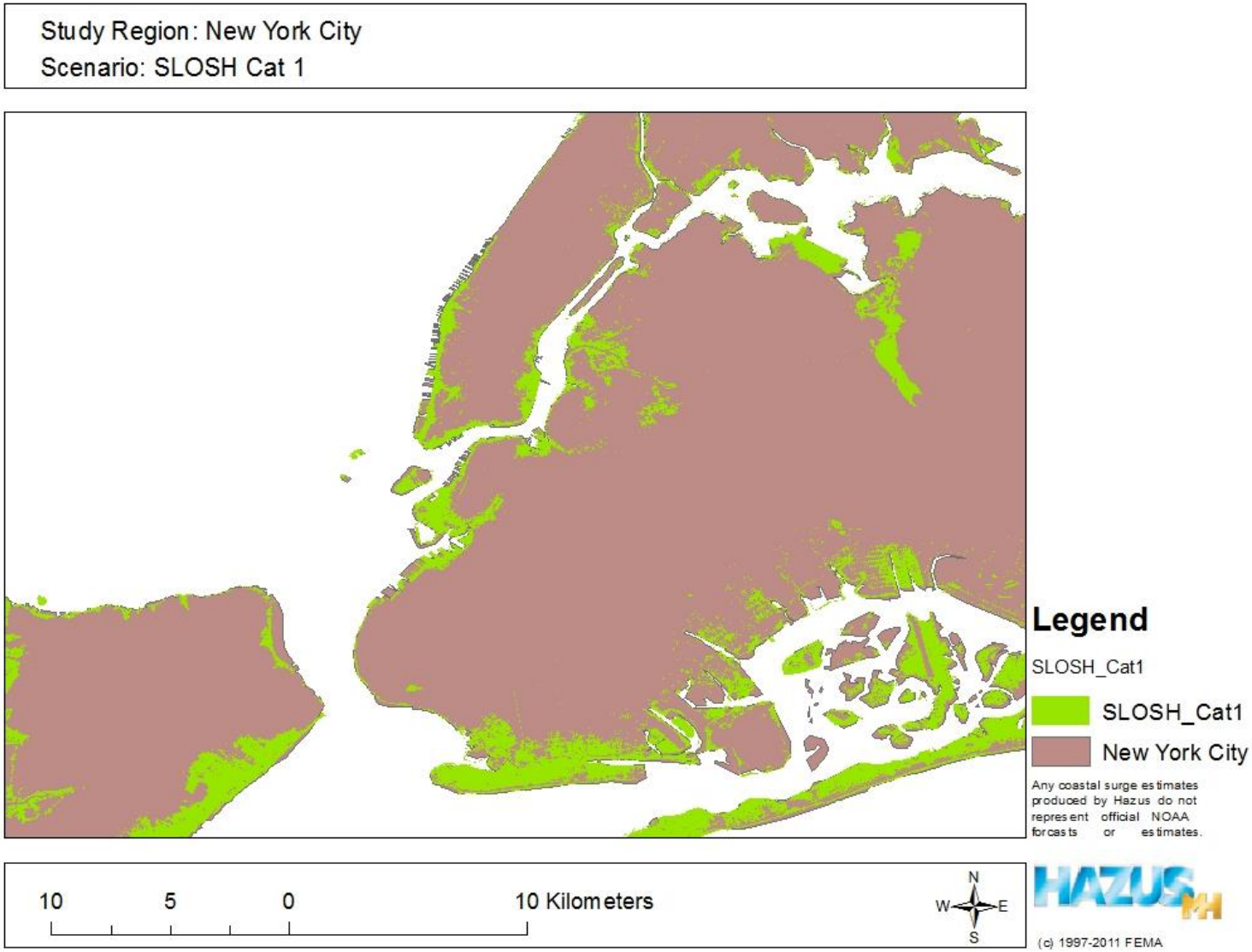
- Coastal Only scenario
  - GBS Analysis

Results



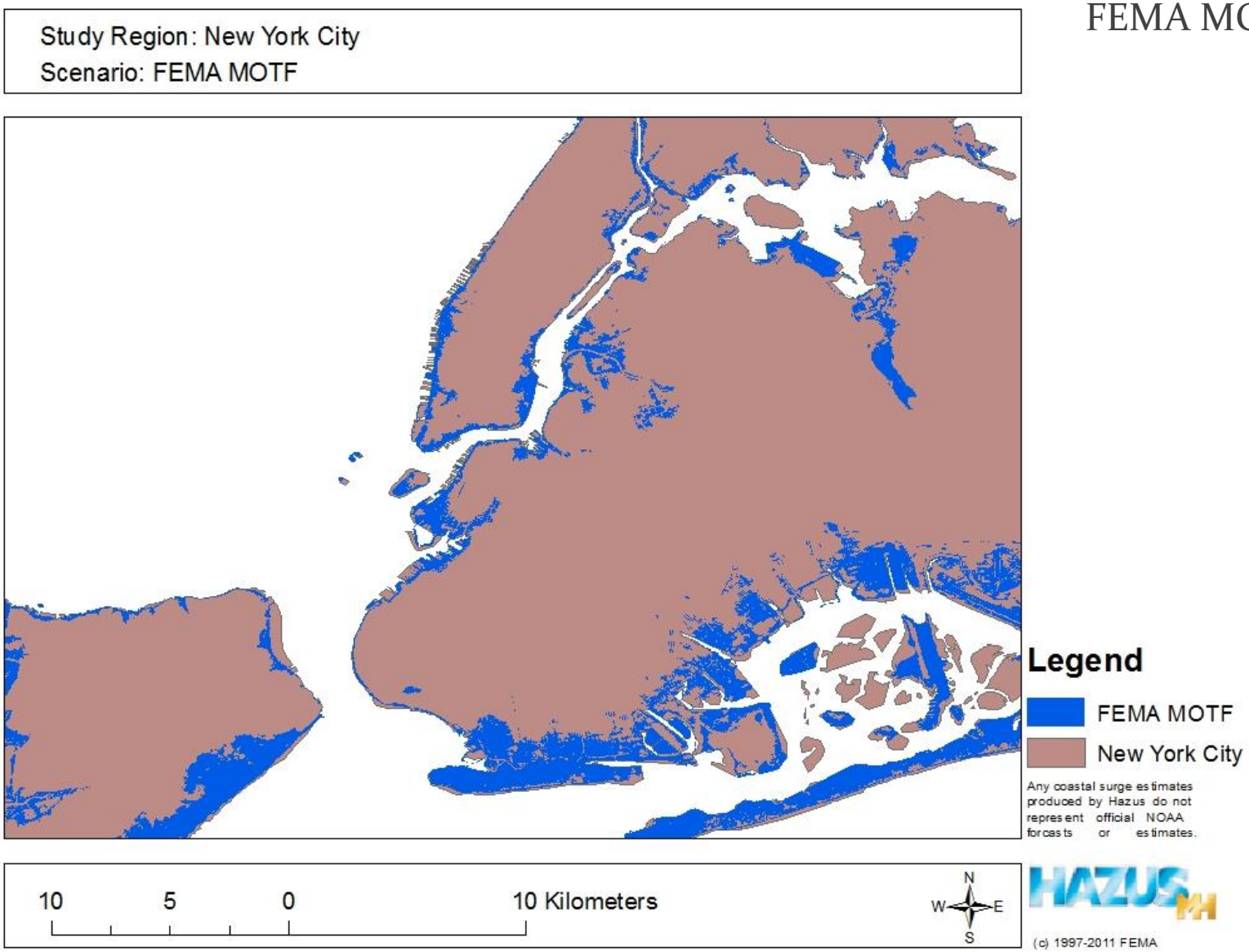
New York City
CSM
No Waves
1 arcsec DEM

Results


Study Region: New York City
Scenario: SLOSH Cat 1
Legend
SLOSH_Cat1
SLOSH_Cat1
New York City
Any coastal surge estimates produced by Hazus do not represent official NOAA forcasts or estimates.
10 5 0 10 Kilometers
N
W
E
S
HAZUS MH
(c) 1997-2011 FEMA

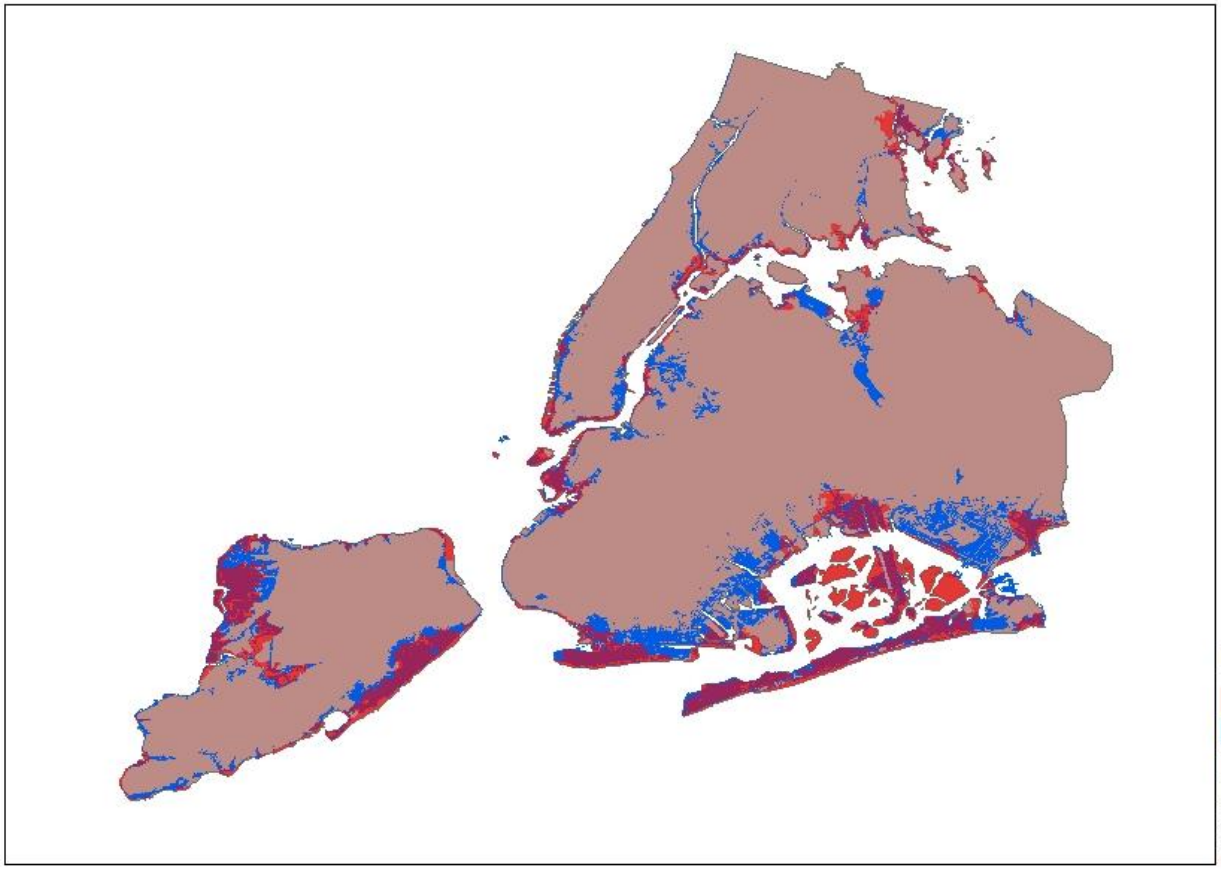
Results

New York City
FEMA MOTF



Results

Study Region: New York City
Scenario: No Waves with 1/3 arcsec DEM



New York City
CSM
No waves &
FEMA MOTF

Legend

- HAZUS CSM
- FEMA MOTF
- Study Region Boundary

Any coastal surge estimates produced by Hazus do not represent official NOAA forcasts or estimates.

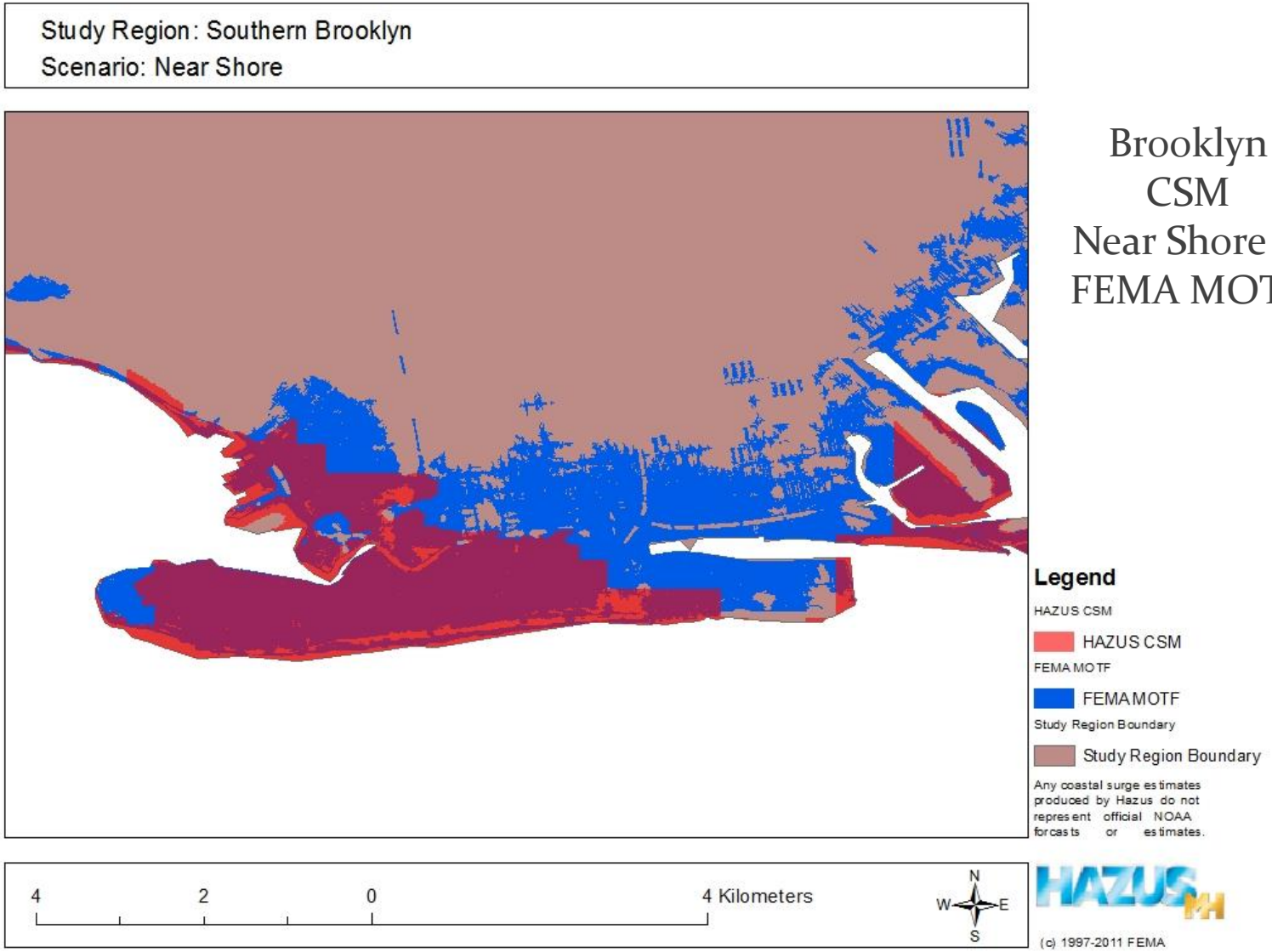
25 12.5 0 25 Kilometers

N W E S

HAZUS MH

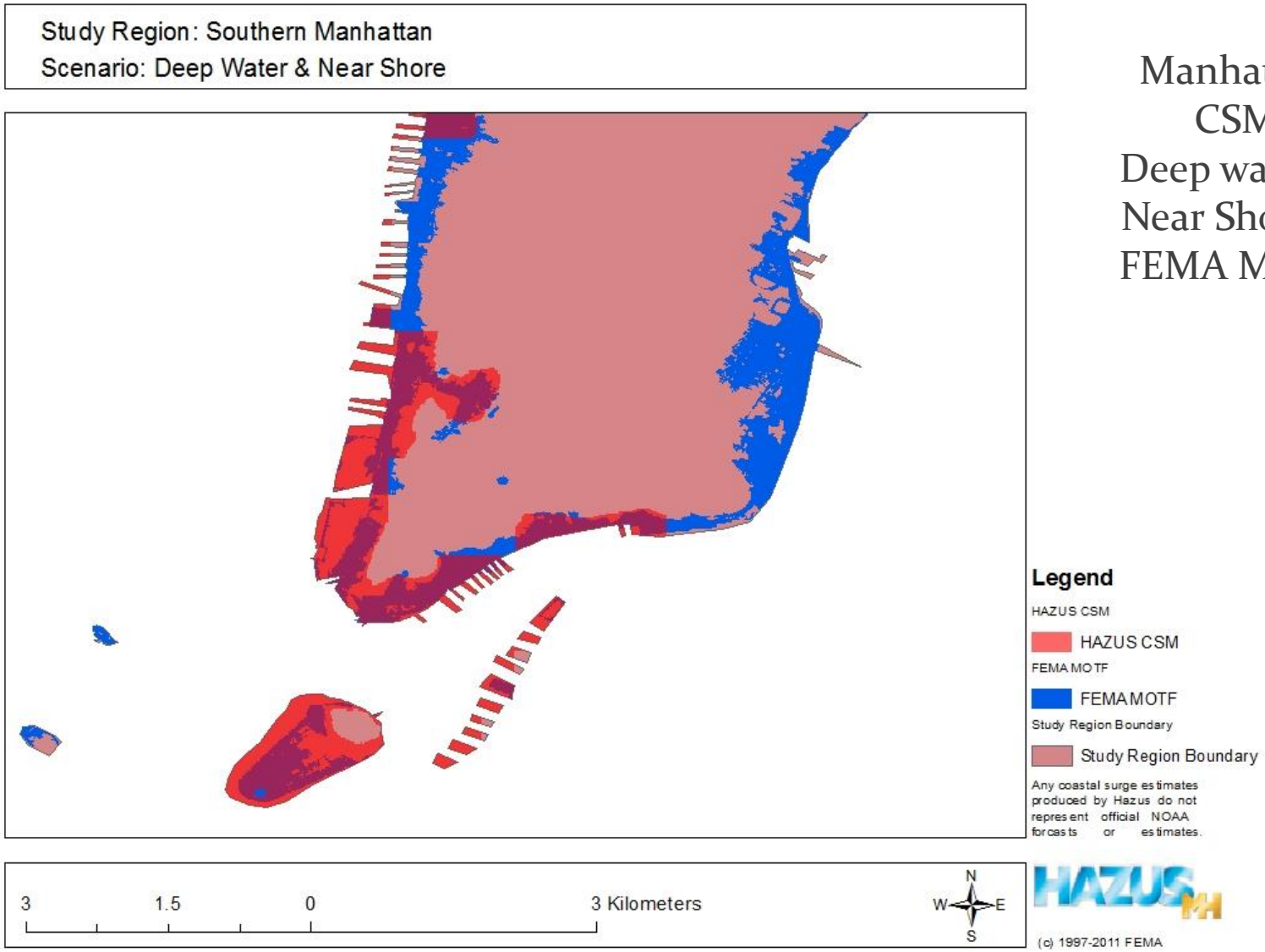
(c) 1997-2011 FEMA

Results



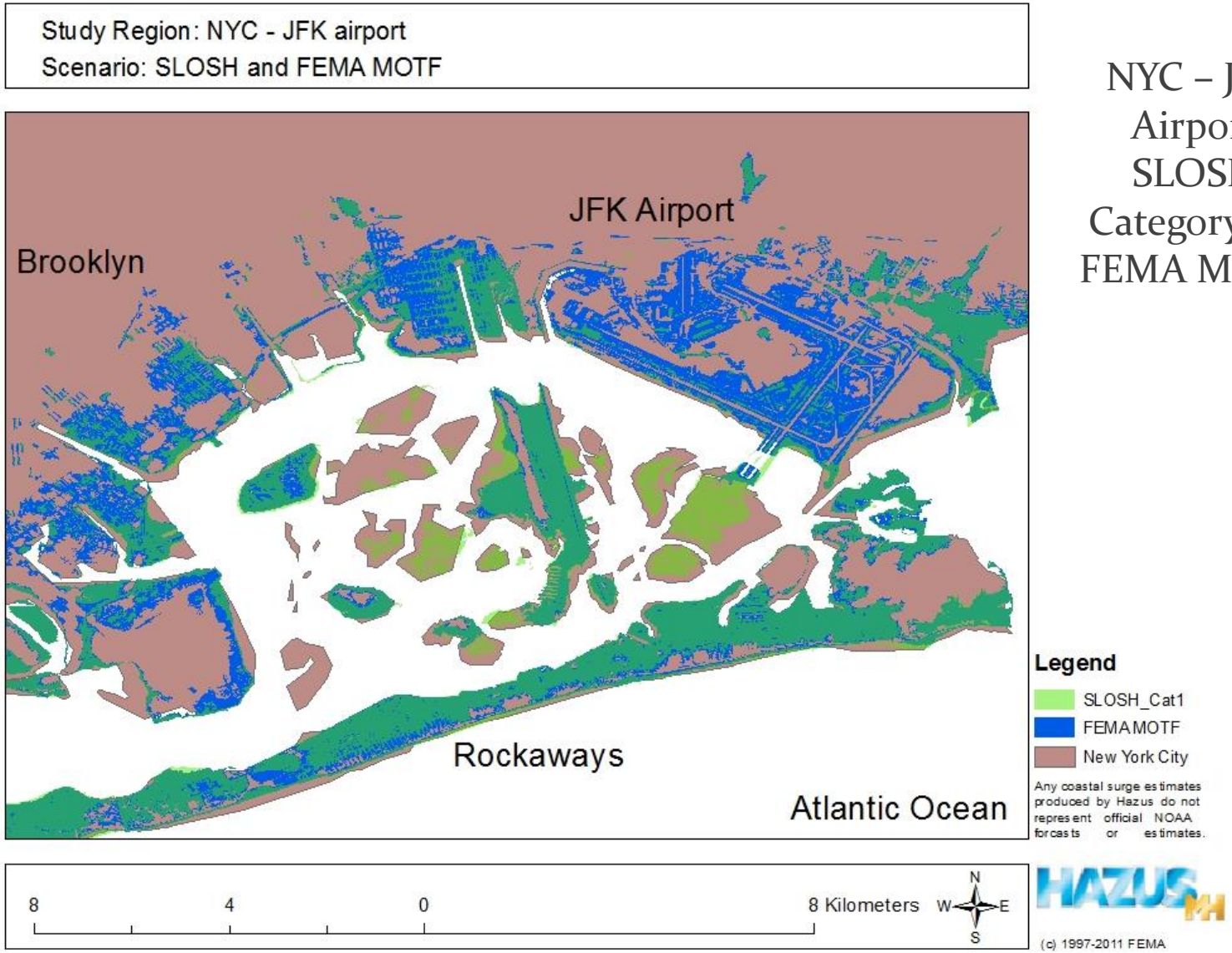
Brooklyn
CSM
Near Shore &
FEMA MOTF

Results



Manhattan
CSM
Deep water &
Near Shore &
FEMA MOTF

Results



NYC – JFK Airport SLOSH Category 1 & FEMA MOTF

Results

Area Shape Matters

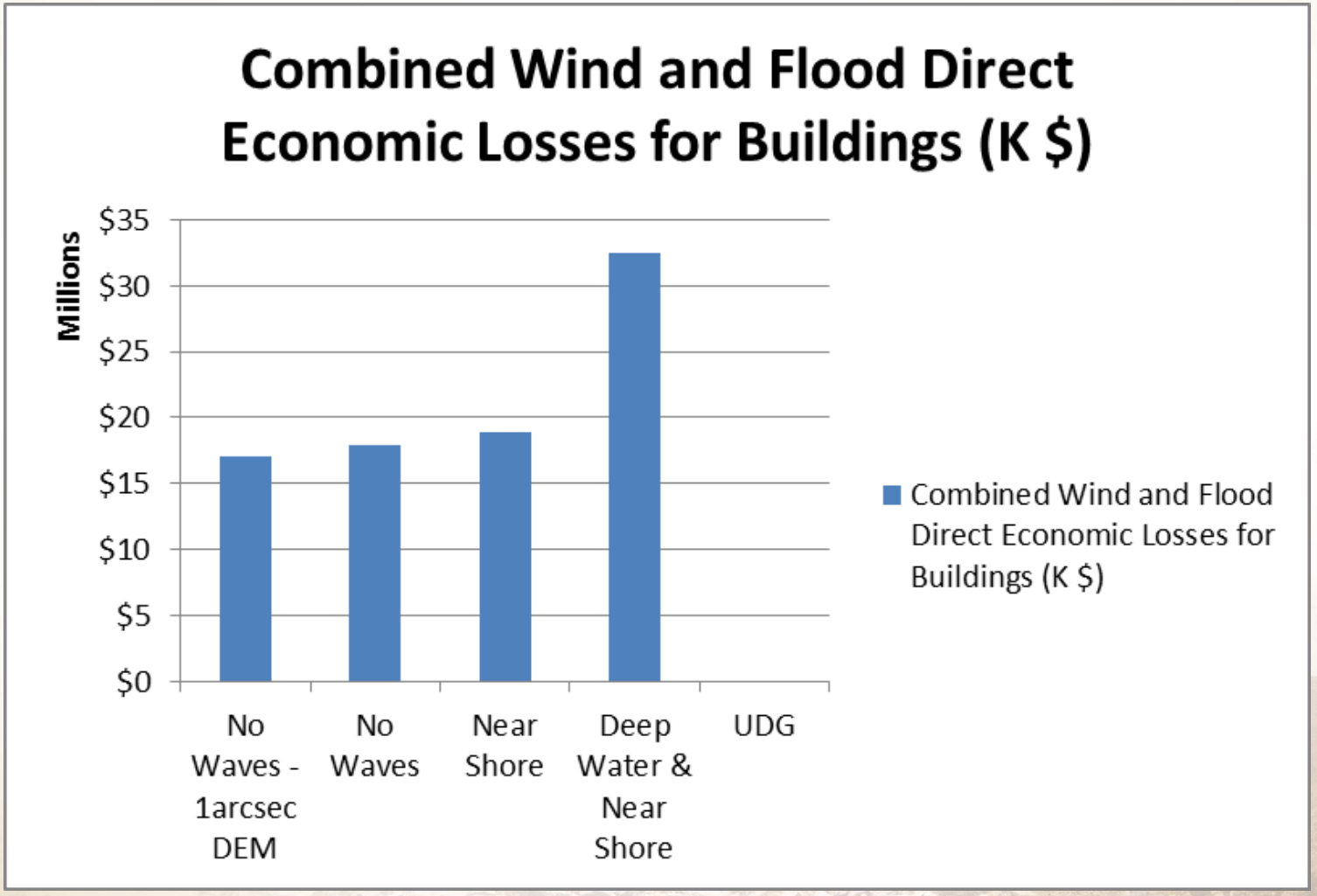
Calculations

- FEMA MOTF
- HAZUS Results
- SLOSH Cat 1

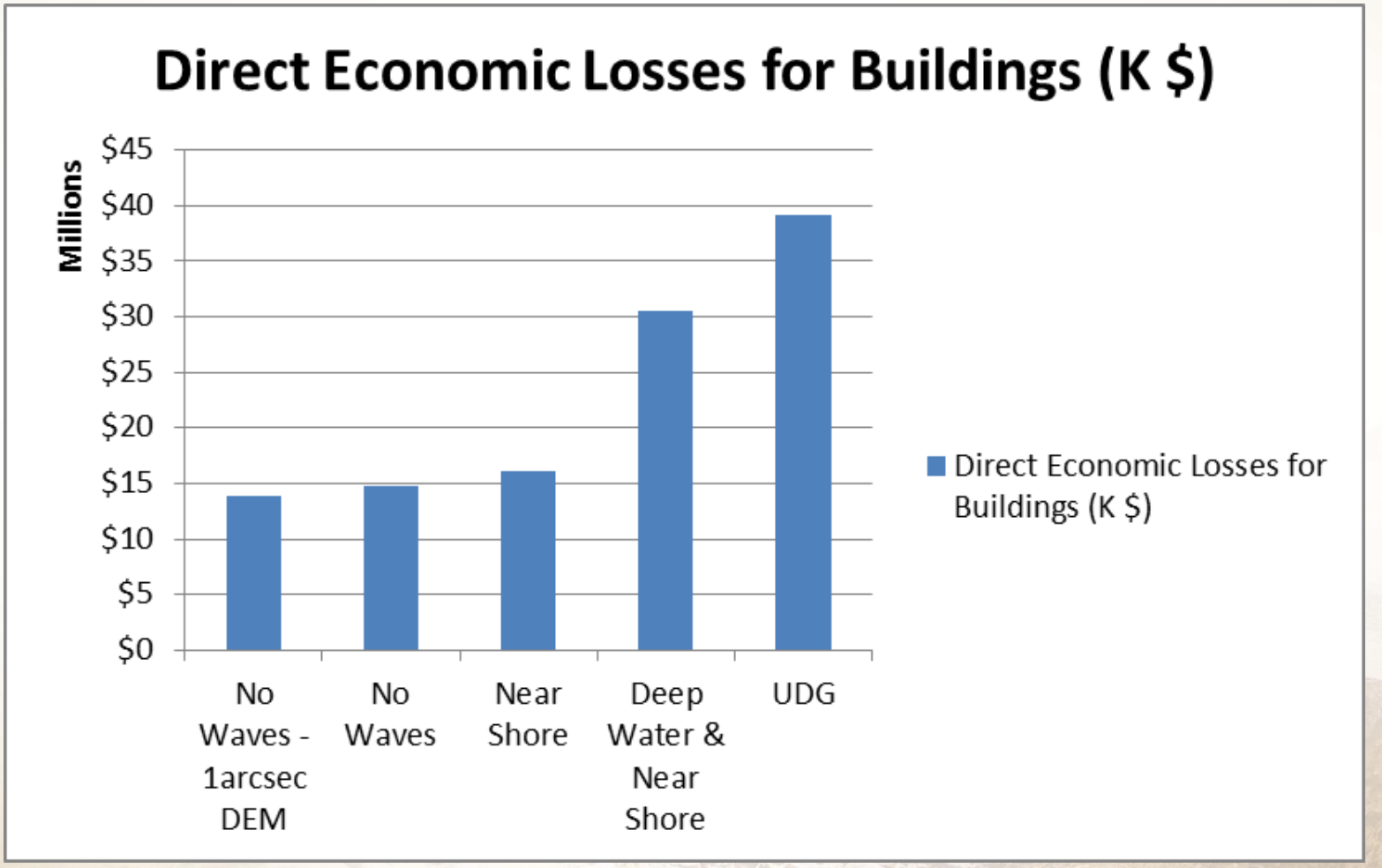
In thousands sq. ft.		
CSM - No Waves	**NYC (1arcsec)**	**NYC (1/3 arcsec)**
FEMA MOTF Area	**1,308**	**1,308**
CSM_area	**1,029**	**1,029**
Difference	**278**	**279**
Diff. Area %	**21.3%**	**21.3%**
Area CSM did not Pred.	**630**	**687**
Diff. did not Pred. %	**61.2%**	**66.7%**

In thousands sq. ft.		
CSM	**NYC (Near Shore)**	**NYC (Deep Water & NS)**
FEMA MOTF Area	**1307.6**	**1307.6**
CSM_area	**990.8**	**1474.6**
Difference	**245.4**	**-176.7**
Diff. Area %	**24.2%**	**-12.77%**
Area CSM did not Pred.	**625.2**	**364.5**
Diff. did not Pred. %	**63.1%**	**24.72%**

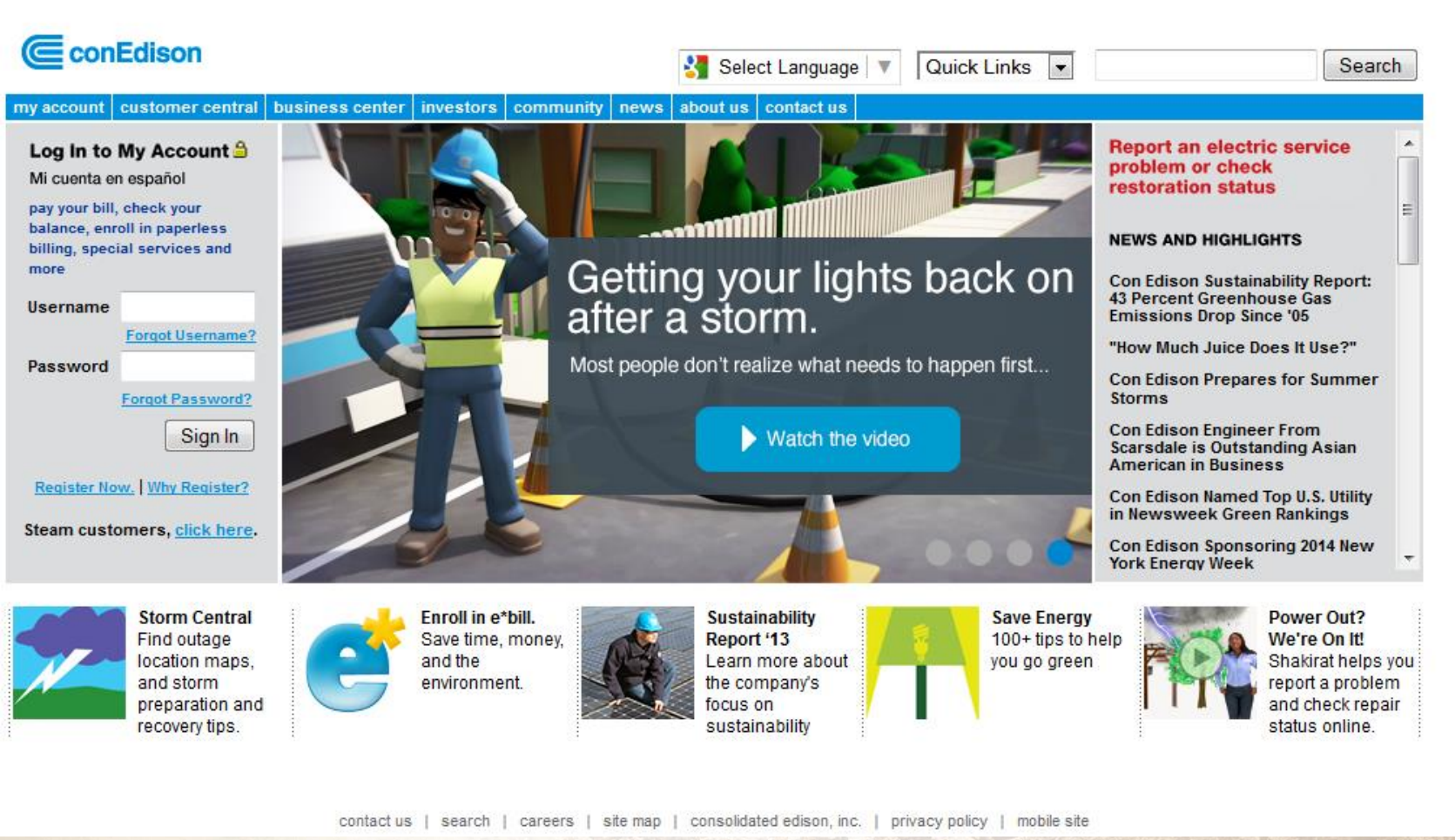
Results - *GBS analysis*



Results – *GBS analysis*



Con Edison, July'14, still …



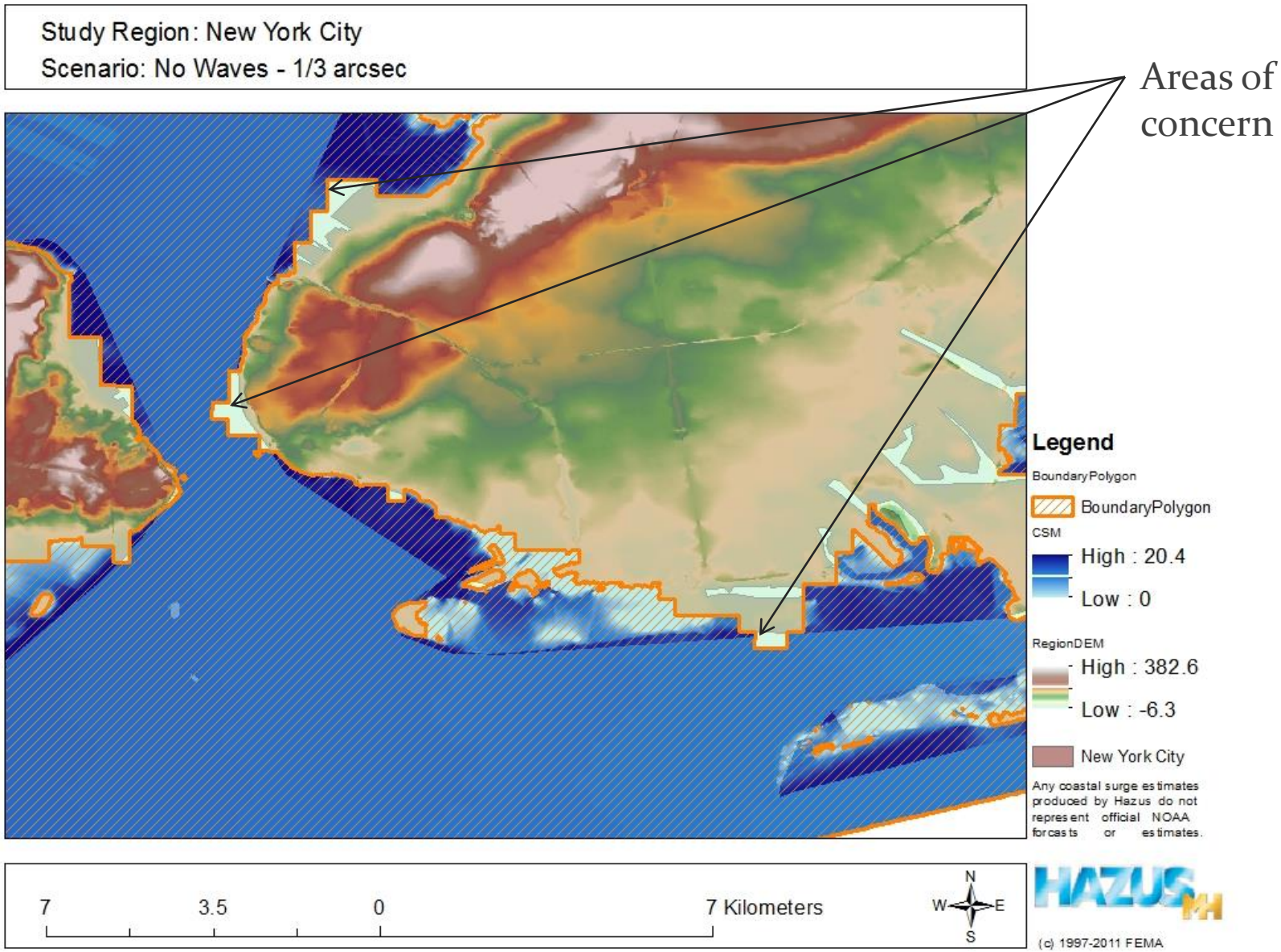
Results
Con Ed Facilities

Method	S/S Count
Con Ed Count	11
FEMA MOTF (observed)	9
SLOSH	10
HAZUS CSM	
No waves (1 arcsec DEM)	6
No waves (1/3 arcsec DEM)	6
Near Shore	5
Deep water & Near shore	5

Within

Outside

Conclusions



Conclusions

CSM ***under***-predicts

- Seems a general problem
- Many flood inundation gaps
- Also not robust to large datasets

Conclusions

SLOSH also inadequate

- Also under-predicts (but less than CSM)
  - Sandy was only Category 1 storm, at landfall
  - Winds and tides made it a “perfect storm” nonetheless
- Does not take into account duration
  - Airports, hence commerce, recovery shut-down ~week
  - Many Long Island homes were affected for 3+ months
  - Standing water and no power is dreadful combo

Future Work

- CSM inundation gaps
- Updated SLOSH model
- Re-run 2011 Census data
  - Sandy 2012

Thank You!

Questions

Contact

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