

ASCE Met Section Infrastructure Group Seminar

March 30-31, 2009

Vulnerability & Potential Losses in NYC from Coastal Flooding

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Overview

- OEM and the Hazard Mitigation Plan
- What is HAZUS-MH?
 - Model overview
 - General Building Stock
 - Damage functions
- Results of 100-year floodplain modeling
- Looking forward...

NYC Office of Emergency Management

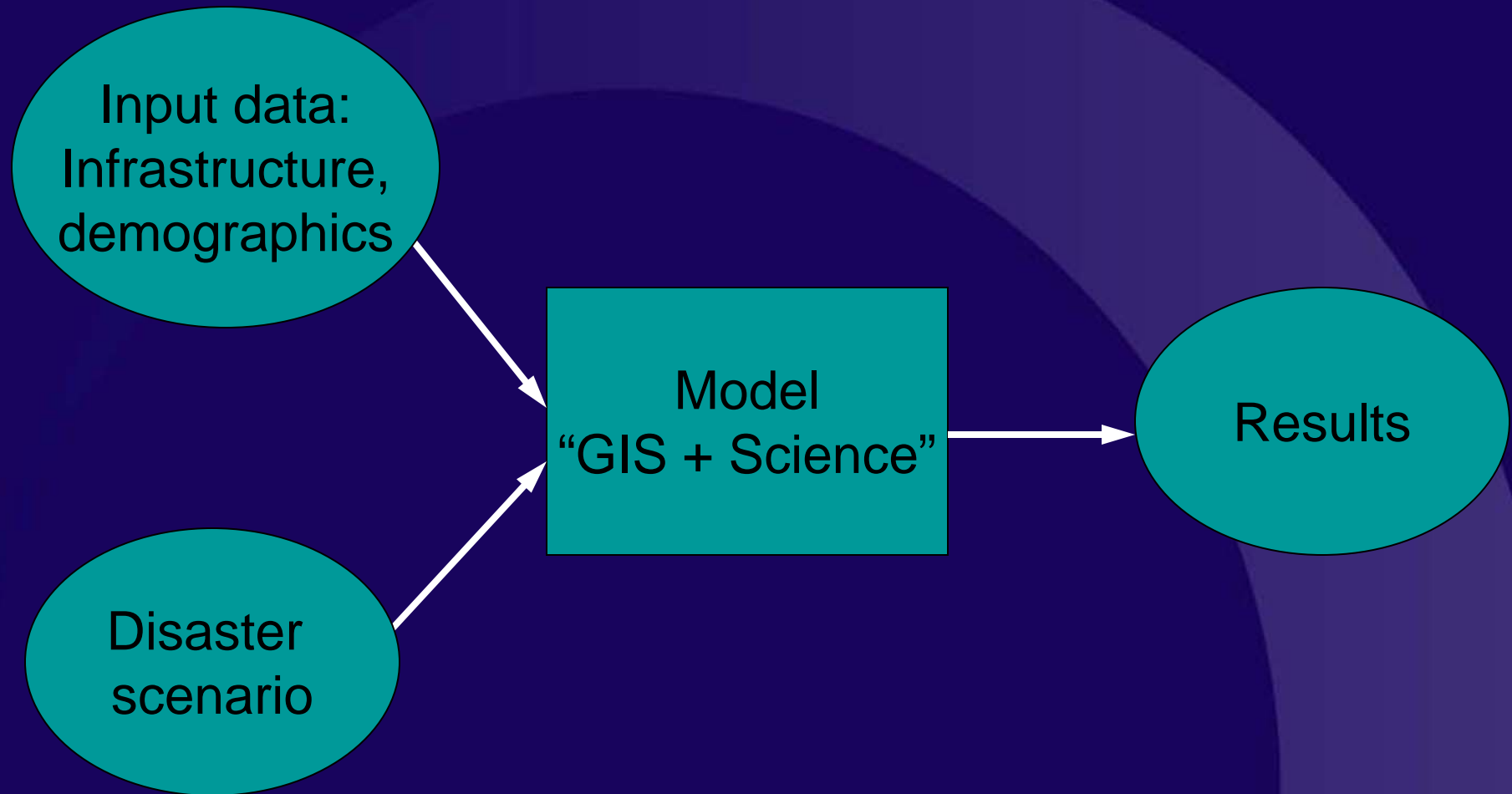
- Planning, Coordination & Education
- GIS: Data, Mapping & Modeling
- Primary responsibility for New York City's 2009 Natural Hazard Mitigation Plan (HMP)

2009 Natural Hazard Mitigation Plan

- Disaster Mitigation Act of 2000 (DMA 2000)
- Hazard mitigation funding
- Stakeholder participation
- Increasing public awareness
- A living document...



- Developed by FEMA and the National Institute of Building Sciences (NIBS)
- Risk Assessment & Loss Estimation Model
- Combines GIS data with established science
- Developed as an extension to ArcGIS
- Flood, Wind & Earthquake modules



Model & Data Limitations

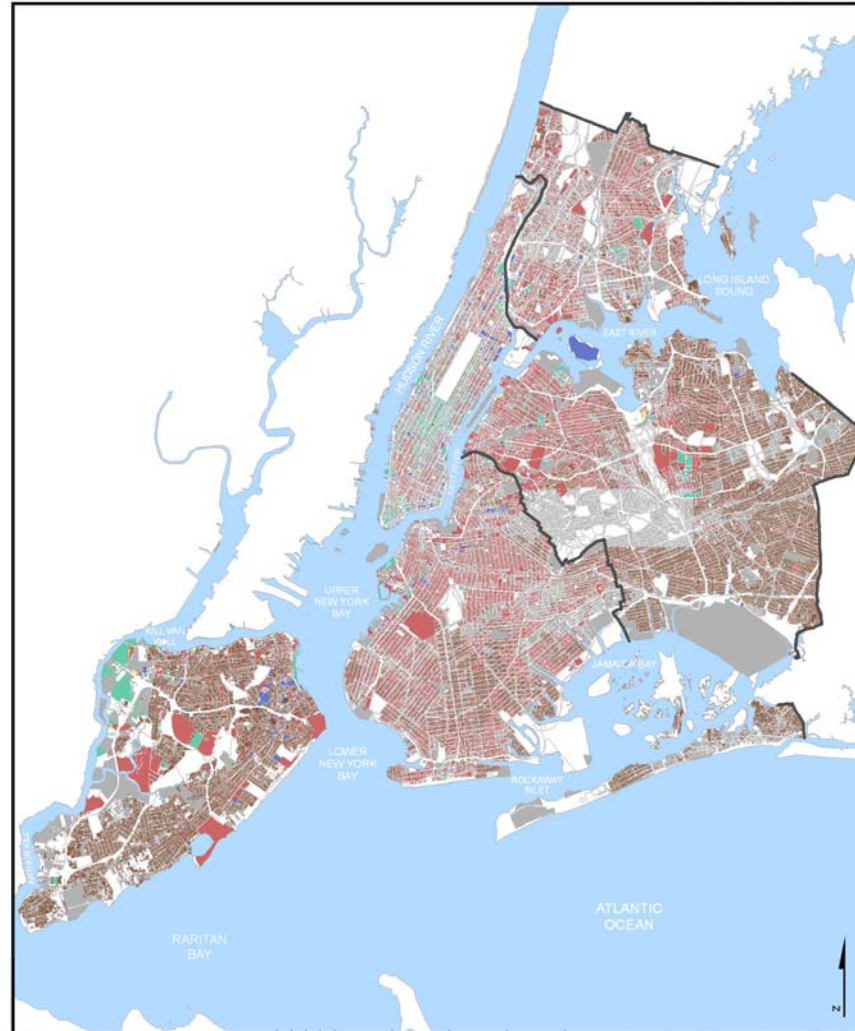
- General vs. site specific analysis
- Aggregated General Building Stock (GBS) data
- Digital Elevation Model (DEM) accuracy
- Defining the hazard
- Wind model without a storm surge (Yikes!)
- The Oscar Mayer factor: “baloney in – baloney out”

HAZUS-MH Analysis Levels

- Level 1: “Straight out of the box”
 - Not an option for NYC
- Level 2: Improved local GIS & hazard data
 - Customized General Building Stock (GBS) data
 - Used for NYC HMP
- Level 3: “Going under the hood”



Construction Type

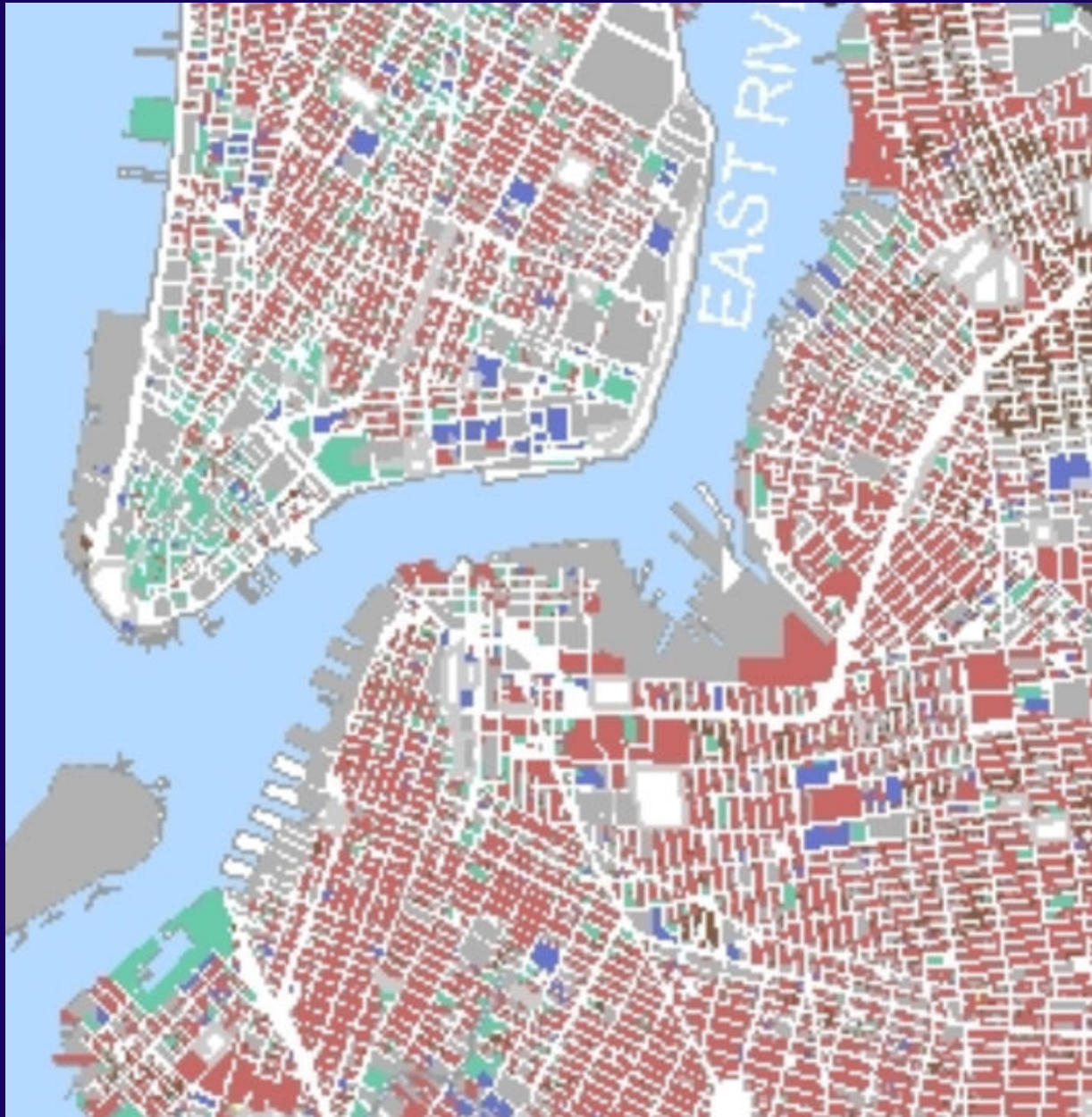
New York City



Created: 8 SEP 2008

Source: Dept. of Finance, Dept. of City Planning

- | | | |
|--|--|--|
|  Concrete |  Steel |  Open Space |
|  Masonry |  Wood | |
|  Manufactured housing |  Unknown | |



New York City
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Building Type Mapping Schemes

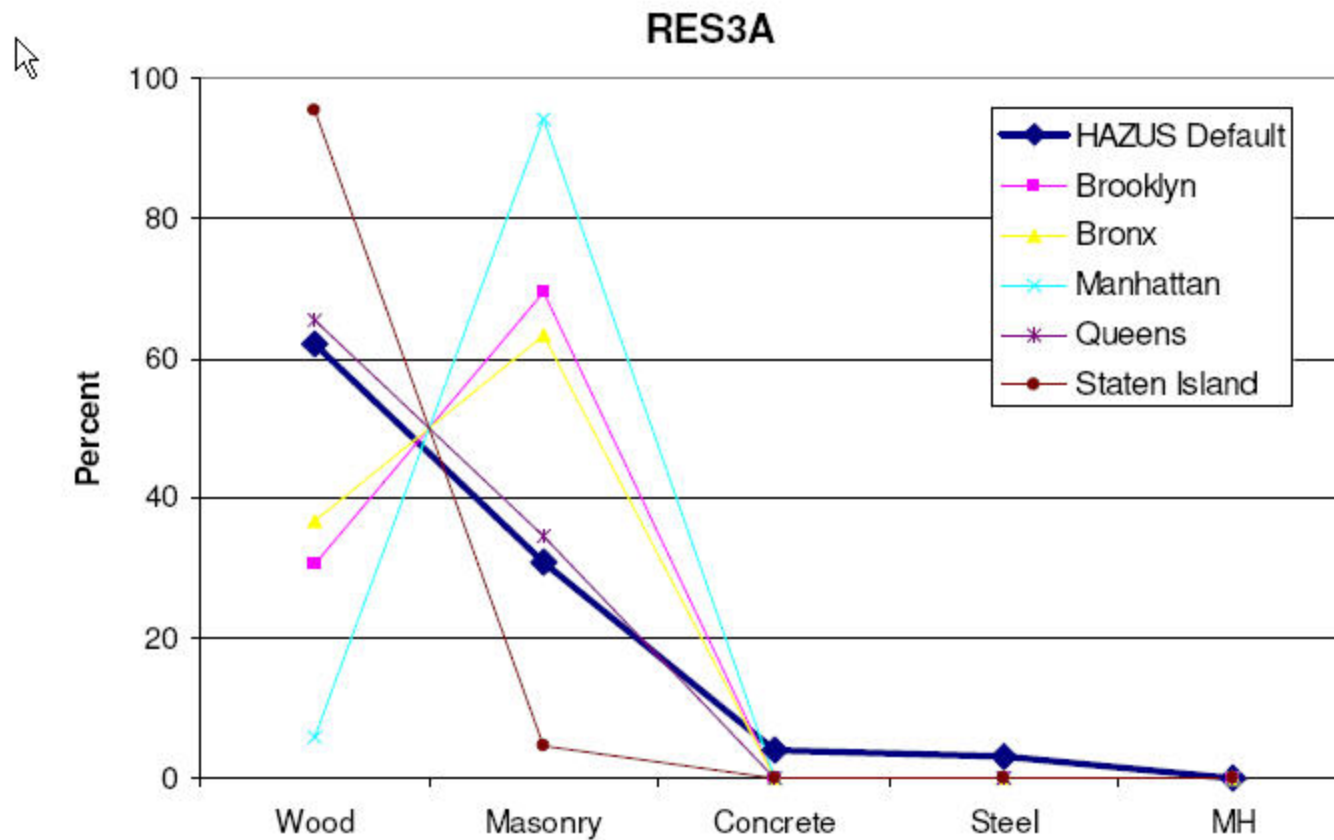
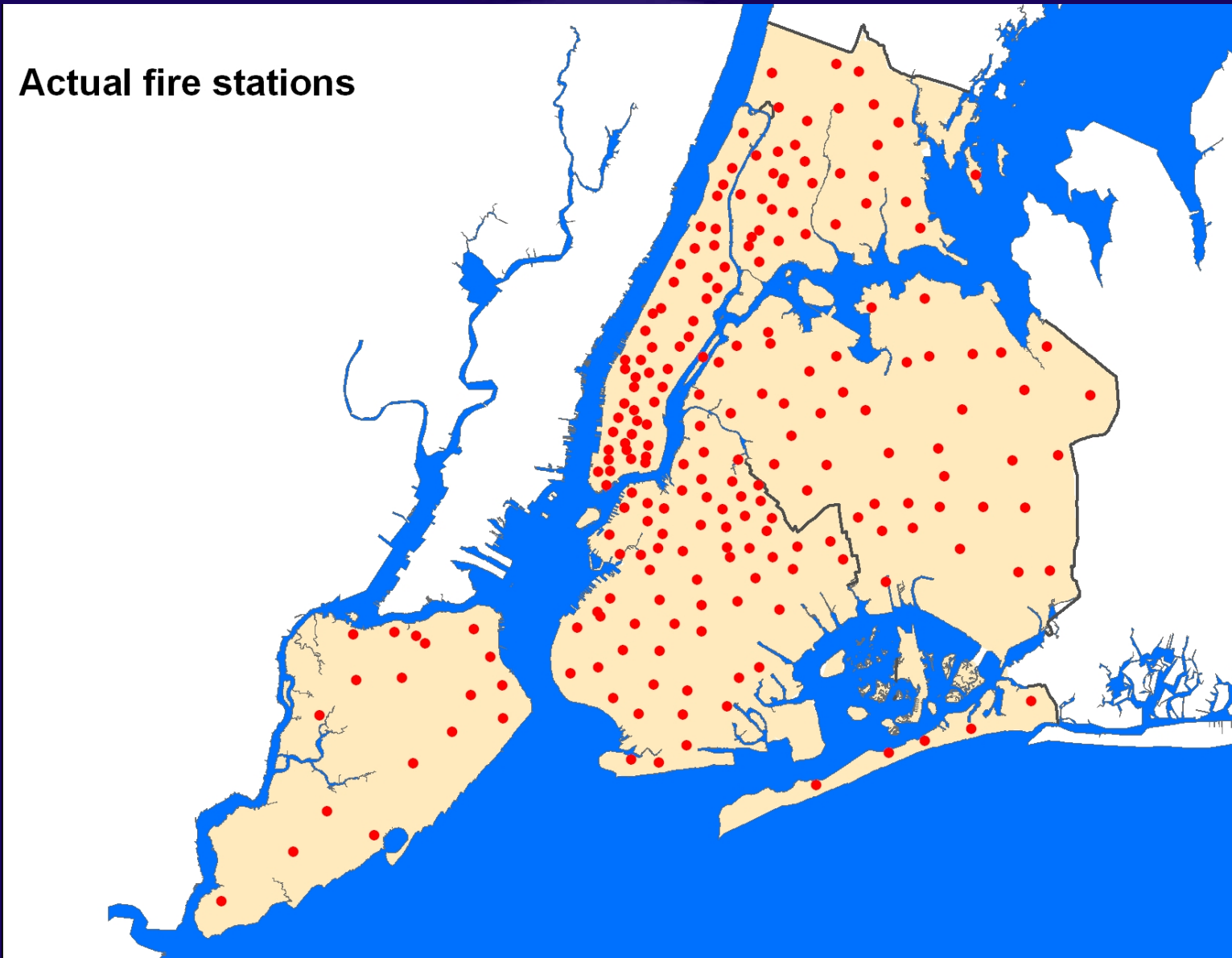


Figure 2. General Building Type Mapping Schemes by County Compared to HAZUS Default for New York City for Occupancy RES3A

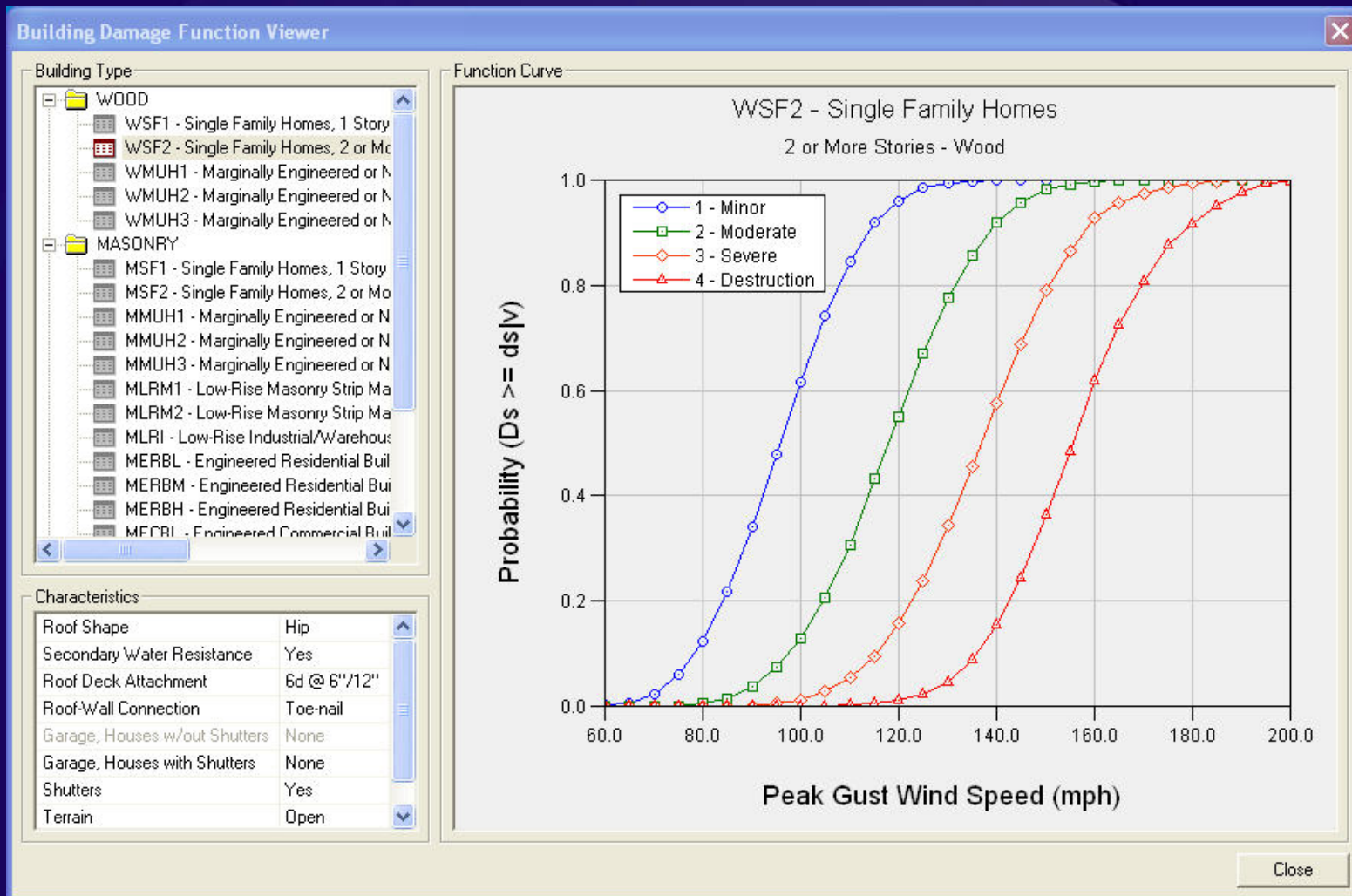
HAZUS default fire stations



Actual fire stations

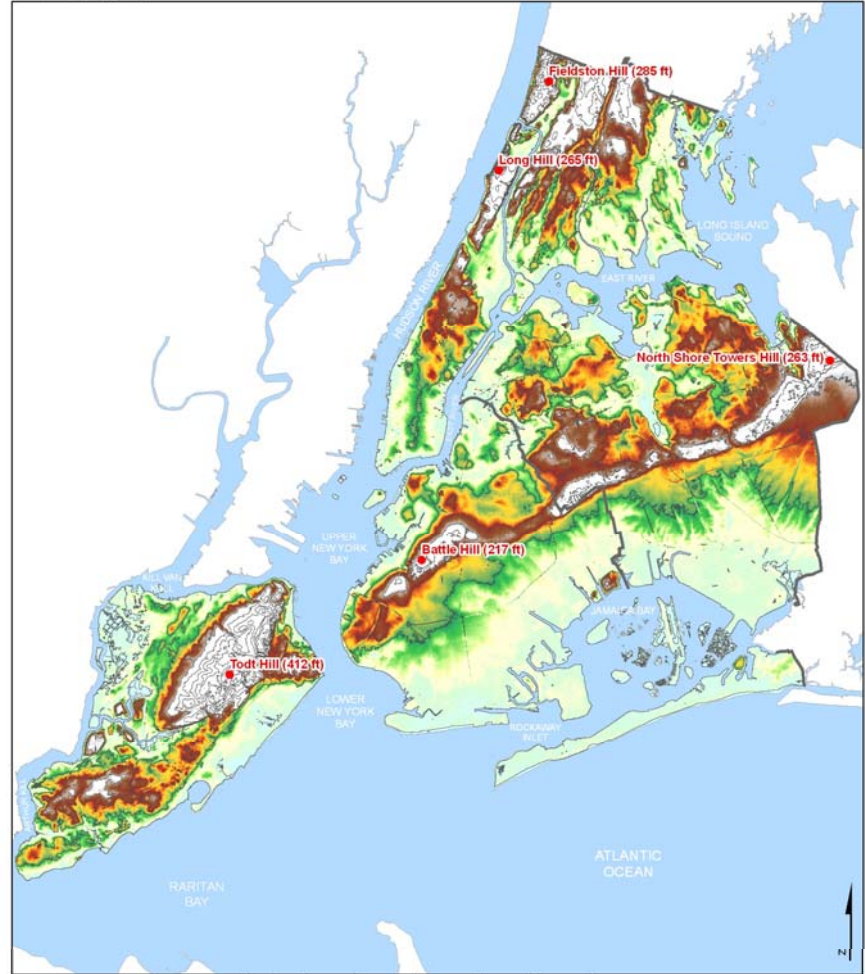


HAZUS-MH Damage Functions



Topography

New York City



Created: 8 SEP 2008

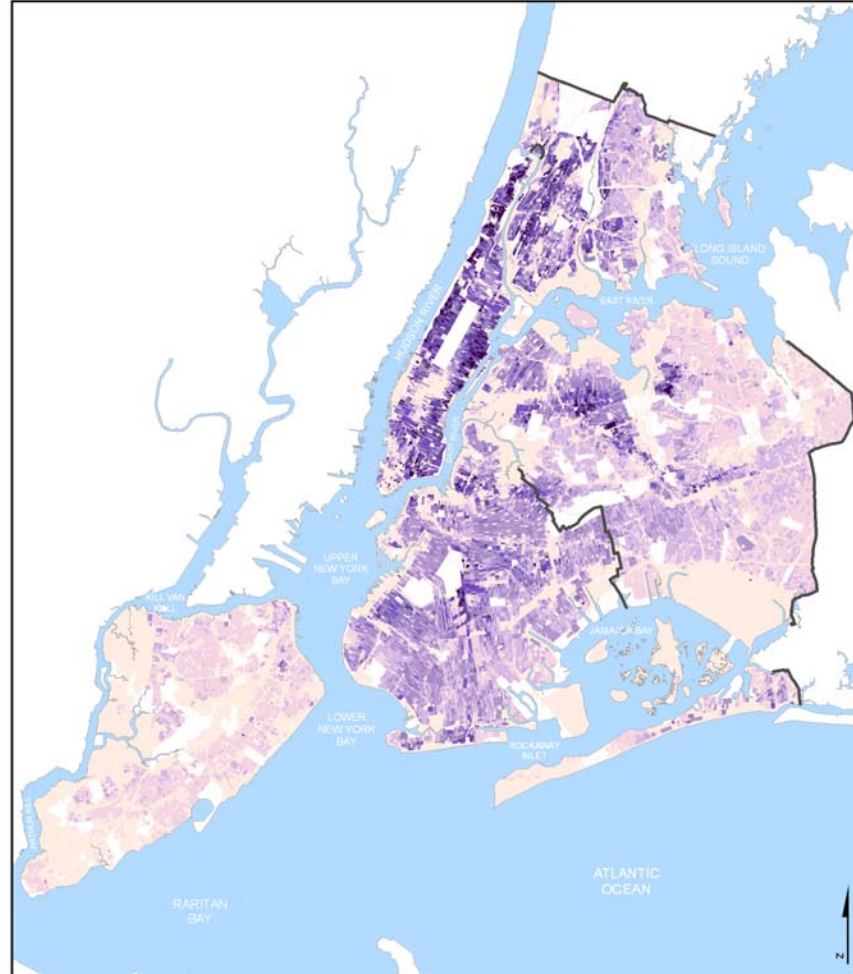
0 1 2 4 6 8 10 12 Miles

Source: OEM GIS Data (NAVD88)



Population Density

New York City



Created: 15 SEP 2008

0 1 2 4 6 8 10 Miles

Source: U.S. Census 2000, File SF1, Table P1



100-Year Floodplain

Brooklyn



Created: 10 SEP 2008

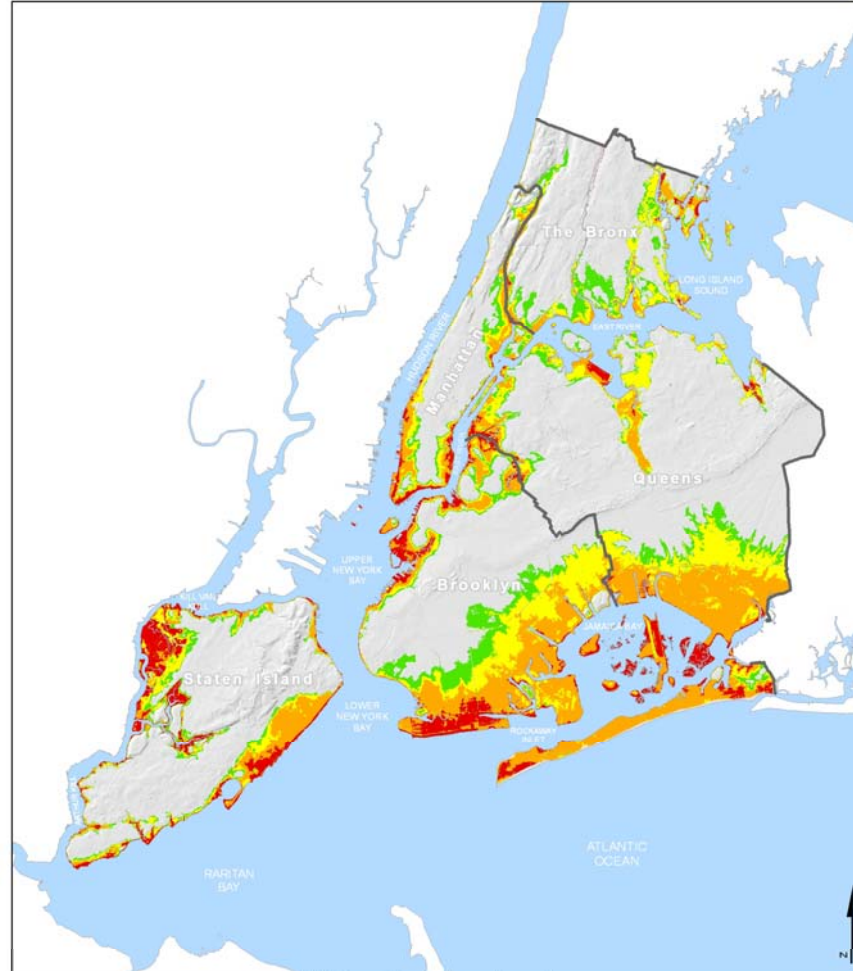
0 0.5 1 2 3 4 5 Miles

Source: FEMA DFIRM Database

DFIRM 100-year floodplain

SLOSH Zones

New York City



Created: 8 SEP 2008

0 1 2 4 6 8 10 Miles

Source: The National Hurricane Center, PBS&J

- SLOSH Category 1
- SLOSH Category 2
- SLOSH Category 3
- SLOSH Category 4

NYC HAZUS Building Summary

- 802,000 Buildings
- Total building value: \$825 Billion
- Total contents value: \$560 Billion

Population and Households in 100-Year Floodplain

Borough	Population	Households
Bronx	11,023	4,188
Brooklyn	63,654	24,477
Manhattan	63,576	24,562
Queens	46,674	18,070
Staten Island	18,108	6,487
<i>Total</i>	<i>203,035</i>	<i>77,784</i>

Critical Assets Located in the 100-Year Floodplain

Critical Asset	#
Subway Stations	14
Rail Stations	18
Bridges and Tunnels	31
Major Roads (miles)	105
Airports	2
Ferry Landings	25
Emergency Services—Police Stations	1
Emergency Services—Fire Stations	8
Emergency Services—EMS Stations	2
Educational—Colleges	4
Educational—Public Schools	45
Educational—Private Schools	18
Healthcare—Hospitals	1
Healthcare—Nursing Homes	10
Cultural Facilities	6
Infrastructure—Power Plants	10
Infrastructure—Wastewater Treatment Plants	1

100-Year Flood Building Damage

Borough	Percentage of Building Damage							Total
	None	1–10%	11–20%	21–30%	31–40%	41–50%	>50%	
Bronx	529	34	295	316	74	90	24	1,362
Brooklyn	2,280	271	450	271	44	46	11	3,373
Manhattan	211	70	70	111	10	1	4	477
Queens	2,512	346	594	655	181	130	89	4,507
Staten Island	1,961	78	478	497	250	148	210	3,622
<i>Total</i>	<i>7,493</i>	<i>799</i>	<i>1,887</i>	<i>1,850</i>	<i>559</i>	<i>415</i>	<i>338</i>	<i>13,341</i>

Capital Stock Losses for a 100-Year Flood (\$1,000s)

Borough	Building Damage	Contents Damage	Inventory	Total
Bronx	302,256	439,998	21,455	763,709
Brooklyn	903,775	2,025,808	148,686	3,078,269
Manhattan	1,737,769	2,639,381	49,764	4,426,914
Queens	1,053,671	2,323,539	72,530	3,449,740
Staten Island	224,797	268,275	10,232	503,304
<i>Total</i>	<i>4,222,268</i>	<i>7,697,001</i>	<i>302,667</i>	<i>12,221,936</i>

A Catastrophic Storm Surge...

- ~ 2,000,000 people & 740,000 households
- ~ 272,000 buildings
- 461 miles of major roadways
- 88 emergency services facilities
- 80 healthcare facilities

Other Model Outputs...

- User defined and/or essential facilities damage
- Debris
- Shelter requirements
- Indirect economic losses

Where to go from here?...

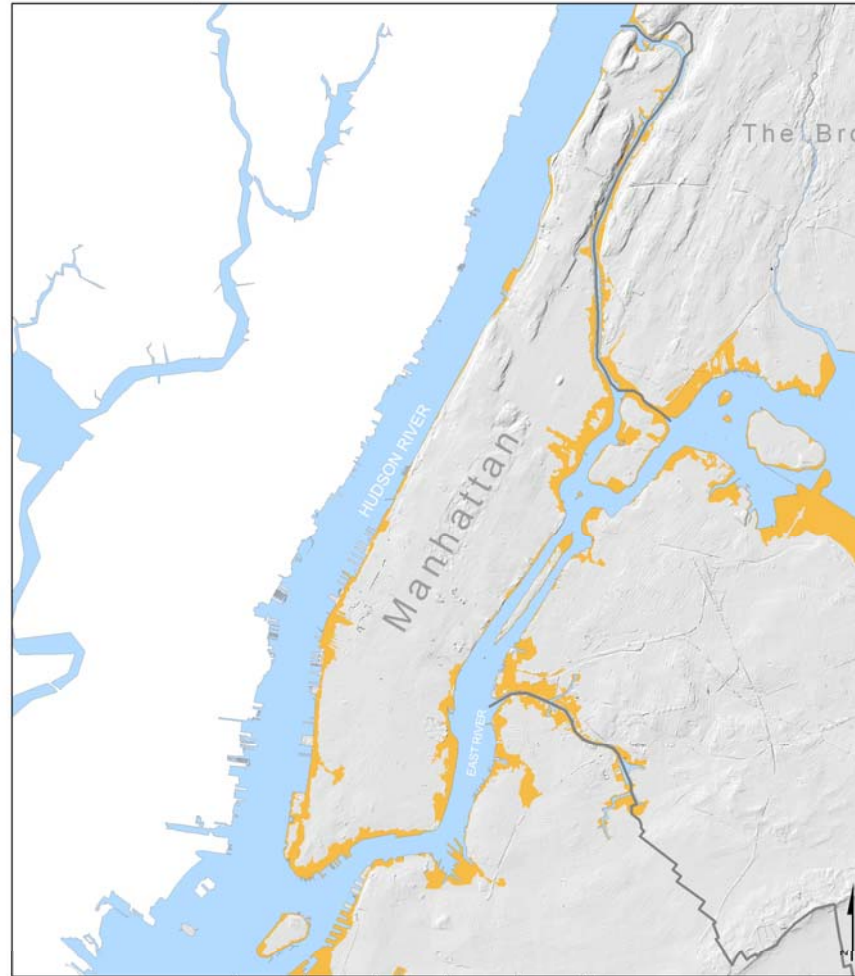
- Refine the data
 - General building stock, essential facilities, terrain, vegetation, demographics
- Refine the model
 - Validation testing, Wind + SLOSH
- Model potential mitigation actions
 - Building codes, land use policies, storm surge barriers?

Questions?

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100-Year Floodplain

Manhattan



Created: 10 SEP 2008

0 0.5 1 2 3 4 5 Miles

Source: FEMA DFIRM Database

DFIRM 100-year floodplain

100-Year Floodplain

The Bronx



DFIRM 100-year floodplain

100-Year Floodplain

Queens



Created: 10 SEP 2008

0 0.5 1 2 3 4 5 6 7 Miles

Source: FEMA DFIRM Database

DFIRM 100-year floodplain

100-Year Floodplain

Staten Island



Created: 10 SEP 2008

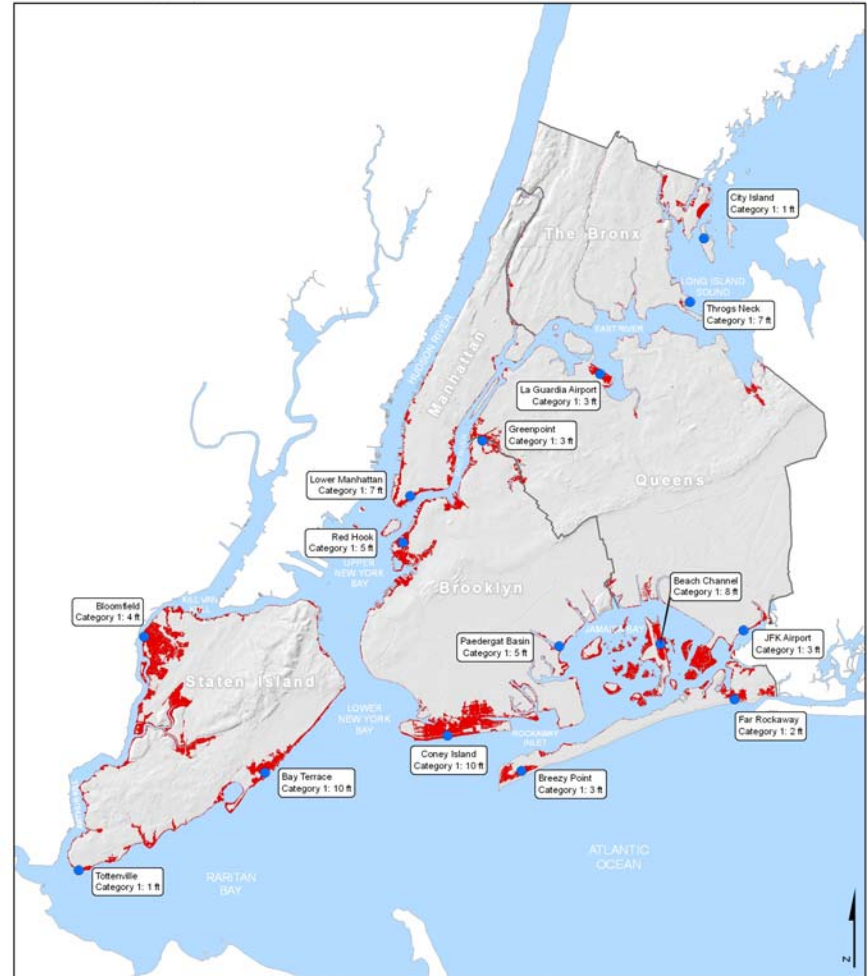
0 0.5 1 2 3 4 5 Miles

Source: FEMA DFIRM Database

 DFIRM 100-year floodplain

SLOSH Category 1

New York City



Created: 12 SEP 2008

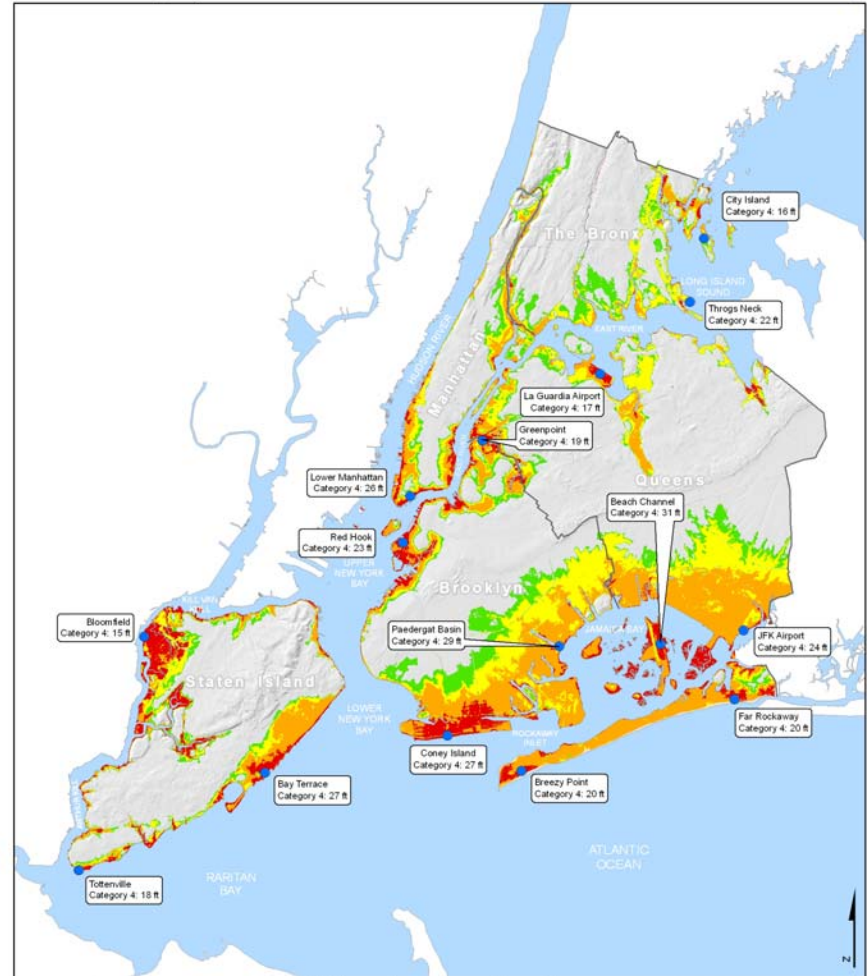
0 1 2 4 6 8 10 Miles

Source: The National Hurricane Center, PBS&J

- Sample Inundation Measurement Point
- SLOSH Category 1

SLOSH Category 4

New York City



Created: 12 SEP 2008

0 1 2 4 6 8 10 Miles

Source: The National Hurricane Center, PBS&J

- Sample Inundation Measurement Point
- SLOSH Category 1
- SLOSH Category 2
- SLOSH Category 3
- SLOSH Category 4

100-Year Flood: Direct Economic Loss

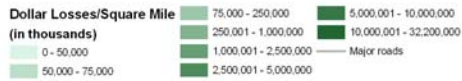
Manhattan



Created: 28 AUG 2008

0 1 2 4 Miles

Source: OEM HAZUS Data



100-Year Flood: Direct Economic Loss

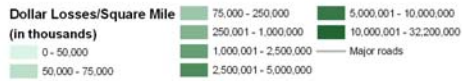
The Bronx



Created: 28 AUG 2008

0 1 2 4 Miles

Source: OEM HAZUS Data



New York City Building Summary Data

Borough	Bronx	Brooklyn	Manhattan	Queens	Staten Island	Total
Number of Buildings	81,603	262,702	42,073	307,970	107,467	801,815
Construction Type (known)						
Masonry	54,434	178,920	28,762	115,062	8,870	386,048
Steel	377	2,367	10,808	1,992	443	15,987
Manufactured Housing	107	55	66	533	922	1,683
Concrete	1,334	676	1,904	65	271	4,250
Wood	24,681	79,239	206	189,050	96,508	389,684
Total	80,933	261,257	41,746	306,702	107,014	797,652
Occupation Type (known)						
Residential	70,780	235,963	30,375	284,904	101,786	723,808
Commercial	8,595	20,041	8,796	18,080	4,691	60,203
Industrial	984	3,828	1,241	3,011	521	9,585
Religion	699	1,735	822	1,178	193	4,627
Government	117	218	224	187	96	842
Education	425	888	615	602	180	2,710
Total	81,600	262,673	42,073	307,962	107,467	801,775
Value (\$)						
Total Building Value	110,218,680,000	212,351,035,000	283,586,028,000	178,547,138,000	41,609,258,000	826,312,139,000
Total Building Content Value	70,120,000,000	141,230,000,000	209,920,000,000	115,910,000,000	25,830,000,000	563,010,000,000
Total	180,338,680,000	353,581,035,000	493,506,028,000	294,457,138,000	67,439,258,000	1,389,322,139,000