Brooklyn Waterfront Research Center
February 24, 2012
8:30AM Breakfast Talk:

Climate Change, Sea-Level Rise, and the Future of the Brooklyn Waterfront

Klaus H. Jacob
jacob@ldeo.columbia.edu
Lamont-Doherty Earth Observatory &
School of International and Public Affairs, Columbia University

Key Points:

Climate change will

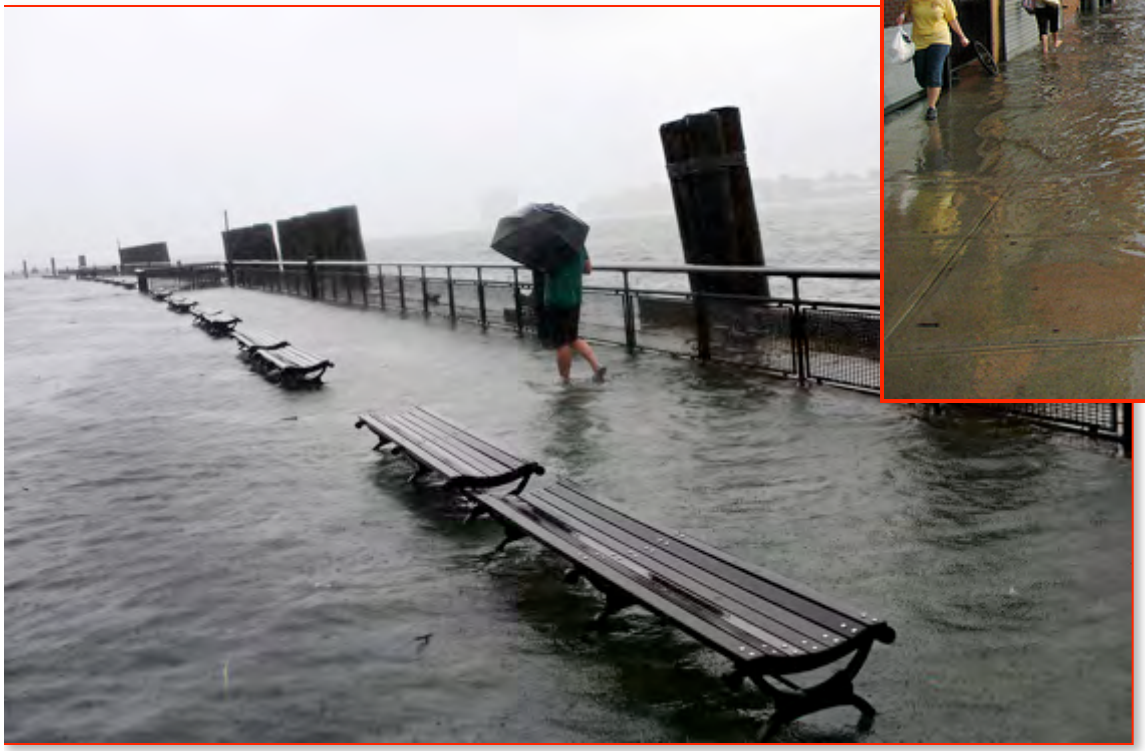
- Increase in number of hot days + strong wind storms
- More excessive rains (more street flooding)
- Sea level rise (SLR) up to +5 ft by 2100, more later !
- SLR in combination with
  - a) Nor'easter winter storms, and
  - b) Hurricanes (tropical cyclones) will

more often & more severely flood Bklyn's waterfront.

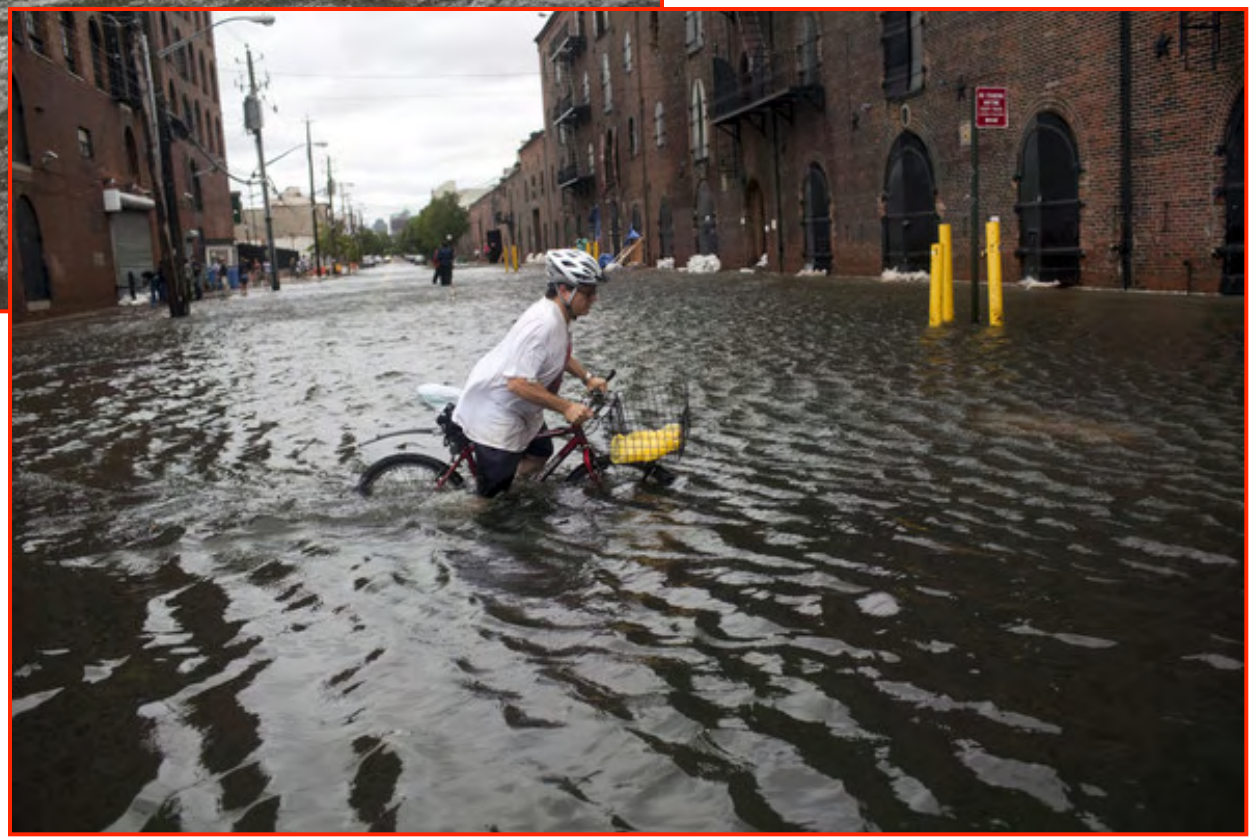
Recommendations:

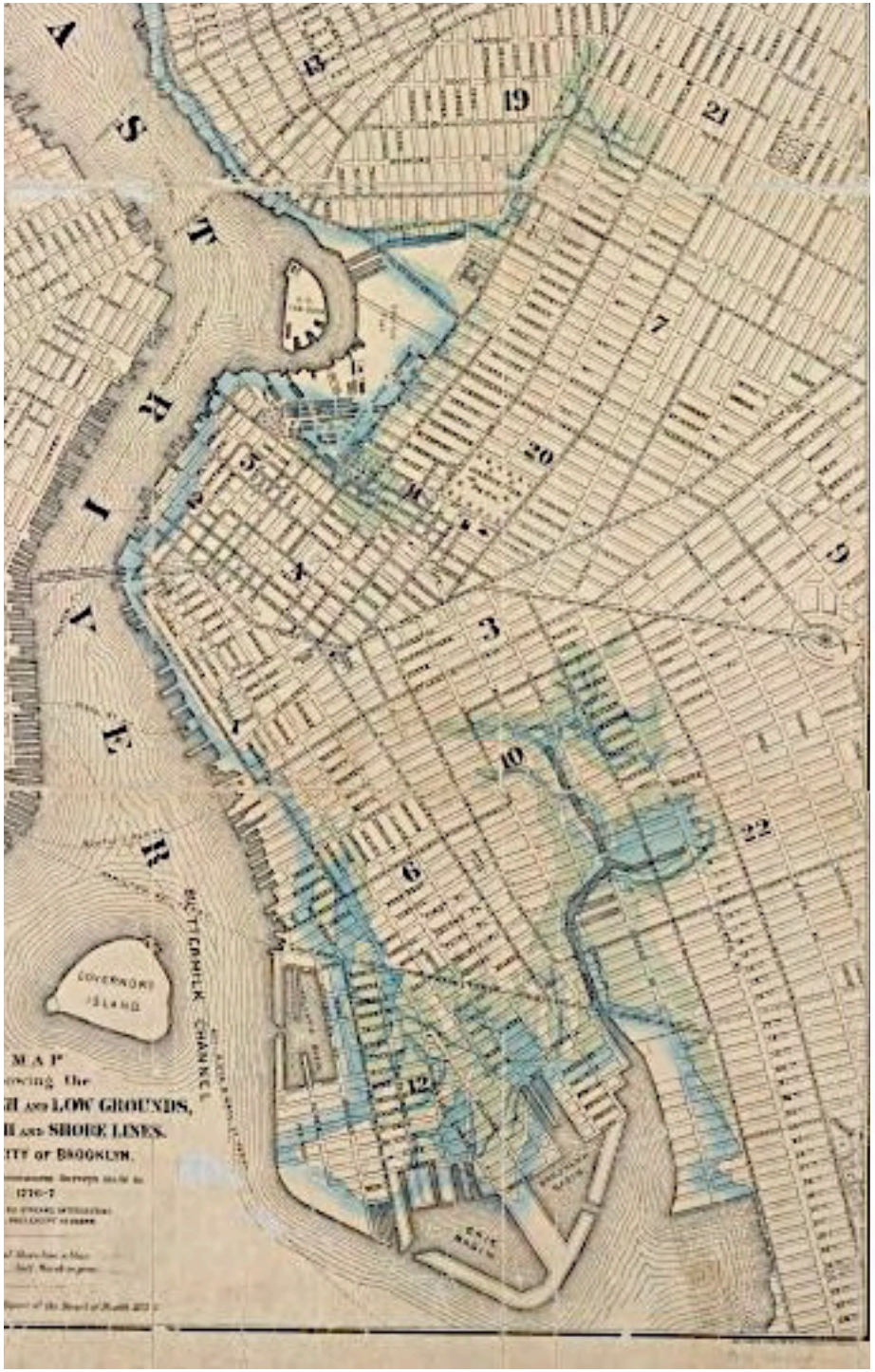
- City & FEMA need Flood Zone Map update
  (or add freeboard, include infrastructure)
- City should update Building Code & Zoning
- City Planning needs to become more SLR proactive
- FEMA NFIP rates => risk consistent (NYC can help)
- Communities must develop *long-term SLR* VISION

Irene, August 28, 2011



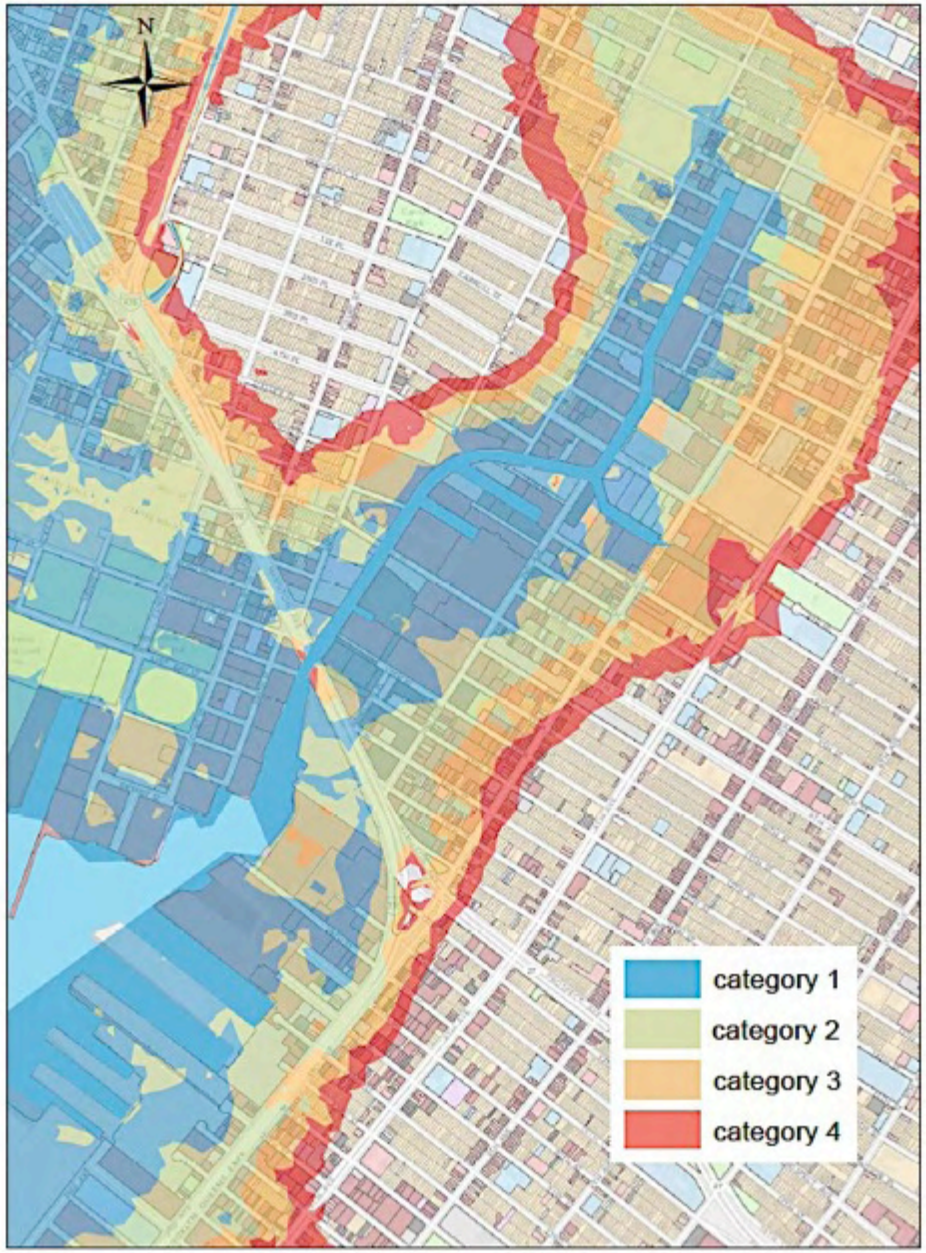
Irene, August 28, 2011





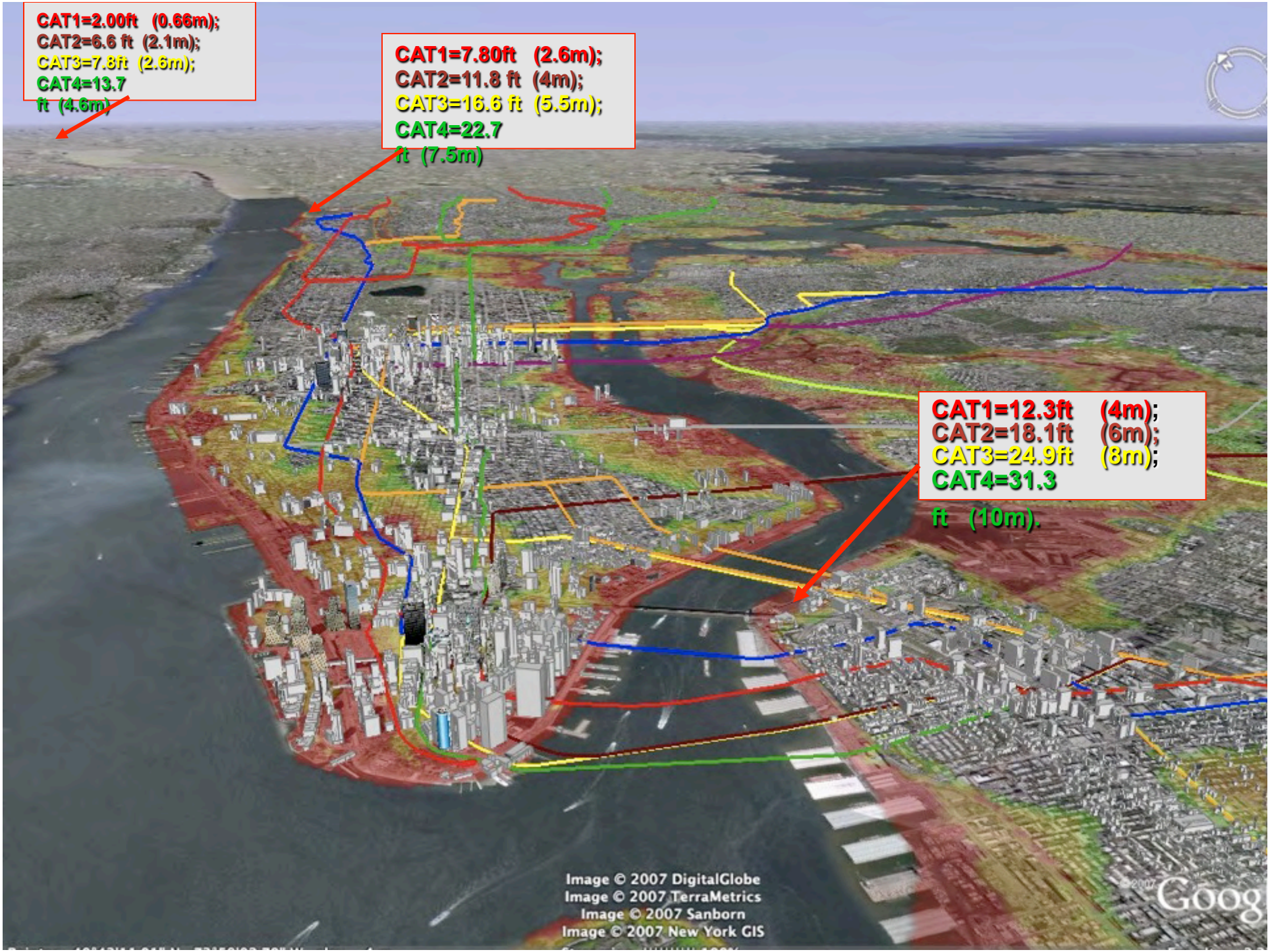
hurricane storm surge
gowanus canal

Gowanus Canal CONSERVANCY

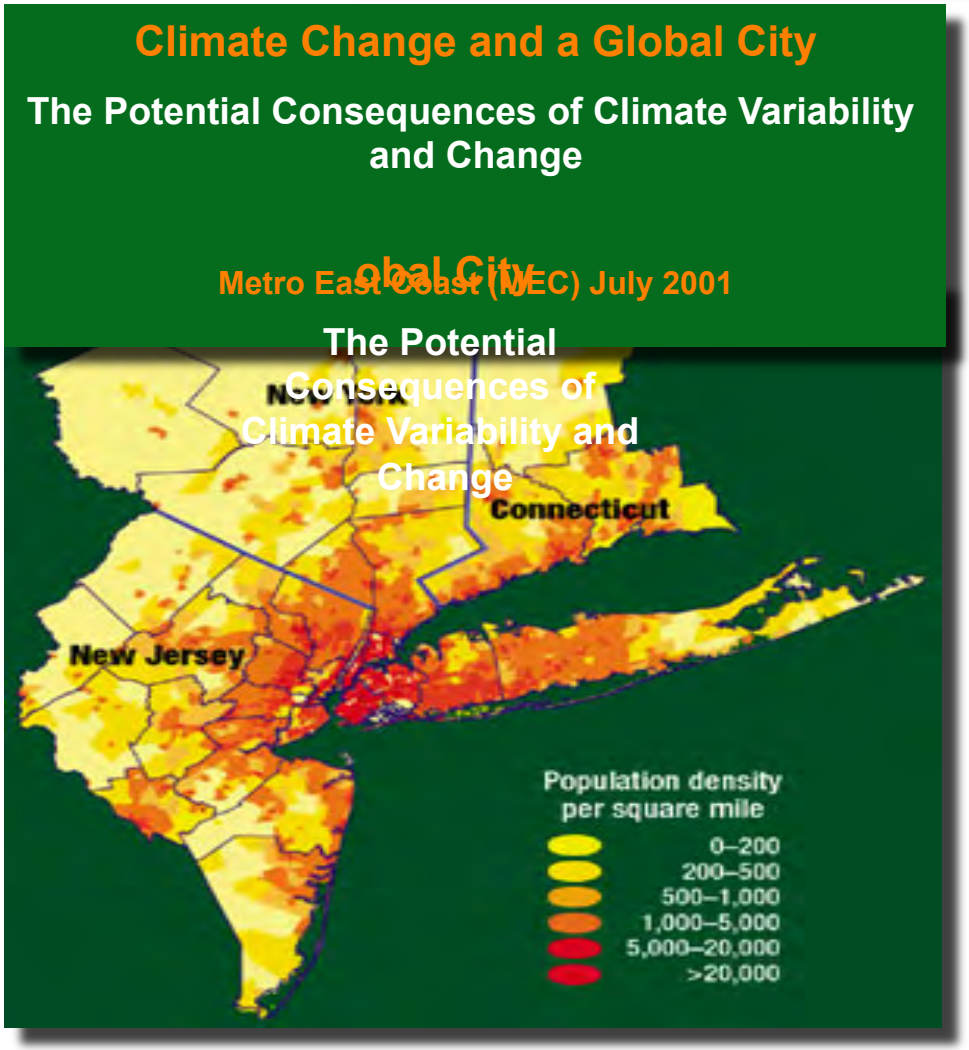


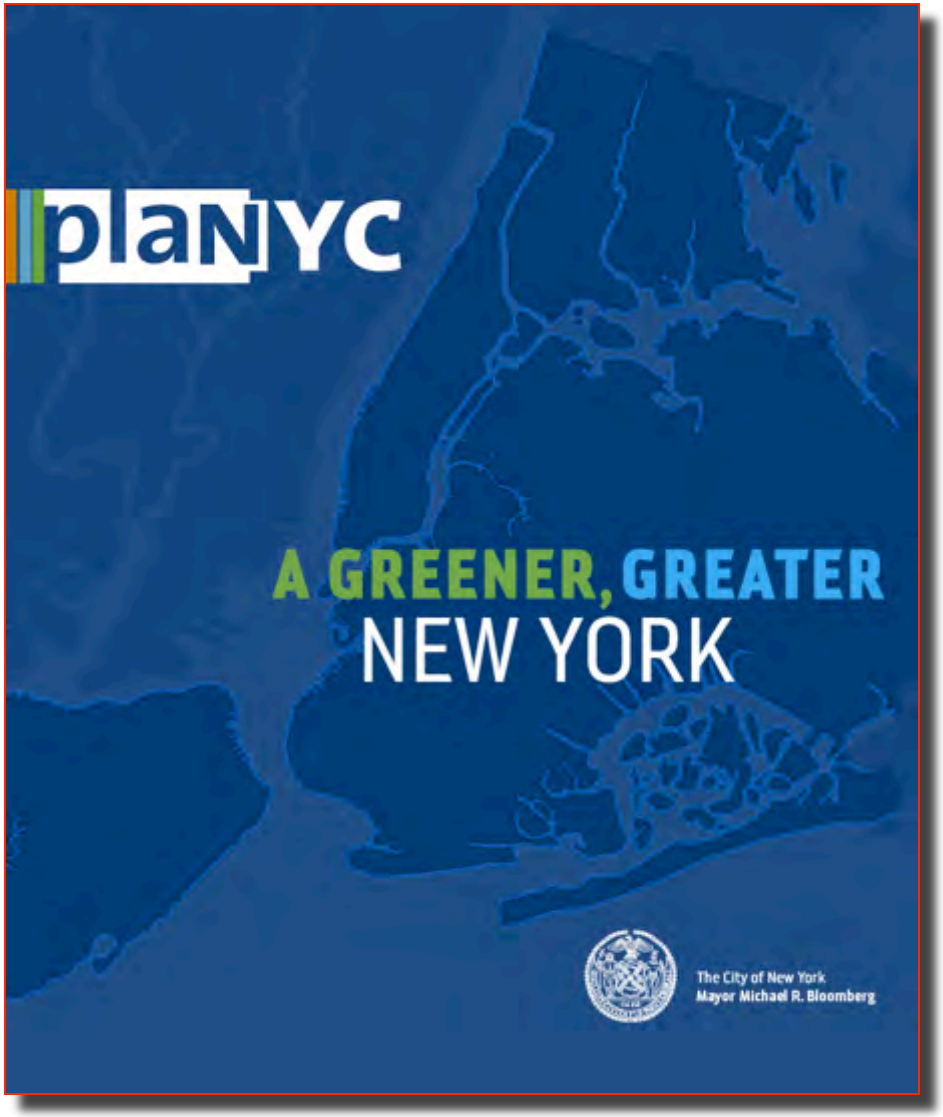
0 475 950 1,900 2,850 3,800 Feet

Sources: FEMA, NYC, NYS

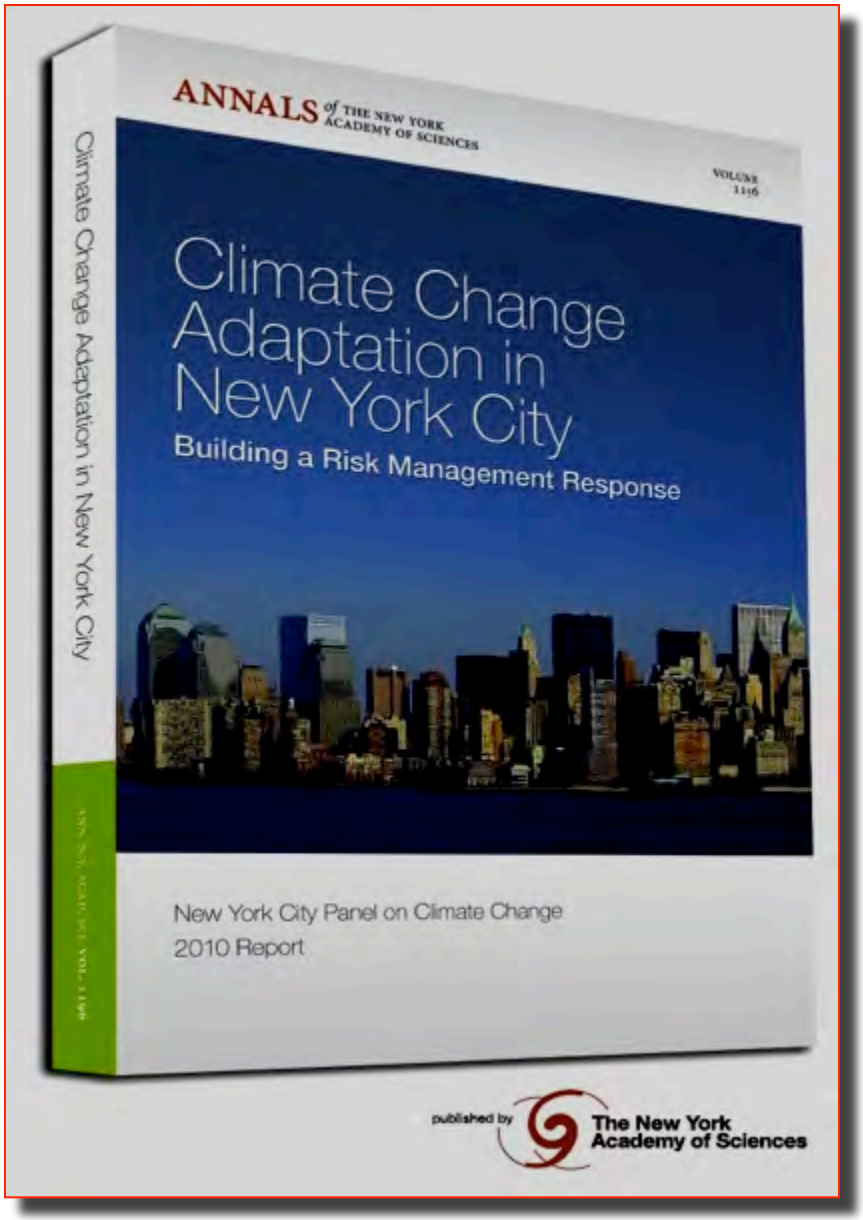

CAT1=2.00ft (0.66m);
CAT2=6.6 ft (2.1m);
CAT3=7.8ft (2.6m);
CAT4=13.7
ft (4.6m)
CAT1=7.80ft (2.6m);
CAT2=11.8 ft (4m);
CAT3=16.6 ft (5.5m);
CAT4=22.7
ft (7.5m)
CAT1=12.3ft (4m);
CAT2=18.1ft (6m);
CAT3=24.9ft (8m);
CAT4=31.3
ft (10m).
Image © 2007 DigitalGlobe
Image © 2007 TerraMetrics
Image © 2007 Sanborn
Image © 2007 New York GIS
Goog

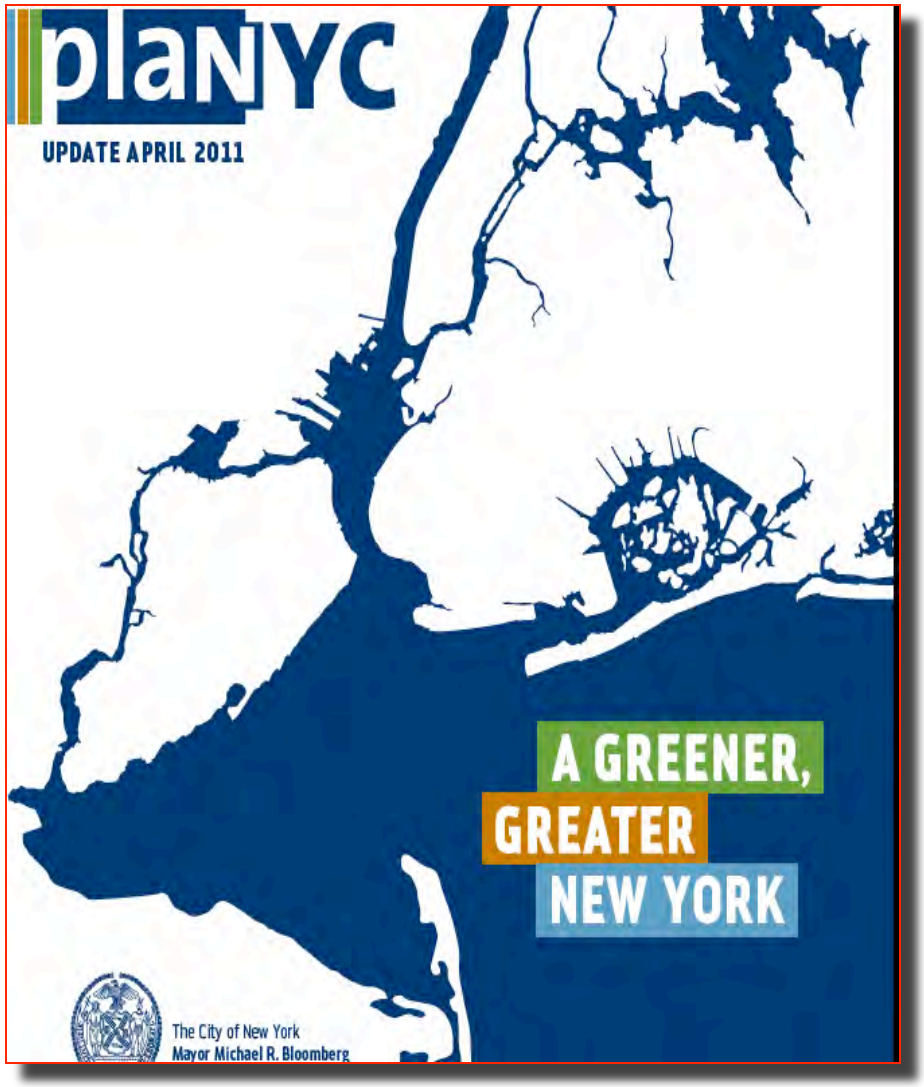
So what has changed in the last decade?



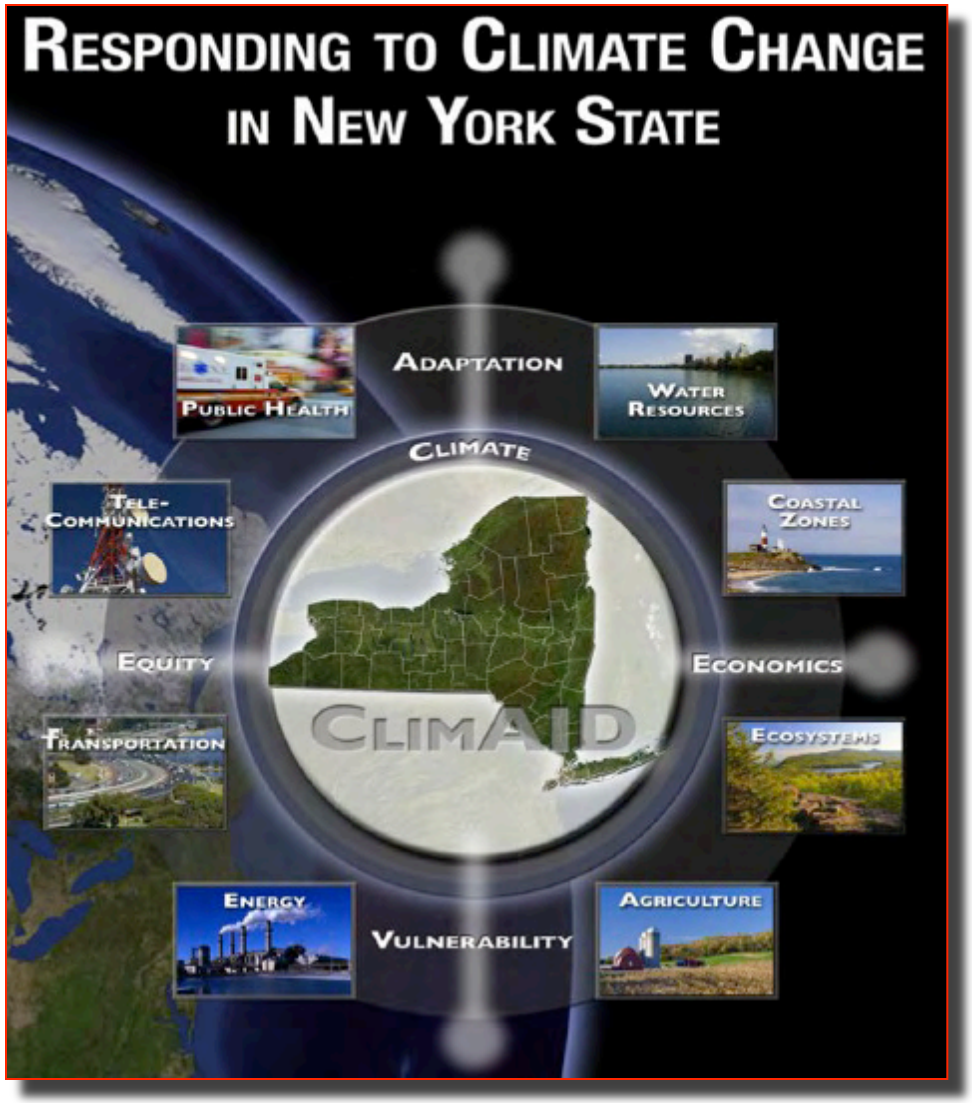


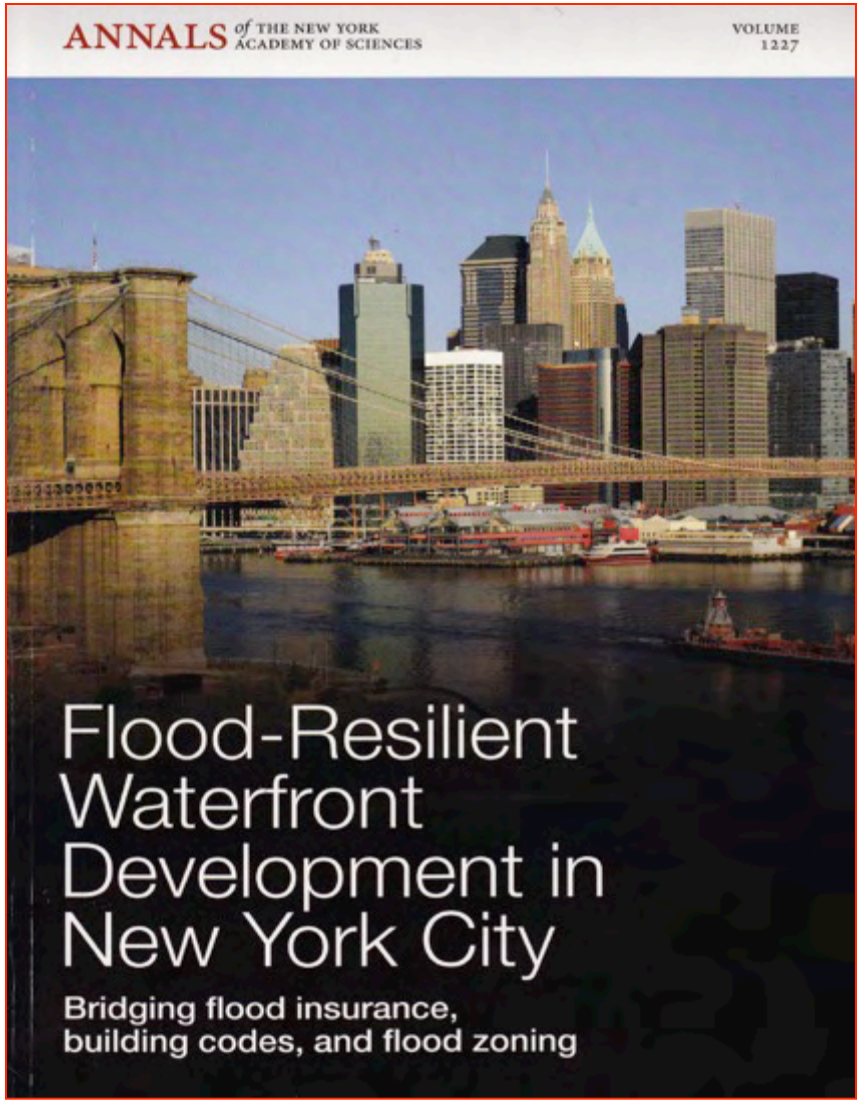
So what has changed in the last decade?





So what has changed in the last decade?



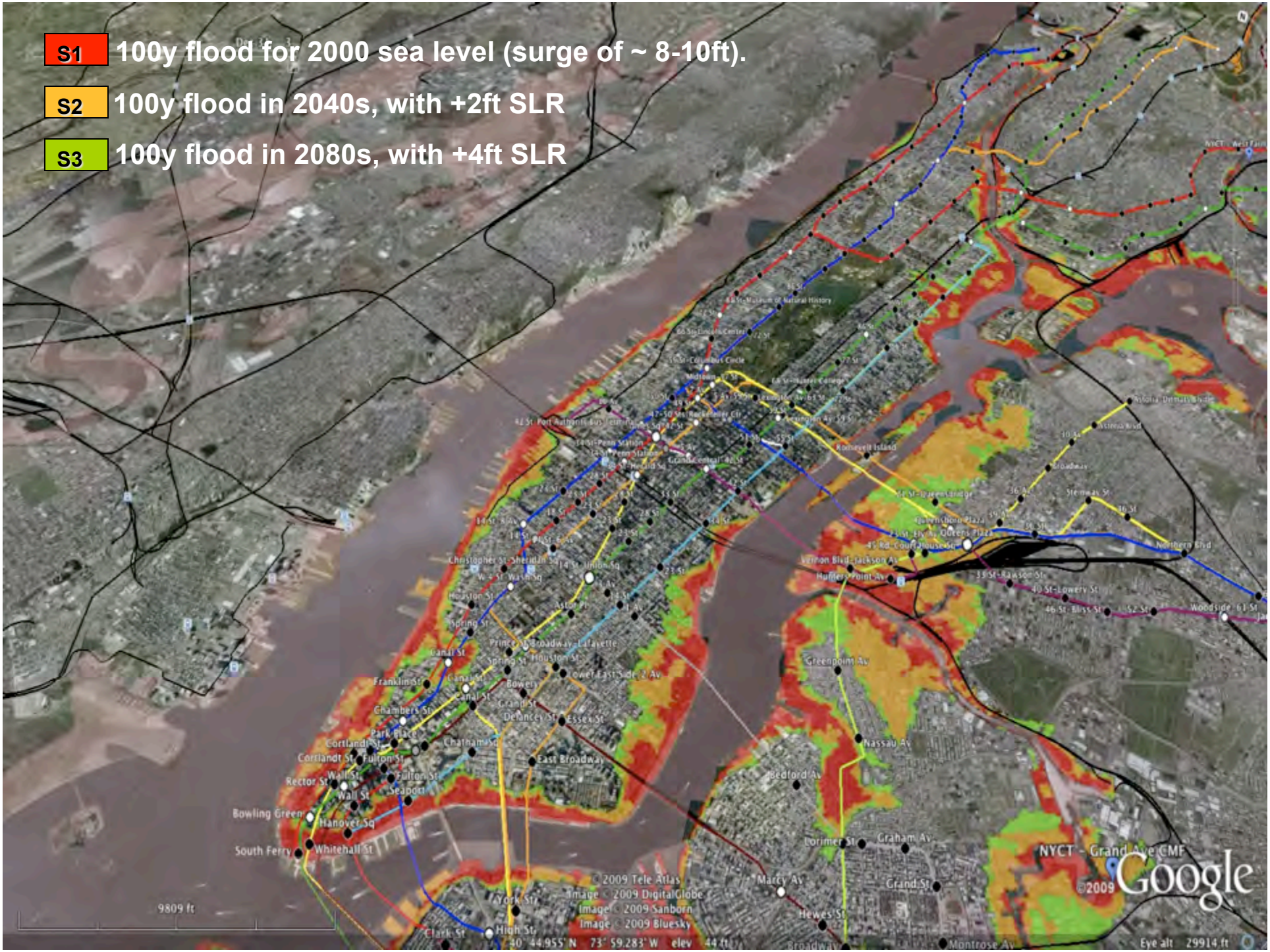


NPCC Climate Risk Information

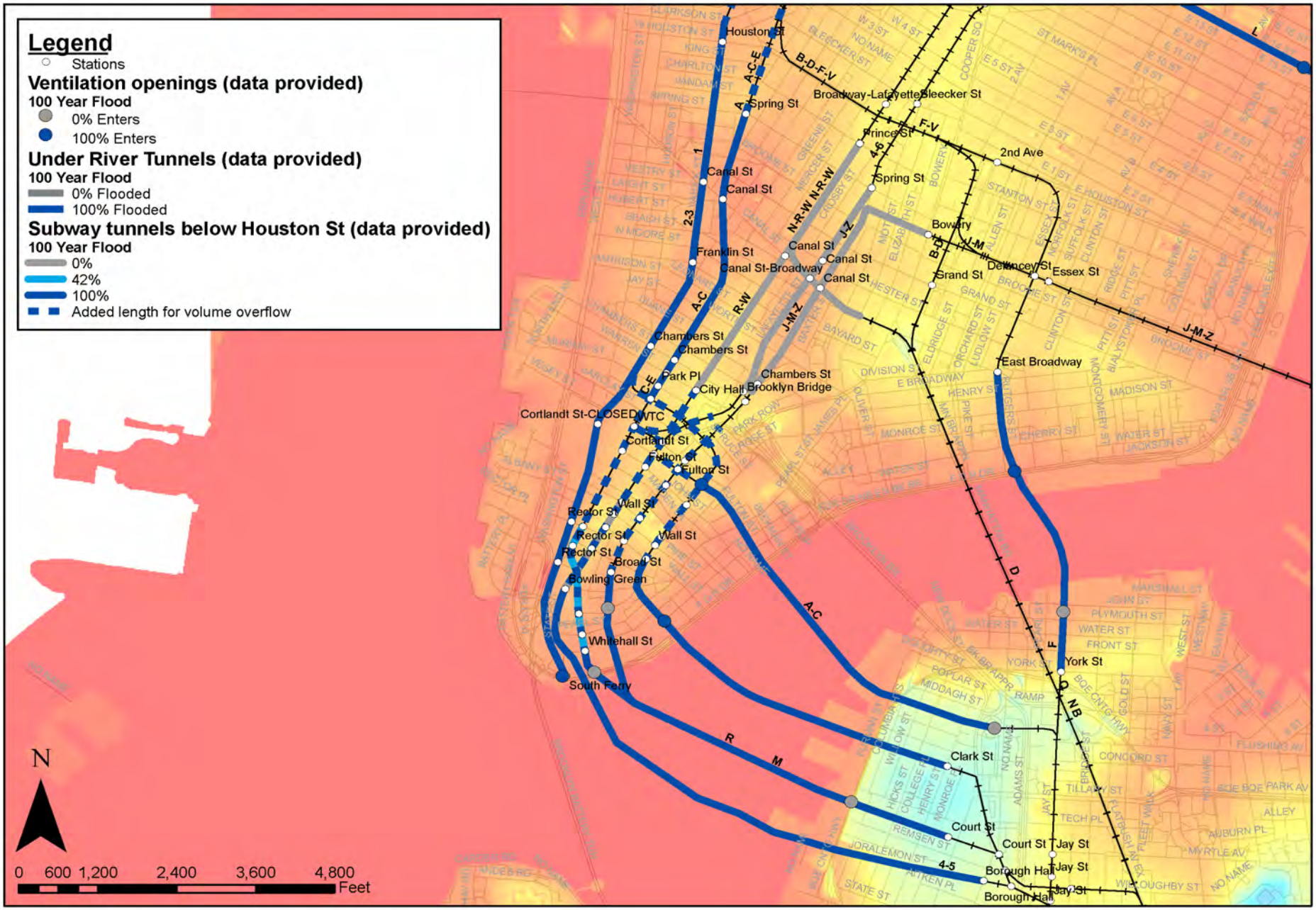
TABLE 1. Baseline Climate and Mean Annual Changes[1]

	Baseline 1971-2000	2020s	2050s	2080s
Air temperature Central range[2]	55° F	+ 1.5 to 3.0° F	+ 3.0 to 5.0° F	+ 4.0 to 7.5° F
Precipitation Central range[2]	46.5 in[3]	+ 0 to 5 %	+ 0 to 10 %	+ 5 to 10 %
Sea level rise[3] Central range[2]	NA	+ 2 to 5 in	+ **0.8ft**	**1.5ft**
Rapid ice-melt scenario[4]	NA	~ 5 to 10 in	~ **2ft**	**4ft**

Source: Columbia University Center for Climate Systems Research


S1 100y flood for 2000 sea level (surge of ~ 8-10ft).
S2 100y flood in 2040s, with +2ft SLR
S3 100y flood in 2080s, with +4ft SLR
Google

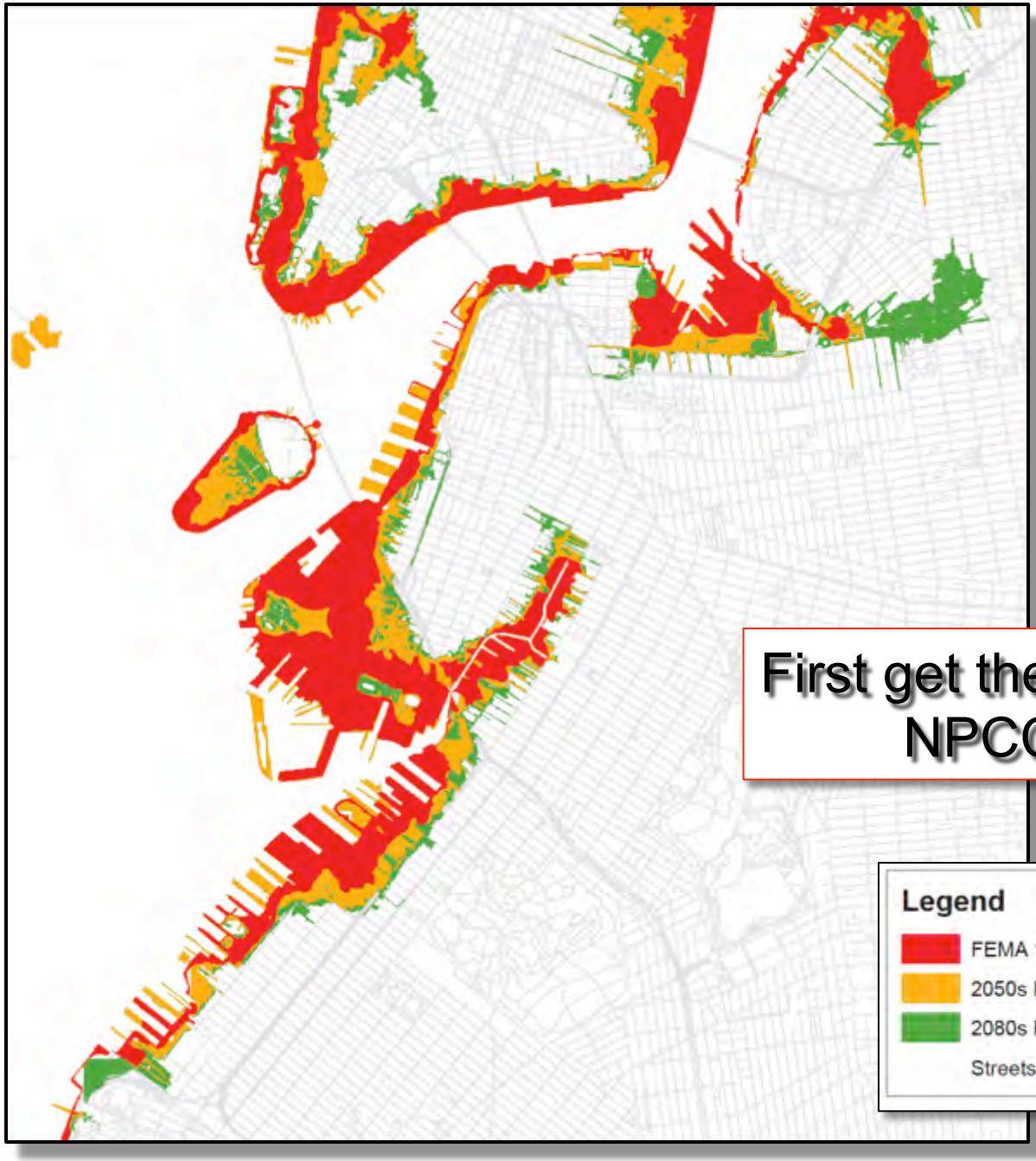
Flooded Subway and Under River Tunnels, Lower Manhattan, 1% Flood



- What is the expected **impact** of SLR on the Brooklyn Water front in Redhook, Gowanus, and Sunset ?

- **What does the City need to do on its own,** and in cooperation with **FEMA**?

- What can **Communities/Neighborhoods do?**



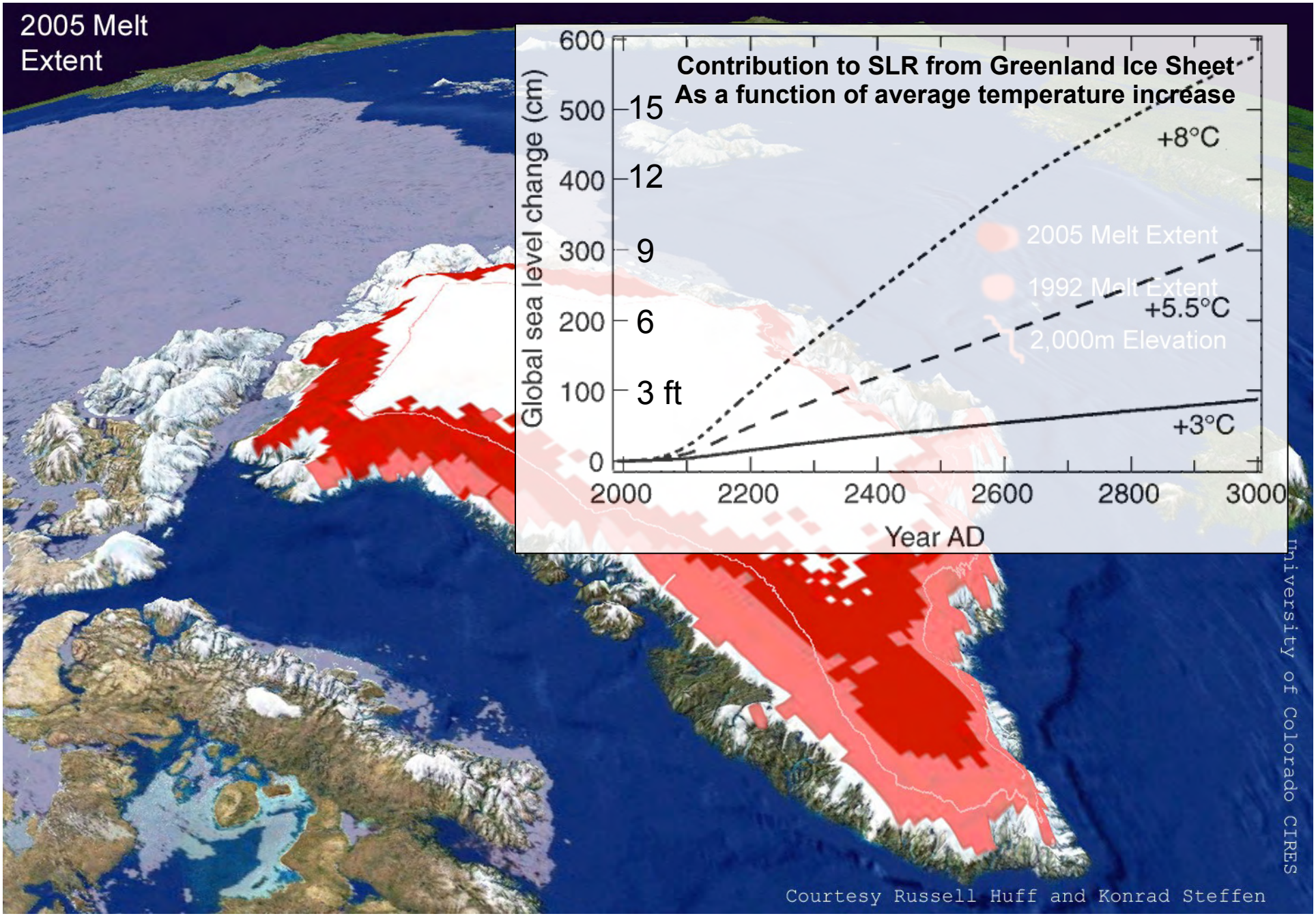
First get the information!
NPCC, …….

Legend

- FEMA 100 Year Flood Zone
- 2050s Rapid Ice Melt + Sea Level Rise
- 2080s Rapid Ice Melt + Sea Level Rise
- Streets


Legend
FEMA 100 Year Flood Zone
2050s Rapid Ice Melt + Sea Level Rise
2080s Rapid Ice Melt + Sea Level Rise
Streets
Image © 2012 DigitalGlobe
5985 ft
40° 42.907' N 74° 1.576' W elev -3 ft
Eye alt 21762

Structural "Solution": 3 or 4 Barriers. Probably Unsustainable. Why?


2005 Melt Extent
Contribution to SLR from Greenland Ice Sheet
As a function of average temperature increase
Global sea level change (cm)
600
500
400
300
200
100
0
15
12
9
6
3 ft
+8°C
+5.5°C
+3°C
2005 Melt Extent
1992 Melt Extent
2,000m Elevation
2000
2200
2400
2600
2800
3000
Year AD
University of Colorado CIRES
Courtesy Russell Huff and Konrad Steffen

Don’t fall into the trap of: New Orleans, Aug 2005.

Response Options:

1) Do Nothing: => Losses will rise quickly

2) Rely on Insurance and/or Federal Disaster Relief Aid

- Will not work in the long run

3) Adaptation Measures/Options:

- **Early Warnings, Evacuation** ('Only' Saves Lives)
- Emergency & Operational Preparedness.
- **Avoid** Growth in Hazard Zones, **Retreat** from Low Coasts & Lands; Restore and Preserve **Wetland**, Softening shores: Create Vegetated Buffer Areas / Parks.
- **Raising** & Hardening Structures; (Unsustainable Barriers).
- **Increase** Capacity of Drainage / Storm Sewer / Wastewater Treatment Plants
- **'Flexible'** / Adaptable Urban Design/Planning & Denser Landuse on High Ground.

4) For Individual Buildings, Projects

- Flood Proofing (Basements, Put Infrastructure high above Ground, Raise Entrances, Install Floodgates, Raise Entire Structures, ….).

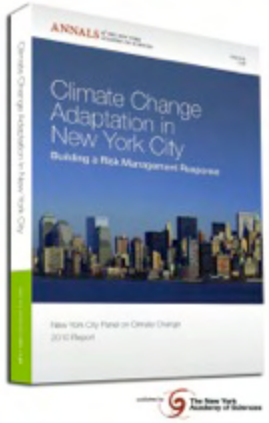
5) Smart Policies: e.g. PlaNY2030 / NPCC / ClimAID, ...

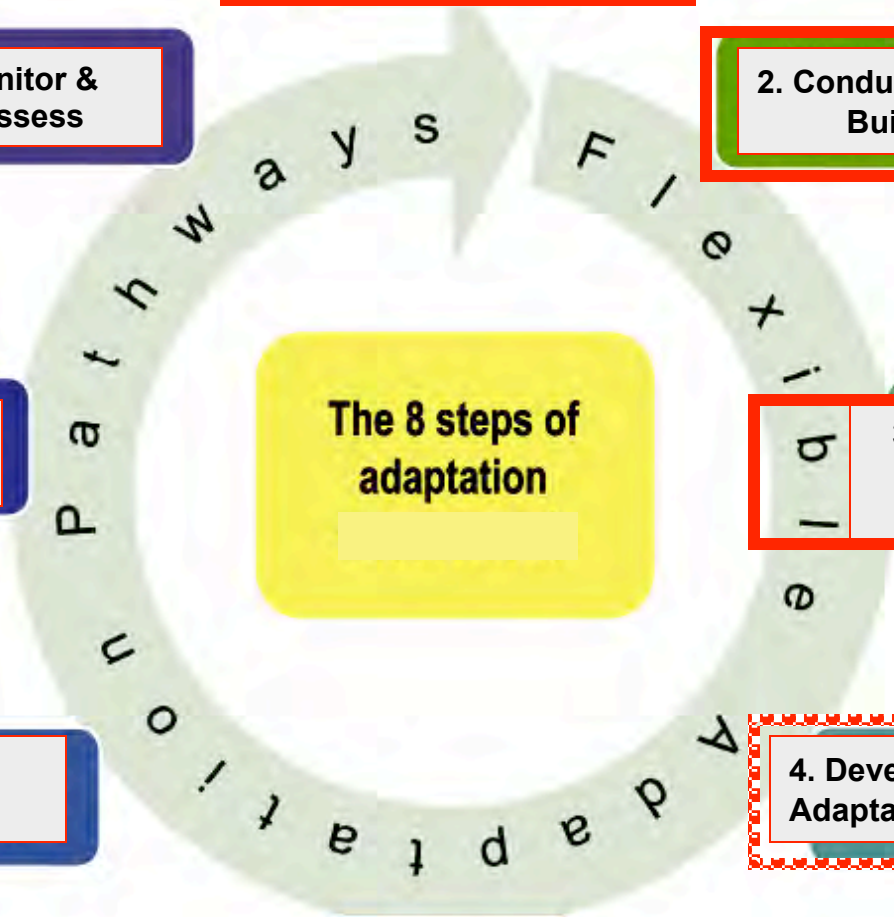
- Capital Investments into *CC-Mitigative & Adaptive* Infrastructure & Landuse are Part of a Smart Growth Path.
- Investments can Achieve Gains for *Today's* Communities (Safety, Health, Quality of Live, 'Green City'), but also Leave in Place a Better Legacy for ***Future*** Generations.

Project-specific temporary steel barriers, require timely deployment

Washington Harbor, D.C.

NPCC-Recommended Adaptation Steps





1. Identify current & future climate hazards

2. Conduct Inventory of Built Assets

3. Characterize Risk of CC on Built Assets

4. Develop Initial Adaptation Strategies

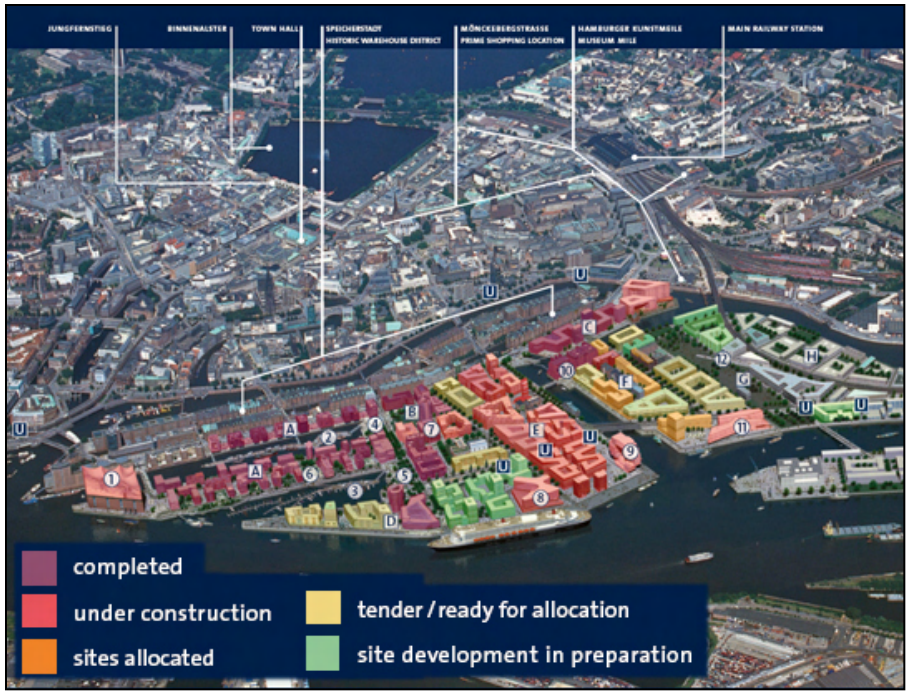
5. Identify Opportunities for Coordination

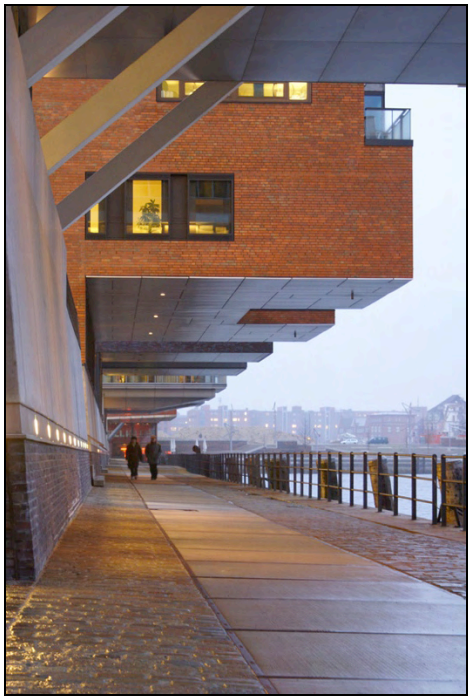
6. Link Strategies to Development Cycles

7. Implement Adaptation Plans

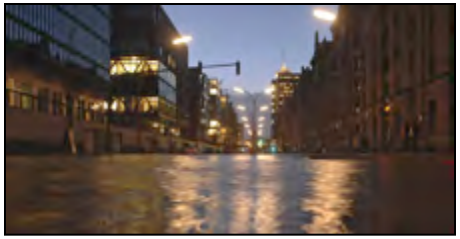
8. Monitor & Reassess

http://onlinelibrary.wiley.com/doi/10.1111/j.1749-6632.2010.05324.x/pdf

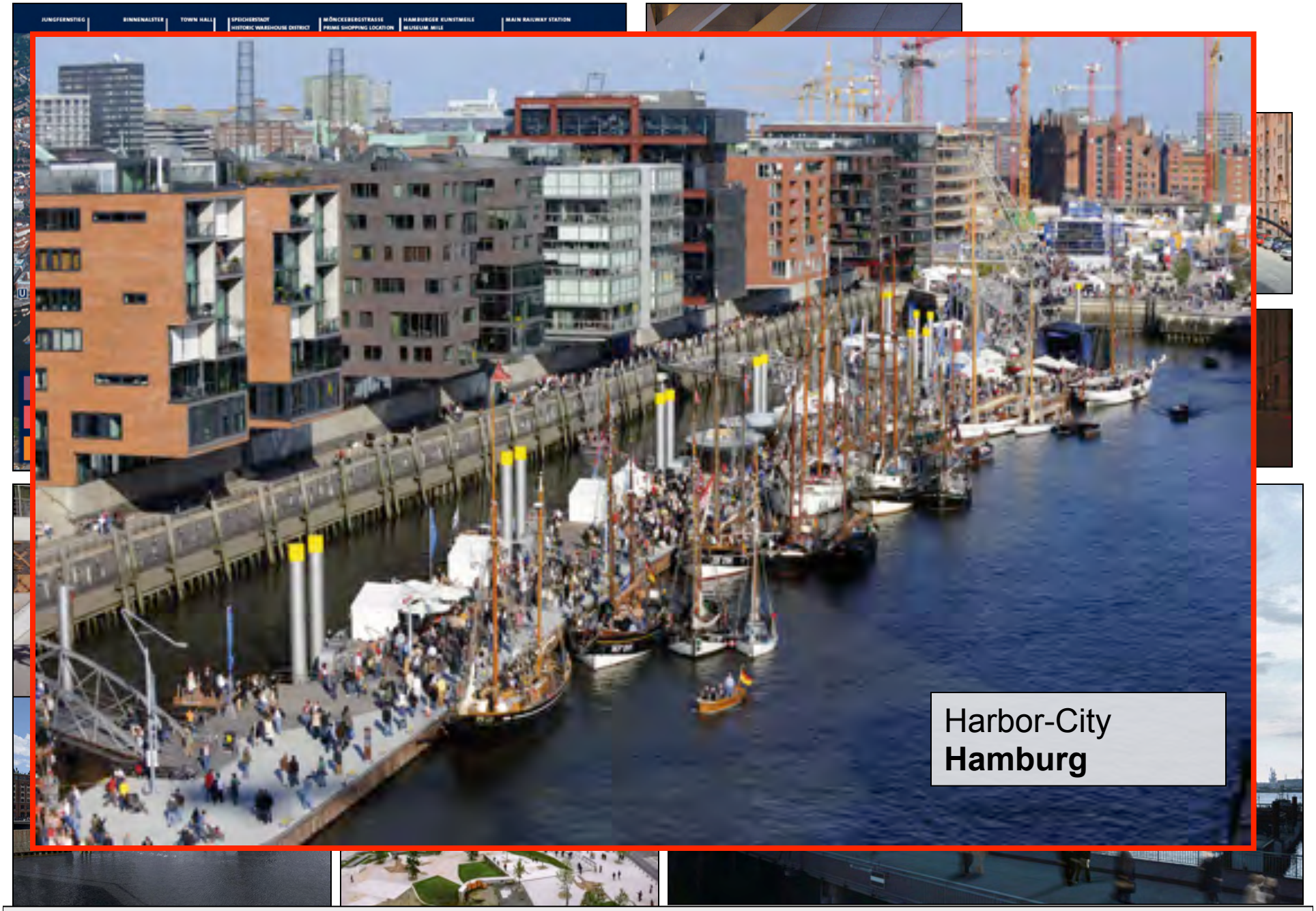




Harbor-City
Hamburg

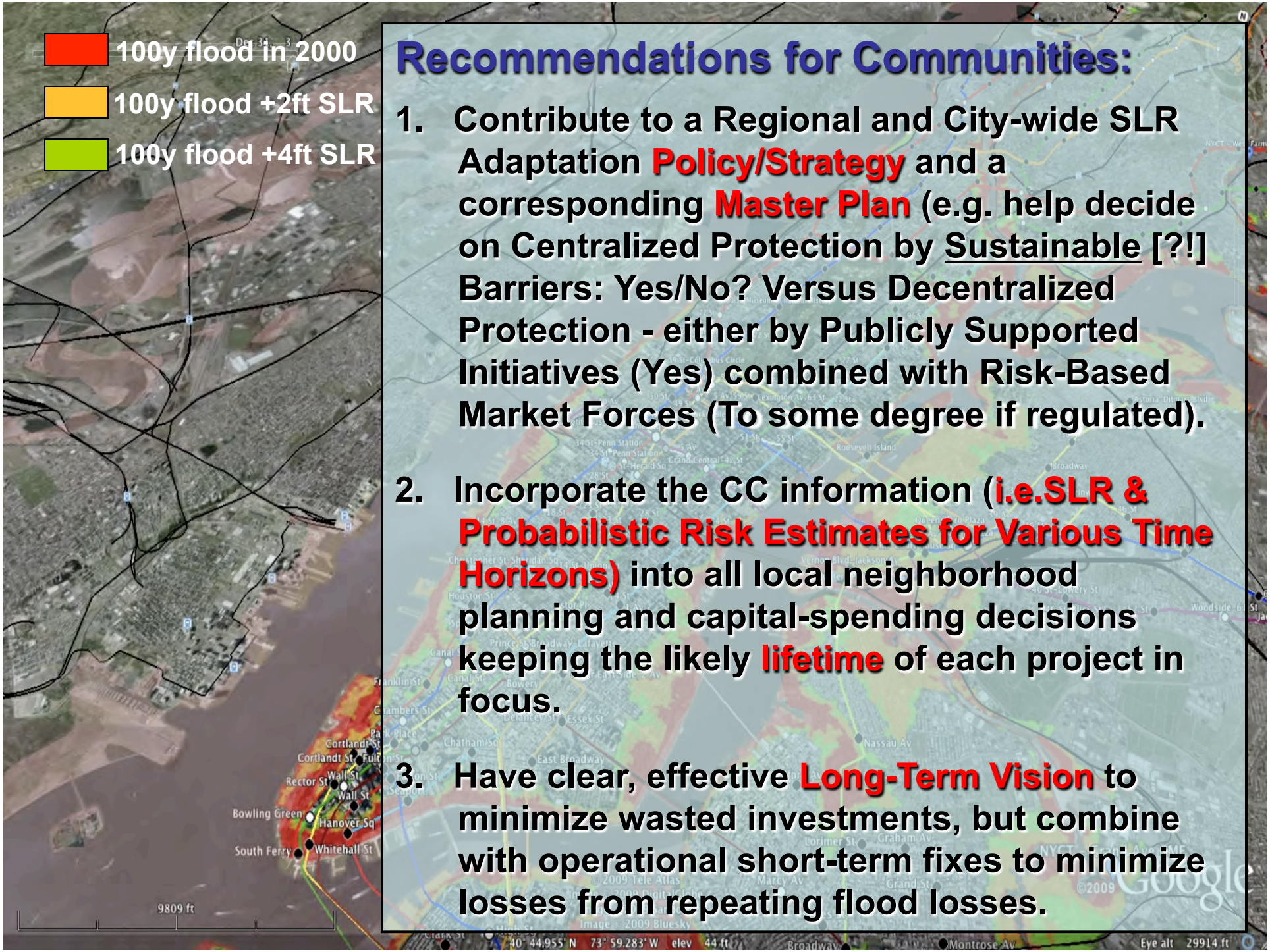


http://green-changemakers.blogspot.com/2010/09/hafencity-case-study-on-future-adaptive.html



Harbor-City
Hamburg

http://green-changemakers.blogspot.com/2010/09/hafencity-case-study-on-future-adaptive.html

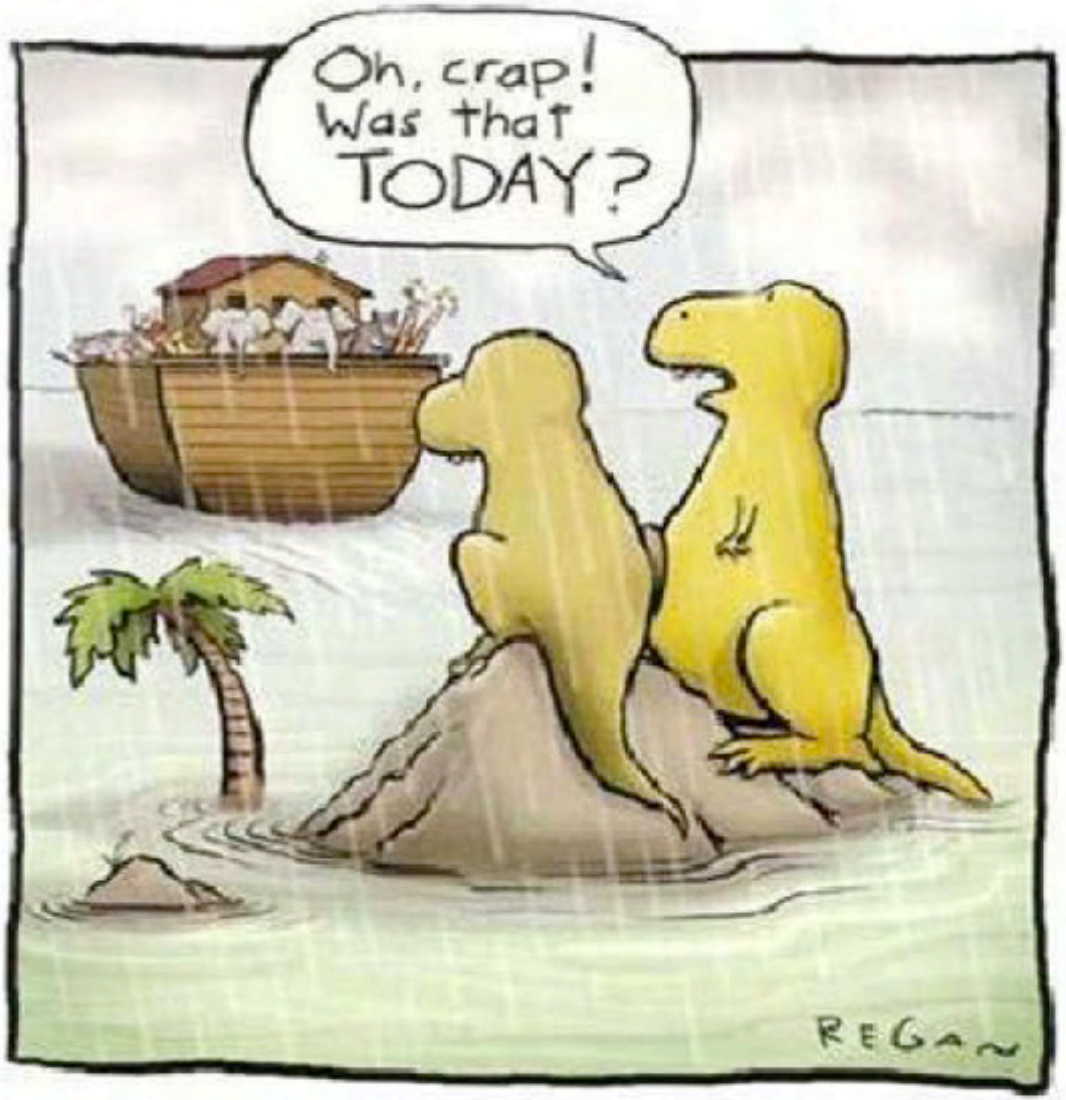


Recommendations for Communities:

1. Contribute to a Regional and City-wide SLR Adaptation **Policy/Strategy** and a corresponding **Master Plan** (e.g. help decide on Centralized Protection by <u>Sustainable</u> [?!] Barriers: Yes/No? Versus Decentralized Protection - either by Publicly Supported Initiatives (Yes) combined with Risk-Based Market Forces (To some degree if regulated).

2. Incorporate the CC information (**i.e.SLR & Probabilistic Risk Estimates for Various Time Horizons)** into all local neighborhood planning and capital-spending decisions keeping the likely **lifetime** of each project in focus.

3. Have clear, effective **Long-Term Vision** to minimize wasted investments, but combine with operational short-term fixes to minimize losses from repeating flood losses.



Timing will be of Essence !

Thank You !