MODELING RISKS TO INFRASTRUCTURE IN URBAN AREAS

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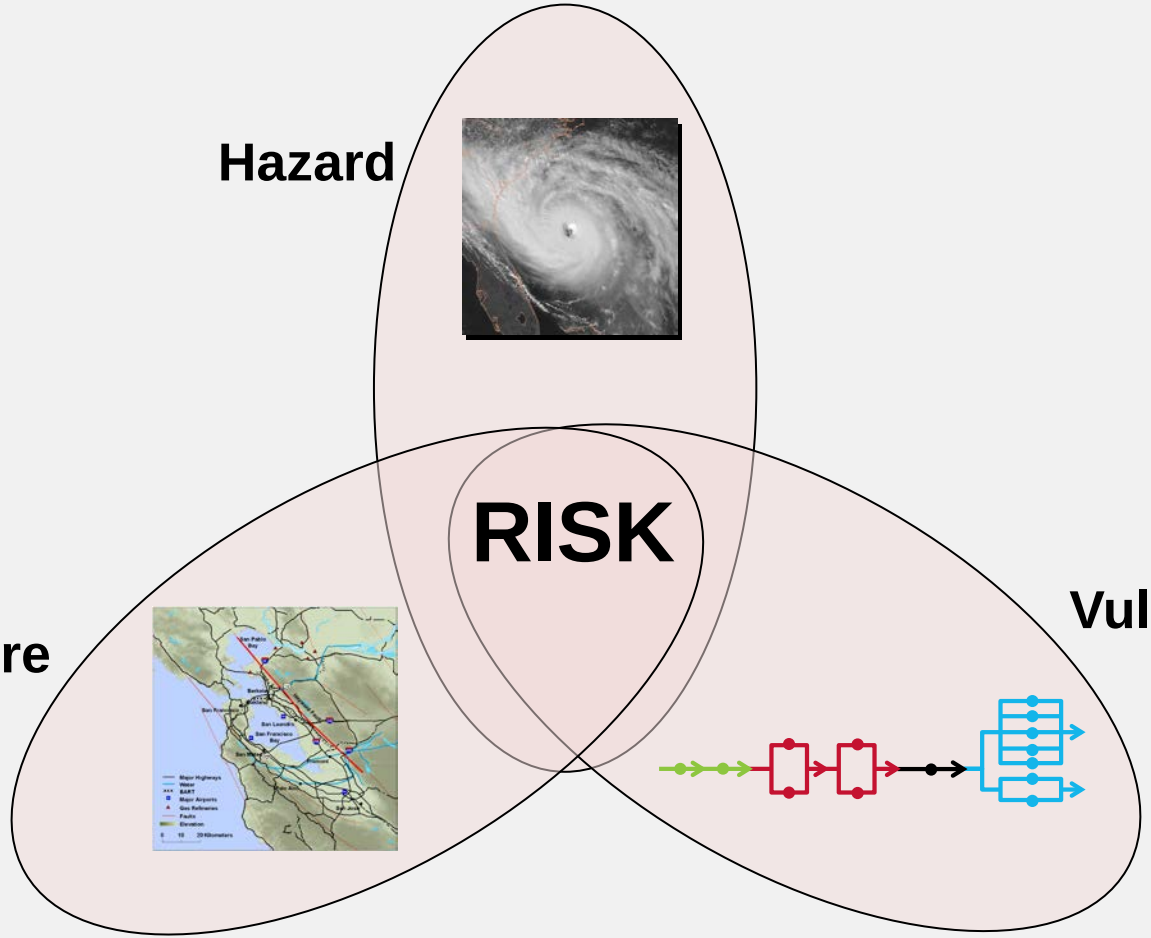
Presentation for FRBNY Conference
November 1, 2013

RMS

OVERVIEW

1. What are the challenges in modeling catastrophe risk?
2. How do the models evaluate critical infrastructure risk?
3. What do catastrophe models tell us about critical infrastructure risk?
    - Example of transportation network
4. What are best practices in utilizing catastrophe models?

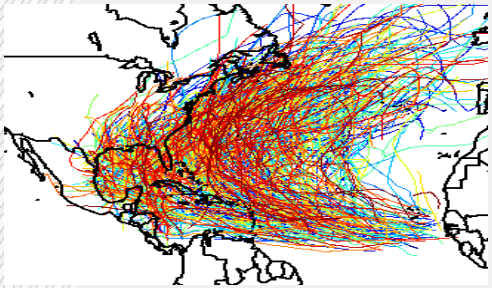
Modeling Catastrophe Risk to Infrastructure



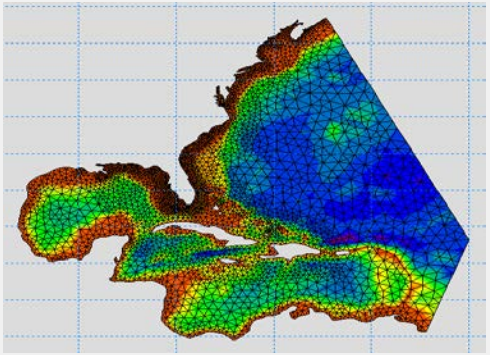
CHALLENGES IN MODELING CATASTROPHE RISK: HAZARD

- Hazard
  - Models provide a **representation** of complex physical phenomena
  - The historical record of events is **not complete** and must be supplemented
  - For high resolution perils (e.g., storm surge), models require **supercomputing resources**

RMS Hurricane Track Set



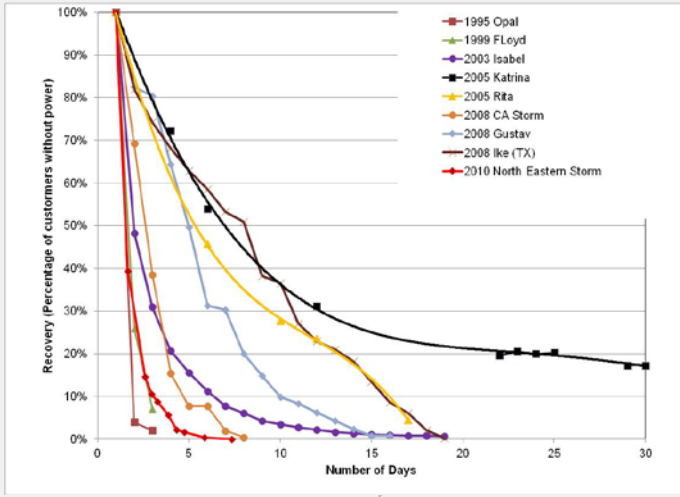
Regional Surge Model



CHALLENGES IN MODELING CATASTROPHE RISK: EXPOSURE & VULNERABILITY

New York MTA

- Exposure
  - Infrastructure (transportation, water, electric and gas power, etc.) is comprised of **integrated and correlated** subsystems that are **geographically dispersed**
  - Infrastructure represented by networks of **nodes and links**
- Vulnerability
  - **Detailed network analysis (**to estimate interruption of service) is best accomplished through **simulation**



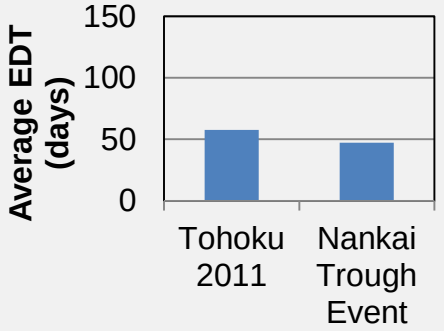
EVALUATION OF INFRASTRUCTURE RISK

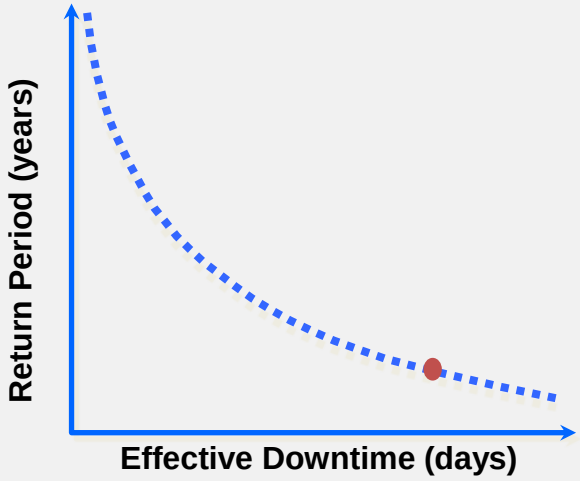
TYPES OF ANALYSIS

- **Probabilistic** analysis using model stochastic event set
- **Scenario** analysis using historical event or customized event footprint

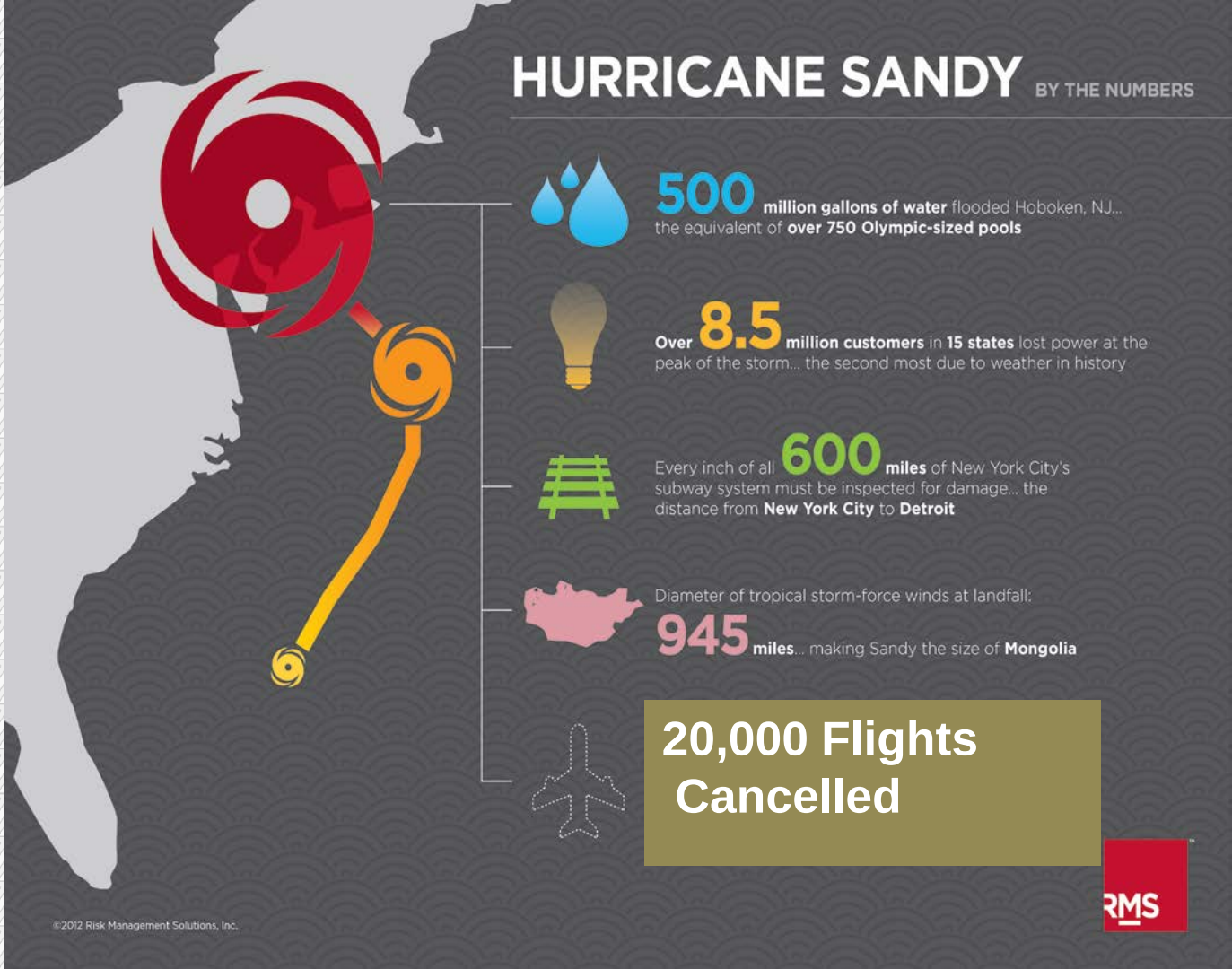
RISK METRICS

- Effective Downtime (EDT)
- Average Annual Downtime
- Return Period Downtime
- Probable Maximum Loss = Downtime * Revenue





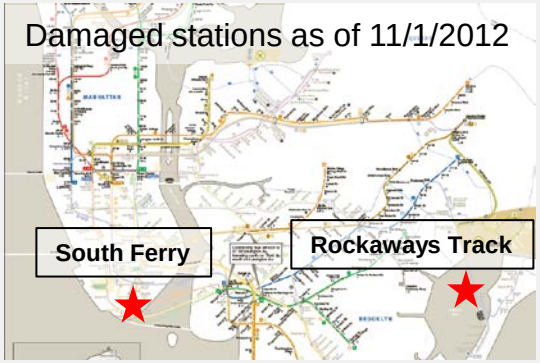
IMPACT OF HURRICANE SANDY



HURRICANE SANDY'S IMPACT ON NEW YORK MTA

Structural losses: $4.75b ($1.06b covered by private insurance; $2.73b covered by FEMA)

Operating loss: $268m (Loss of "fare and toll" revenue along with the necessary expenses to prepare for and reestablish services after the storm)

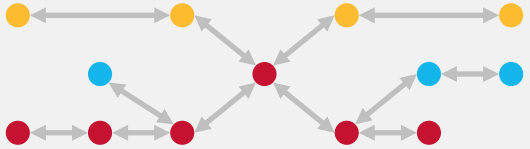



South Ferry

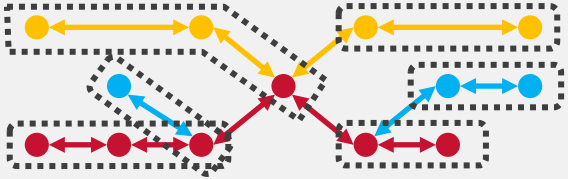

Rockaways track

NETWORK ANALYSIS OF NEW YORK MTA

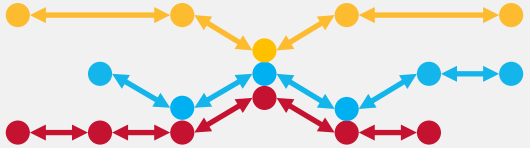
- Case 1: All stations are independent.
  - Damage to any station doesn't propagate to the other stations.



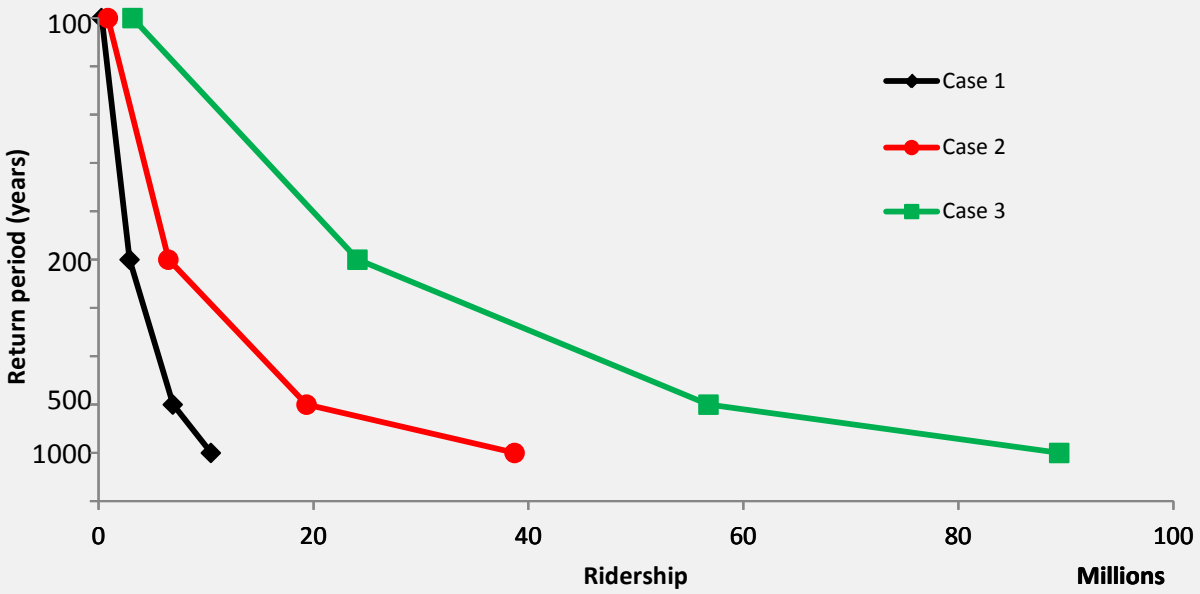
- Case 2: Multiple segments in each line.
  - Damage to any station stops operation of its segment.



- Case 3: Stations are connected by serial connection within each line.
  - Damage to any station stops operation of entire line.



RETURN PERIOD DOWNTIME



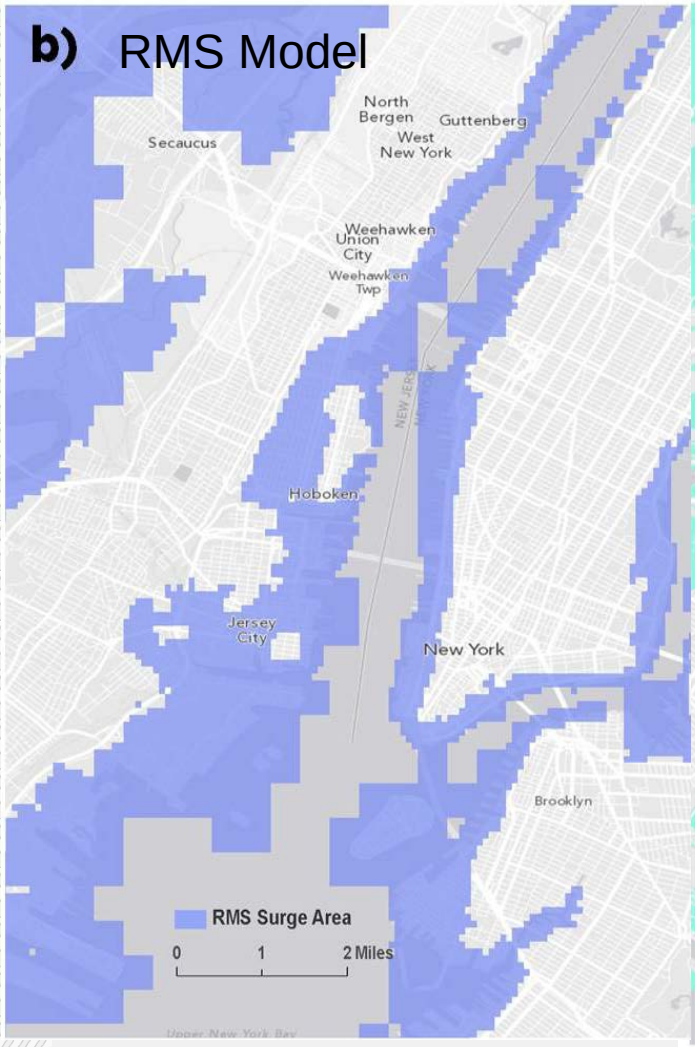
FOR ILLUSTRATIVE PURPOSES ONLY

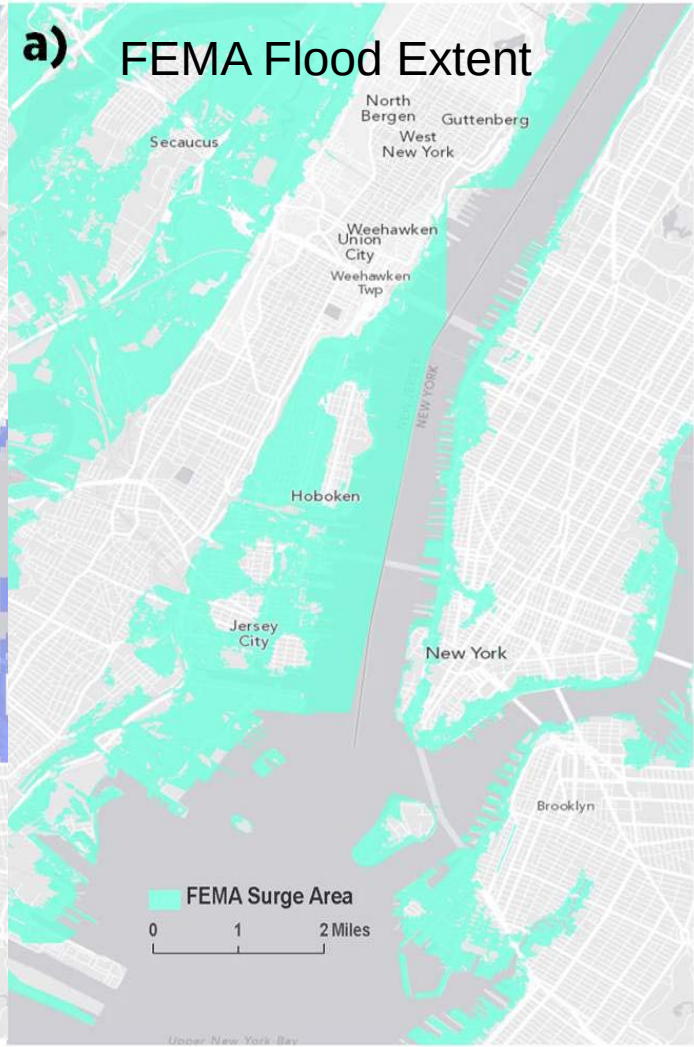
BEST PRACTICES IN MODELING CATASTROPHE RISK

- Models are comprised of formulas, assumptions, parameterizations, and corollaries to similar environments
  - Know the modeling assumptions
  - **Compare** and validate **against real world events**
- Models allow for the calculation of future expected loss and the quantification of uncertainty around results
  - Explore uncertainty through stress testing

RMS SURGE EXTENT VERSUS FEMA FLOOD ZONES

100m VRG resolution of flooding in RMS model as good as best data developed by FEMA using detailed engineering studies.





THANK YOU