SKANSKA

Climate Change Symposium

Sustaining Coastal Cities

Challenges with the Built Environment

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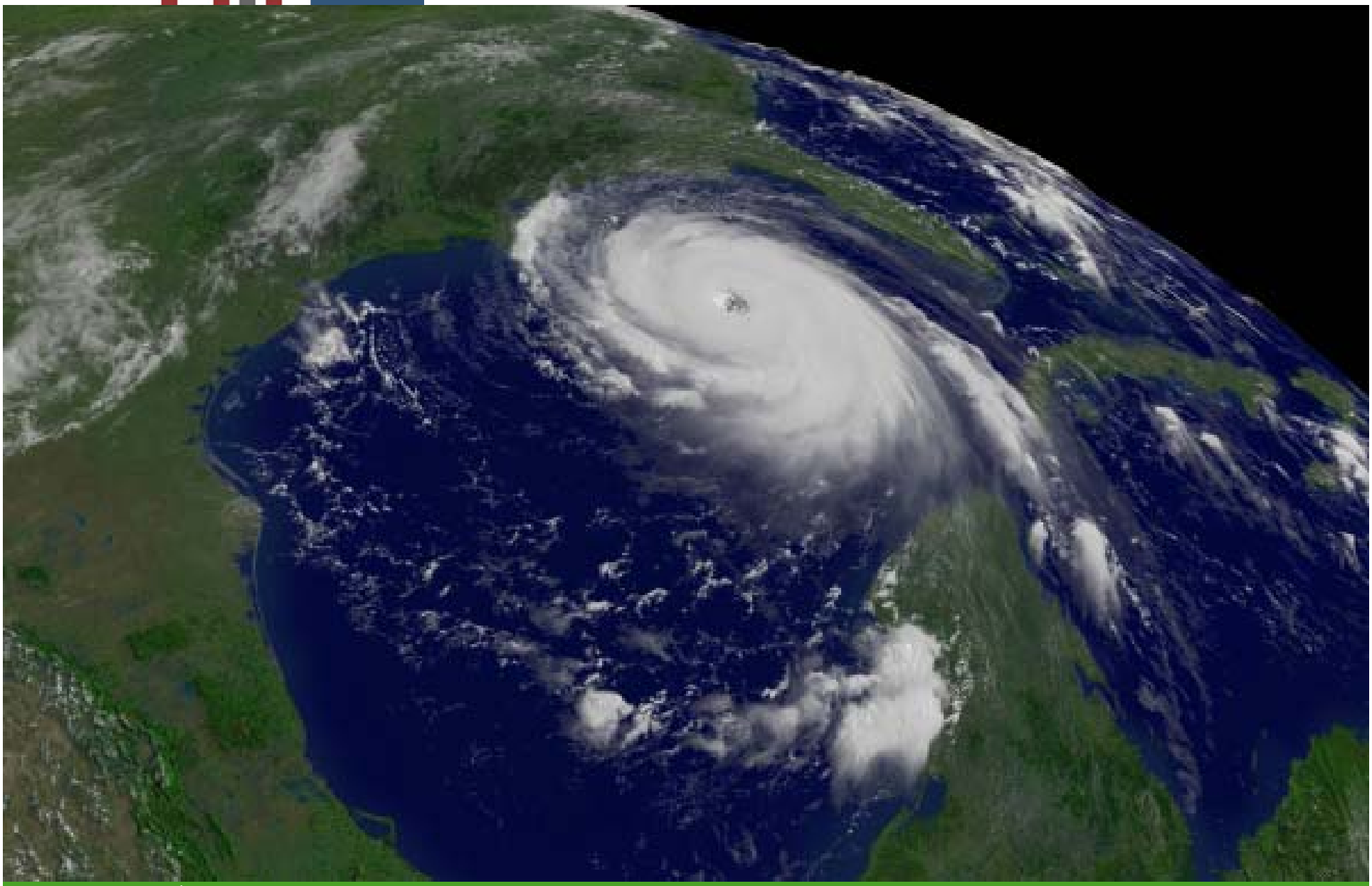
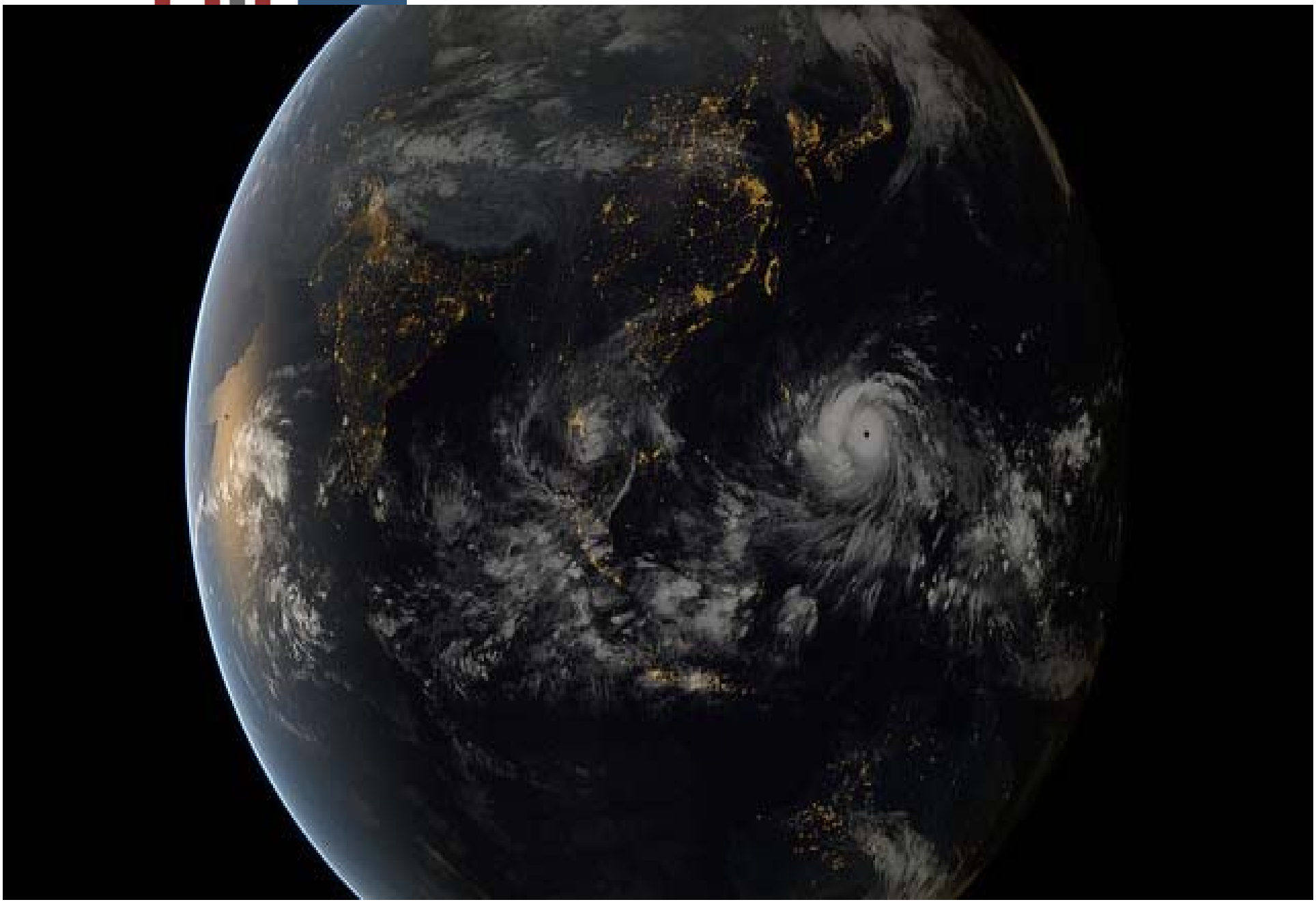
Background & Context: Area of Focus

- Impacts & Adaptation around the Built Environment
- Why do buildings respond as they do?
- What are the ways to evaluate adaptation measures?
- Focused on single purposed buildings, infrastructure systems or networks

Observations



CLIMATE CHANGE SYMPOSIUM



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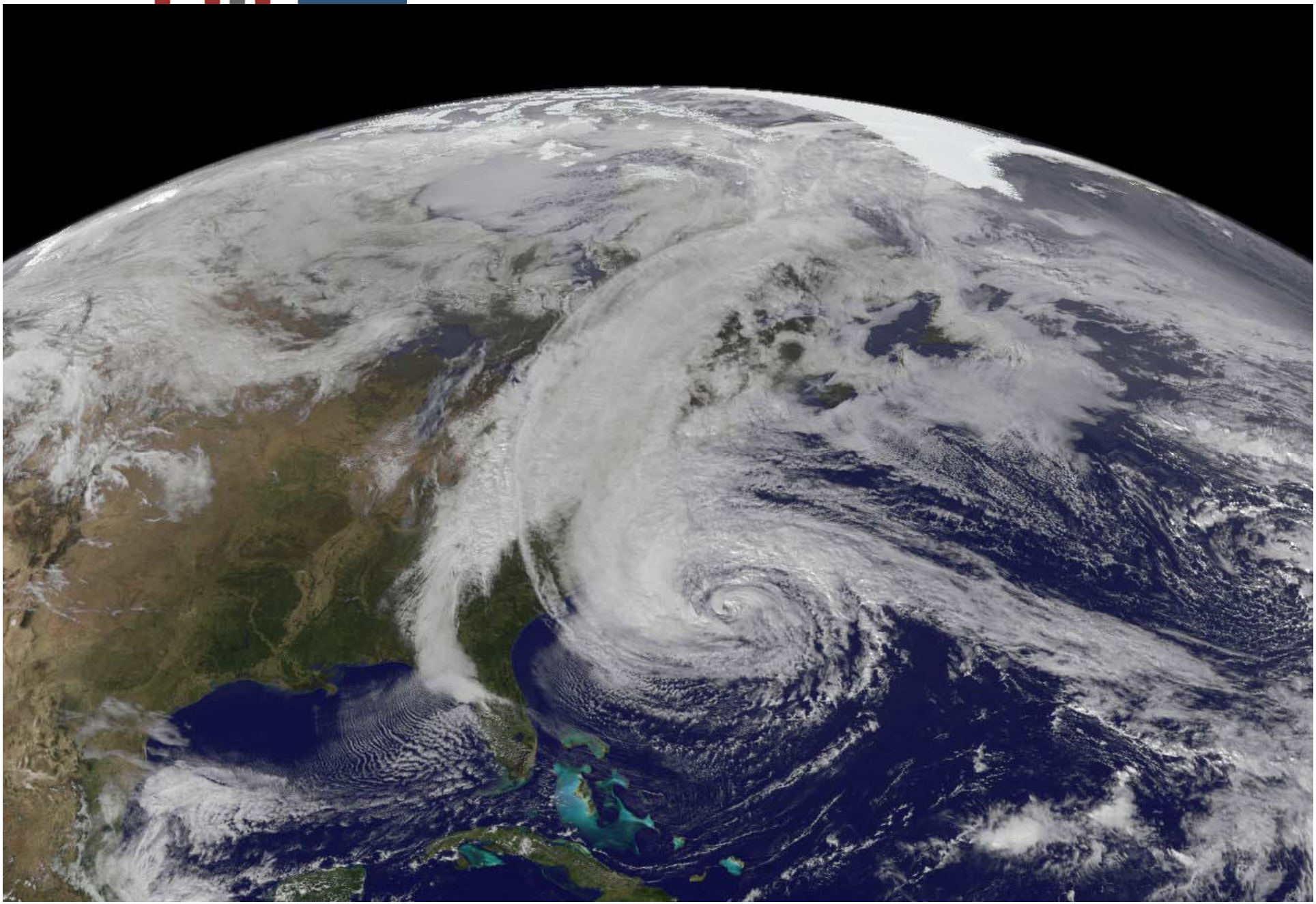
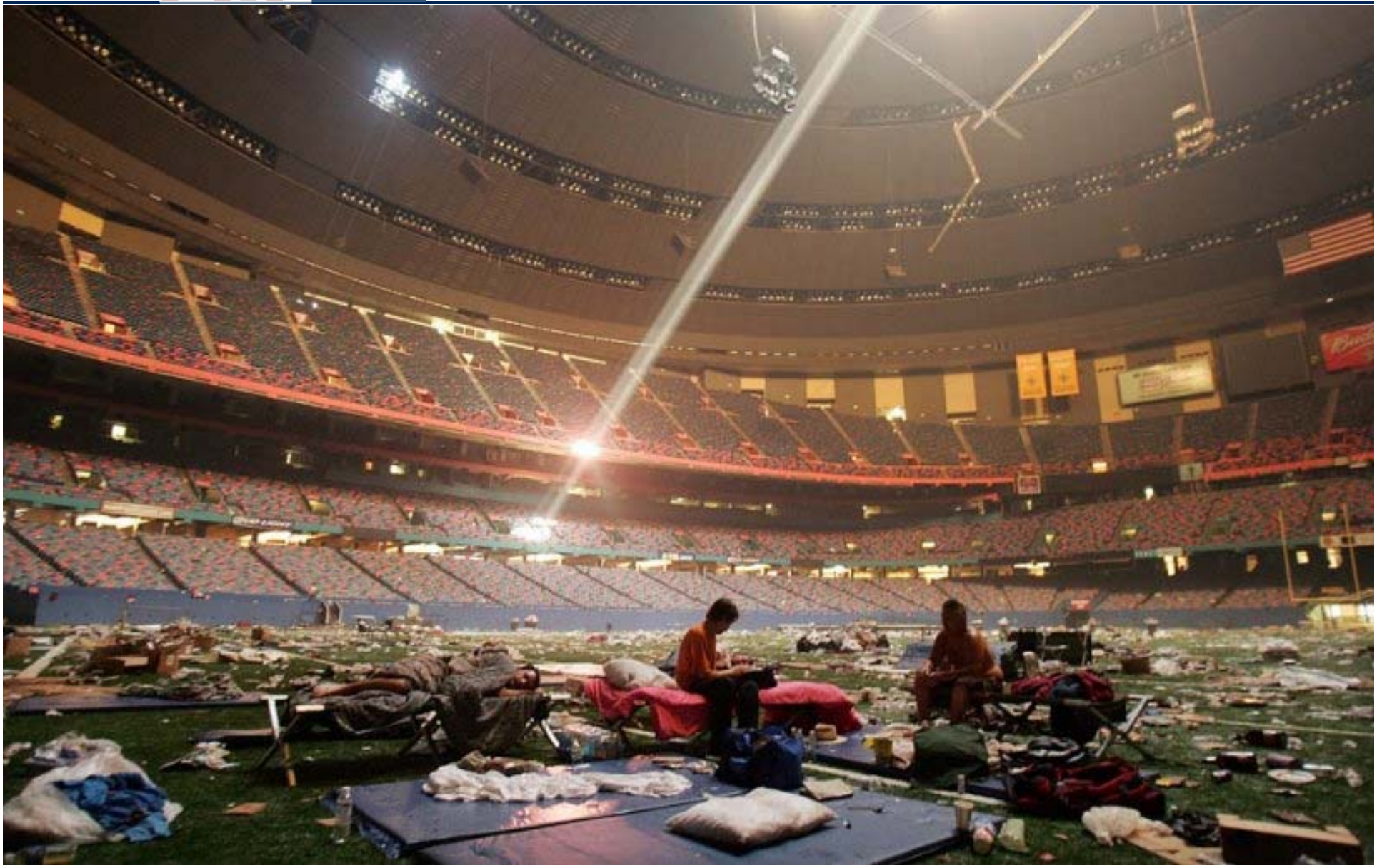


Outcomes

MIT Sea Grant

CLIMATE CHANGE SYMPOSIUM


POLICE

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CLIMATE CHANGE SYMPOSIUM

Current Approaches; where are we now?

- The strategies that currently make for good design are often counter to resiliency planning where you place critical assets out of harms way
- Critical utilities co-located for serviceability
- Areas of refuge are external
- Life Safety systems designed for occupant protection & egress e.g. elevator recall
- As result These buildings have a high degree of survivability from internal events
- Redundant strategies largely based on maintaining utilities & fuel supply

New Resiliency Paradigm Required

- New approach and metrics needed; What makes a successful resilient design?
- Take into account current climate vulnerability as well as future events
- Need to future-proof for low probability major events
- No longer designed for min safety and to allow people to get out of the building
- Many facilities will need to be able to support a minimum operational condition during extended periods of outages
- E.g. Dual electric feeds was a resilient strategy, now in-situ generation given consideration.

How do we get there?

- Guessing on current strategies to plan for a future which we know is uncertain
- Predictive modeling inherently brings uncertainty
- Complex systems that are being evaluated
- Two dimensions of uncertainty
  - Predicting what will happen (severity)
  - Predicating when it will happen (probability)

- How to overlay and apply business case real world requirements to events that haven't happened for business case justification and pay off

Barriers

- Lack of awareness or an unsupportive institutional environment
- Conflicting priorities and time pressures which can lead to long delays
- A tendency to focus on the short-term
- Resistance to organizational change

Existing Business Environment

- Scarcity of capital
- Not immediately tangible (although awareness is rising)
- Business / Investment climate operates with a short term perspective
- Long term defensive strategies with complex paybacks are hard to sell
- Adaptation investment could be perceived as taking resources away from core business mission; delivering healthcare, manufacturing products etc.

Evaluation & Assessment

- Review Climate Model
- Identify Risk
- Assess Vulnerability
- Develop Adaptation Measures
- Quantify analysis
- Implement
- Monitor & Improve

Methodology

- Two main aspects
  1) Identification of the adaptation measure
     - Structured decision making
  2) Quantification and Implementation
     - Utilizes Benefit/Cost & Net Present Value to normalize these effects

Evaluation Tools

- Combination of weighted risk analysis & structured decision making
- SWOT
- Kepner Tregoe
- Sensitivity analysis
- Monte Carlo
- Tracer analysis
- Impact assessment

Key Questions

- What data is required?
- Where does this data come from, and how is it evaluated?
- How to translate the science data into assessment and evaluation of vulnerabilities?
- Basis is not typical, compared and modeled against the cost of doing nothing. all while doing this on a conceptual predictive basis

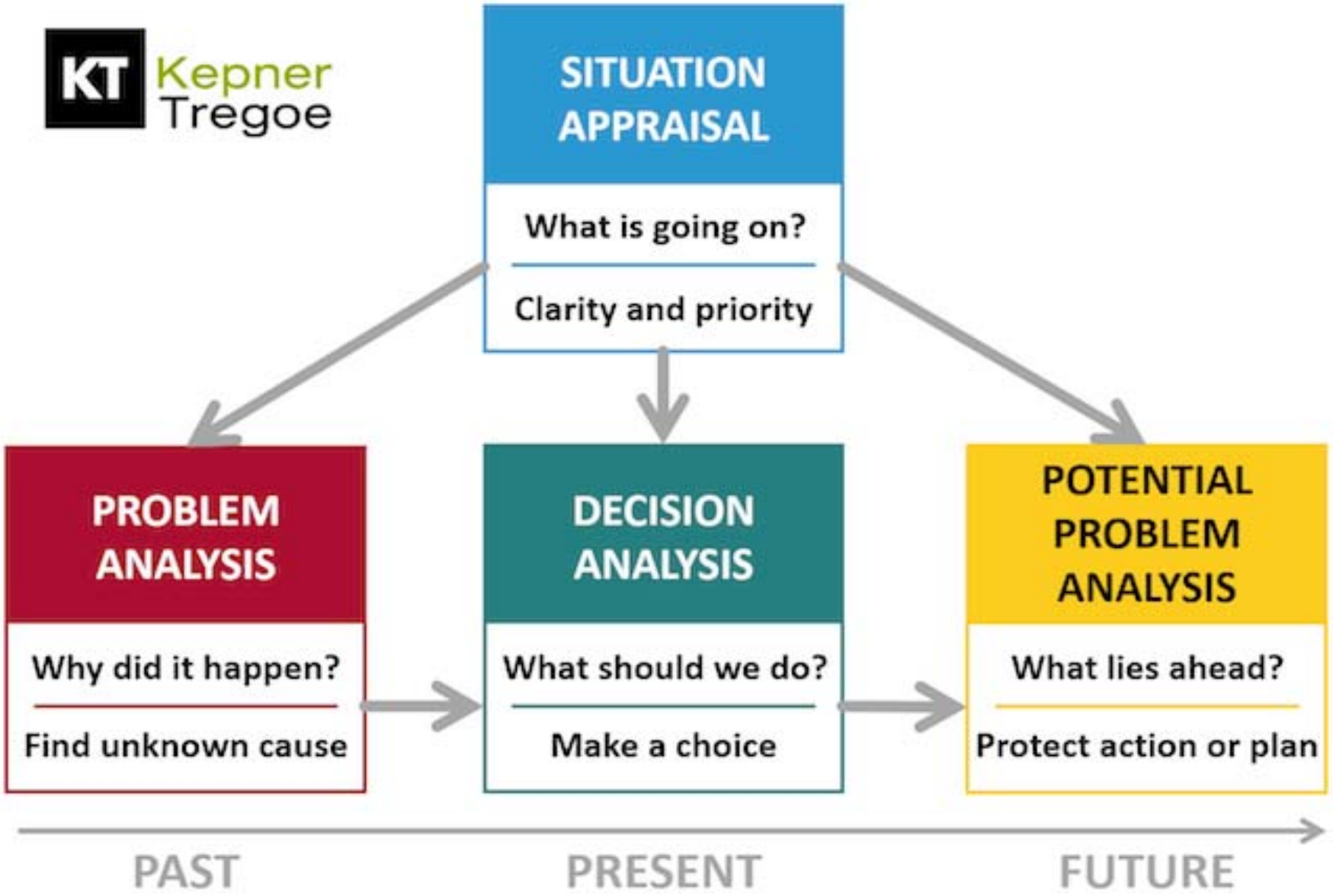
Attributes of methodology

- How does the absence of costs or costs avoided factor into an evaluation
- Where to direct investment to achieve the highest level of protection
- How can these adaptation steps be incorporated as part of a larger capital investment plan
- Analysis Considers:
  - Cost of doing nothing
  - Operational cost impacts
  - Full scope of the mitigation
  - Quantification of avoided costs
  - Not only first costs, secondary and tertiary costs
  - Operational impacts & cascading effects

Key Considerations

Identify Cost and Risk-Significant Items Only

- Risks that increase rapidly due to climate change
- Look for thresholds that once crossed kick off other responses e.g. power outages
- Risks with a long planning and implementation horizon
- Evaluate and prioritize risks relative to other known risks
- Recognize the uncertainties associated with the information


KT Kepner Tregoe
SITUATION APPRAISAL
What is going on?
Clarity and priority
PROBLEM ANALYSIS
Why did it happen?
Find unknown cause
DECISION ANALYSIS
What should we do?
Make a choice
POTENTIAL PROBLEM ANALYSIS
What lies ahead?
Protect action or plan
PAST
PRESENT
FUTURE

Example of weighted analysis

Item	Potential Adaptation Measures: (Please note: the key task for now is to edit this list of potential measures.)	Summary-Level Analysis: Buildings	Summary-Level Analysis: Neighborhoods	Summary-Level Analysis: Infrastructure	Summary-Level Analysis: Average Rating	Engineering Analysis: Initial Cost	Engineering Analysis: Life Cycle Cost	Engineering Analysis: Construction Complexity	Engineering Analysis: Permitting & Approvals Complexity	Engineering Analysis: Environmental Impacts	Engineering Analysis: Navigation Impacts	Engineering Analysis: Reliability/ Effectiveness	Engineering Analysis: Average Rating	Combined Score
	HARD ADAPTATION MEASURES (Traditional Civil Engineering)													
A	**Harbor/Coastline**													
A.1	Storm Surge Gates (Movable Elements)	3	2	3	2.67	1	1	1	1	*	*	*	1.00	1.83
A.2	Sea Wall (Fixed)													
A.3	Levees (Fixed)													
A.4	Wetlands - Reclamation/Recreation													
A.5	Wetlands - Floating	2	2	2	2.00	2	2	2	1	3	*	2	2.00	2.00
A.6	Other TBD													
B	**Transportation Systems**													
B.1	Tunnel Improvements (Highway/MBTA)	0	0	3	1.00	2	3	2	3	3	0	3	2.29	1.64
B.2	Raised Subway Grates, Entrances, & Air Vents	0	0	3	1.00	3	3	3	2	3	0	3	2.43	1.71
B.3	Floodable Roadways													
B.4	Flood-Resistant Evacuation Routes													
B.5	Other TBD													
C	**Buildings**													
C.1	Building Hardening - Commercial													
C.2	Building Hardening - Residential													
C.3	Building Hardening - Governmental													
D	**Power/Utilities/Communications**													
D.1	Water/Sewer Infrastructure - TBD													

Summary-Level Analysis — Rating System

3 Most Advantageous
2 Moderately Advantageous
1 Least Advantageous
0 Not Applicable
* No Data

Engineering Analysis — Rating System

3 Least Costly & Complex; Lowest Constructability Challenge; Least Env. Impact; Greatest Reliability; Lowest Navigation Impact
2 Average Scores Across All Categories
1 Most Costly & Complex; Greatest Constructability Challenge; Worst Env. Impact; Lowest Reliability; Worst Navigation Impacts
0 Not Applicable
* No Data

Attributes of Costs; considered & not considered

- Loss of life
- Injury and cost of treatment see Jones pdf attachment
- Types of adaptation local S1 & Regional S2
- Focused on S1
- Focused on current and future storms this adds a difficulty factor
- Building code considerations Single event catastrophic vs probable

Financial calculations

- Utilize both NPV and B/C calculations
- NPV calculations show the amount of economic benefit of the capital deployed
- Include avoided damages in cost model
- Benefit / Cost ratio show the efficiency of an adaptation measure
- For any given year, evaluate the benefit of the adaptation strategy against its cost at and appropriate discount rate

Attributes of Methodology

- Reverse root cause
- Trace nodes back to the most effective adaptation
- Similar to Forward Pass and then Backward Pass
- In this case it's a backward pass and then a forward pass

Summary Approach & Conclusions

- Start with today's climate variability and extremes to identify risks and opportunities for longer-term climate change.
- Adaptive management and continuous improvement will reduce uncertainty and improve decision-making
- Drive to find the most cost and risk effective adaptation options
- Look for synergies and adaptation measure that cross protect other assets
- Monitor and evaluate the effectiveness Make climate action and risk assessment part of SOP

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Thank You

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References

- Supplementary Materials for
- **Evaluating Flood Resilience Strategies for Coastal Megacities**
- Jeroen C. J. H. Aerts, W. J. Wouter Botzen, Kerry Emanuel, Ning Lin, Hans de Moel, Erwann Michel-Kerjan
- *Corresponding author. E-mail: erwannmk@wharton.upenn.edu
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