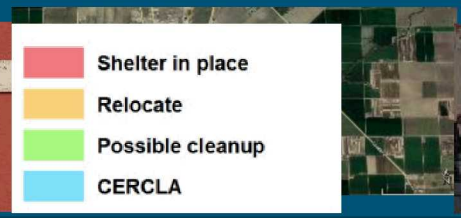
SAND2020-4173PE

ECONOMIC IMPACTS OF A RADIOLOGICAL DISPERSAL DEVICE PRESENTED TO NAS APRIL 2020

Vanessa Vargas
Lawrence Trost

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.
SAND XXXX-XXXX



ORS PM: Mark West

We did a series of studies to provide a technical basis for radiological material security programs.

- **Motivation**
- Approach
- The NYC 2017 study
- The Category III Scenario
- The California 2019 Study
- Overall Conclusions

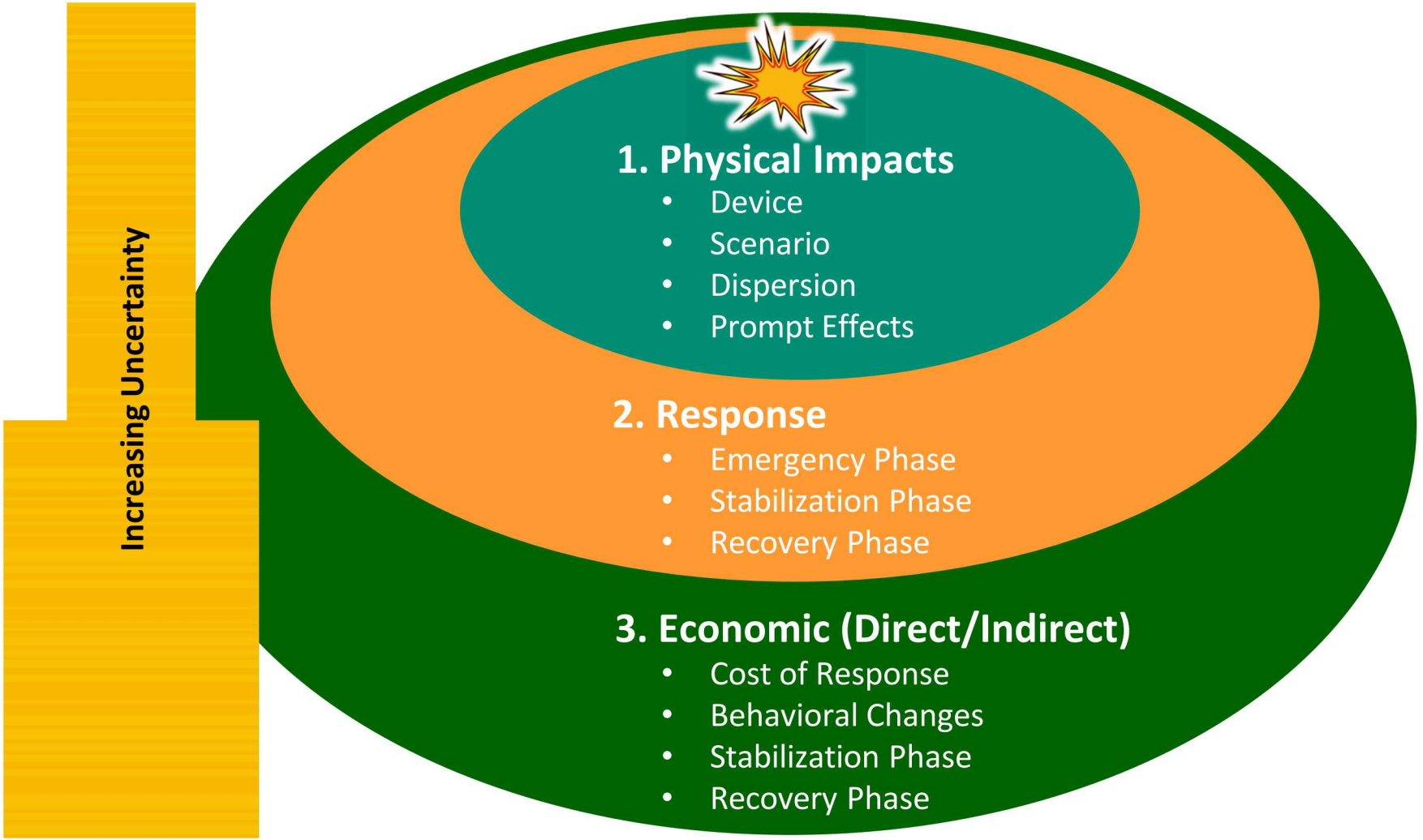
Motivation: Develop a rigorous understanding of the consequences and impacts from the malevolent use of radiological material (e.g., RDD).

Significant economic impacts shown by NA21/ORS study in 2006-2008 by LANL & SNL.

New modeling tools and data from Fukushima, as well as other incidents since 2008, allow for more rigorous analysis.

We did studies involving urban and rural targets.

The analysis is in three parts:
Physical impact, response, economic impact



Key tools and data allow detailed analysis

Physical Analysis

TurboFRMAC (used for contamination dose rates)

Quick Urban Industrial Complex (QUIC) (used for outdoor dispersion)

Below Ground Model (BGM) (used for subway infiltration and transport)

Probabilistic Anthrax Risk Assessment Tool (PARAT) (used for building infiltration)

Specialized Hazard Assessment Response Capability (SHARC) (used for blast casualty analysis)

DOE OGT Study (used for wall contamination)

Landscan data developed at ORNL (used for population estimates)

Response Analysis

Prioritization Analysis Tool for All-Hazards/Analyzer for Wide-Area Restoration Effectiveness (PATH/AWARE) (used for Lower Manhattan and Brooklyn)

Resource Estimation and Scheduling Tool for Optimized Recovery (RESTORe) (used for evaluating subway restoration)

EPA 2016 PAG Manual (used for response levels)

Various radiological response and recovery plans used for emergency response

Economic Analysis

Regional Economic Accounting Tool (REAcct) (used for first year impacts)

Regional Economic Models Inc. (REMI) (used for multiple year impacts)

Zip code business patterns from Bureau Economic Analysis (BEA) (business impact analysis)

Various Fukushima Reports (used for evacuation deaths and perceptual effects)

Outreach

NYC Office of Emergency Response (OER)

NYC Fire Department (FDNY)

California Governor's Office of Emergency Services (EOS)

California Department of Food and Agriculture (CDFA)

California irrigation district officials

California county agricultural officials

National Urban Security Technology Laboratory (NUSTL)

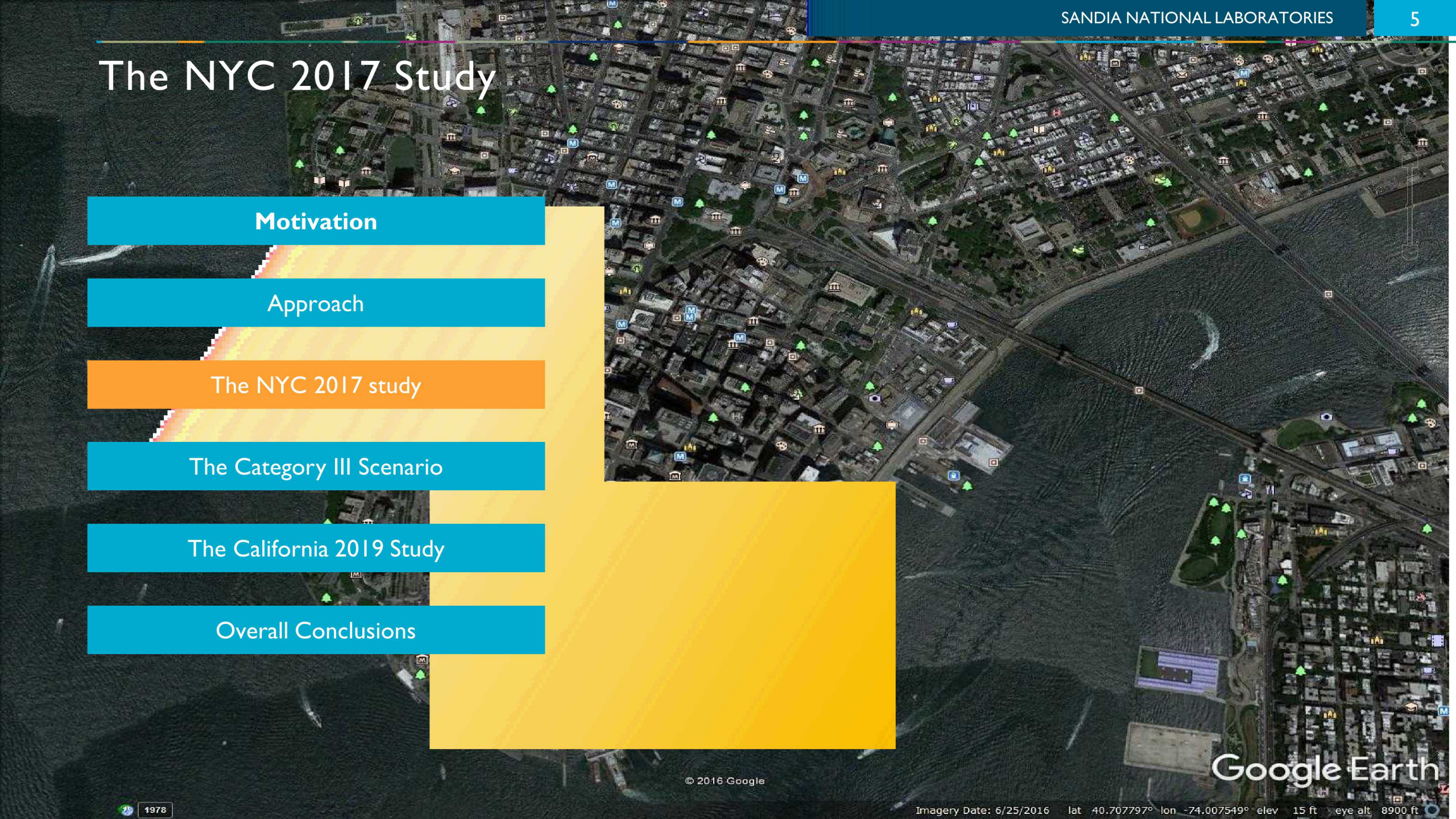
Los Alamos National Laboratory (LANL)

Argonne National Laboratory (ANL)

Regional Economic Models Inc (REMI)

The NYC 2017 Study

- **Motivation**
- Approach
- The NYC 2017 study
- The Category III Scenario
- The California 2019 Study
- Overall Conclusions



First study: Consequences for an RDD event in an urban area

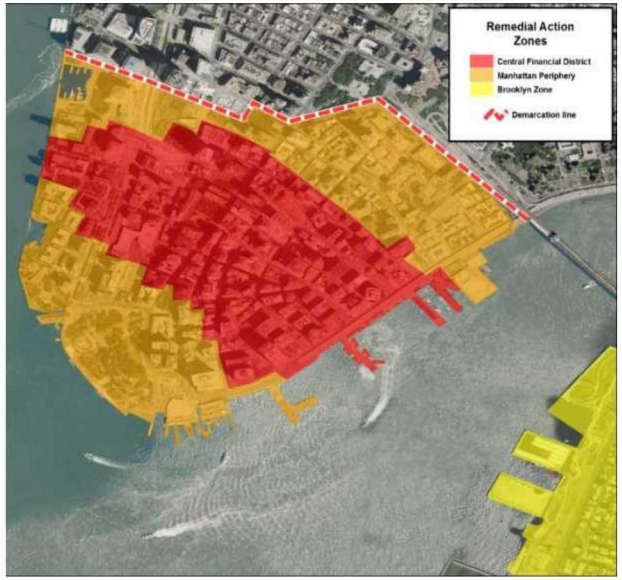
Representative, not worse case, scenario defined for a New York City Scenario.

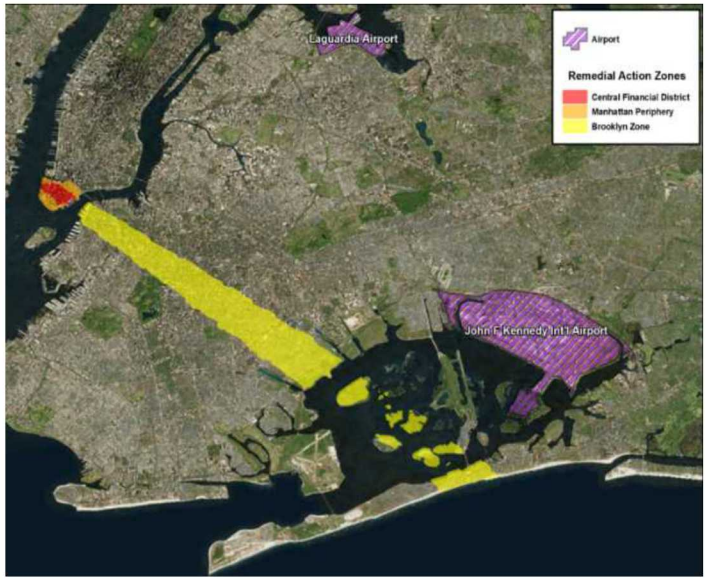
Scenario

- Lower Manhattan.
- Prevalent weather conditions.
- Tall buildings accounted for.
- Device design aligned with threat definition.

Assumptions

- Threshold of action defines actions and area of concern.
- Prompt and affective response protocols for analysis.





The study used the US relocation threshold of 5mSv/2yr, which is guidance, not the law.

Response activities define many of the costs.

195,000 people evacuated could cause a significant number of deaths.

Event (40 min.)	Emergency Phase (4 days)	Stabilization (10 days)	Recovery (10 years)	
				
▪ Plume rises following release. ▪ Plume extends beyond New York City area into ocean. ▪ Some serious casualties and deaths from bomb blast only.	▪ Public safety protocol: shelter in place. ▪ All businesses shut down. ▪ Some subways stations closed.	▪ Closure line established by protocol. ▪ Survey, evacuation and relocation.	▪ Indoor / Outdoor decon and disposal. ▪ Exterior and interior remediation.	▪ Outer areas (Brooklyn) below response levels (shown in yellow). ▪ Some wash down of public buildings.

Assumed perfect availability of resources

Event lasts for 40 minutes.
However, remediation can last 10 years.
New York City is very, very well prepared and that was accounted for in the study.

Decontamination activities differ by zone, level of effort

Manhattan: Major Remediation

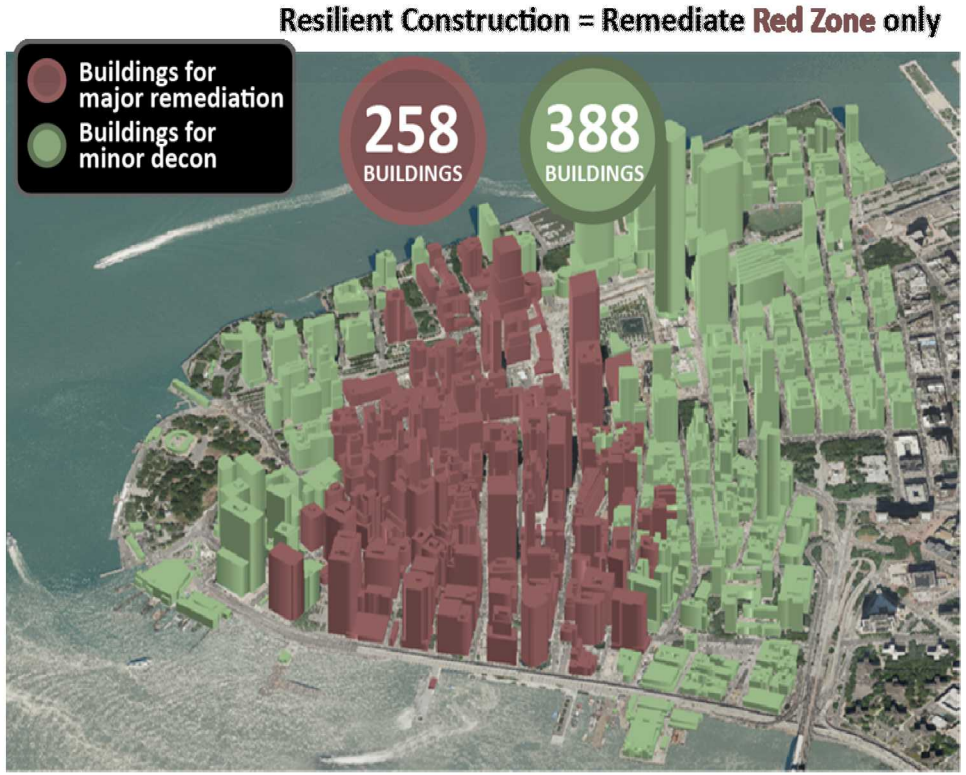
- **Streets, sidewalks, and open spaces**: removed and resurfaced
- **Building interiors**: decontaminated using scabbling and strippable coatings
- **Rooftops**: scabbled or stripped of their membranes
- **Building facades**: removed and replaced if possible. Scabbling and/or demolition are last resort.

Manhattan: Minor Remediation

- **Interior floors, walls, and ceilings**: decontaminated using strippable coatings

Brooklyn

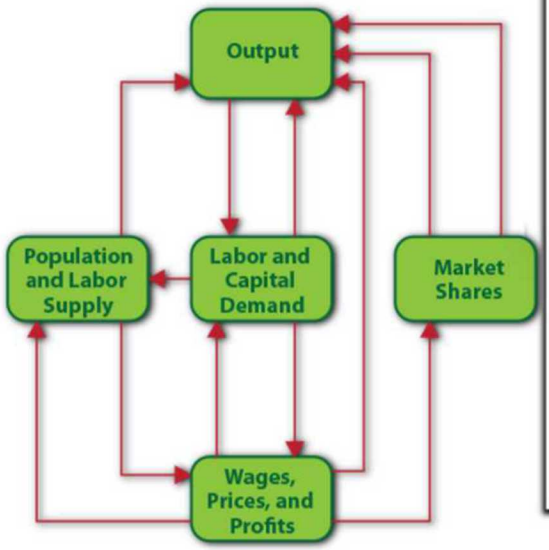
- **Private property**: owners will assume responsibility for cleanup (if any)
- **Public buildings:** interior floors will be decontaminated using strippable coatings



- **Building-by-building analysis reduces cost and time from one size fits all approach: Façade replacement.**
- **Costs highly dependent on actual decontamination effectiveness.**

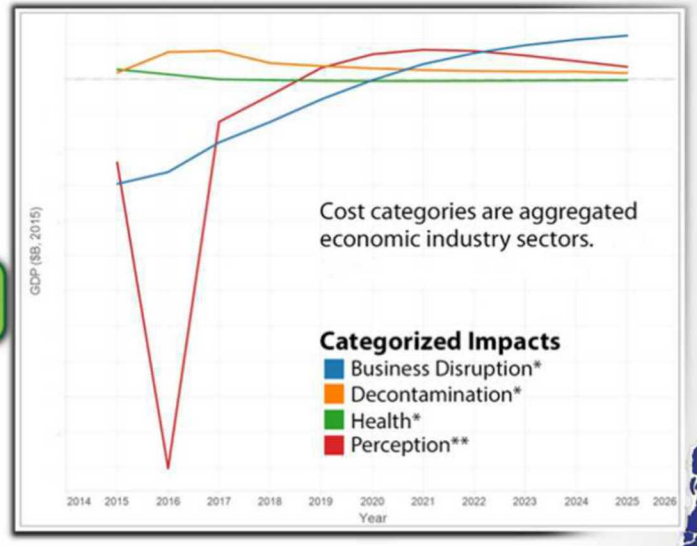
Total US economic consequences:
Net 10's of $Billions GDP Loss over 10 Years

The economy: circular and dynamic

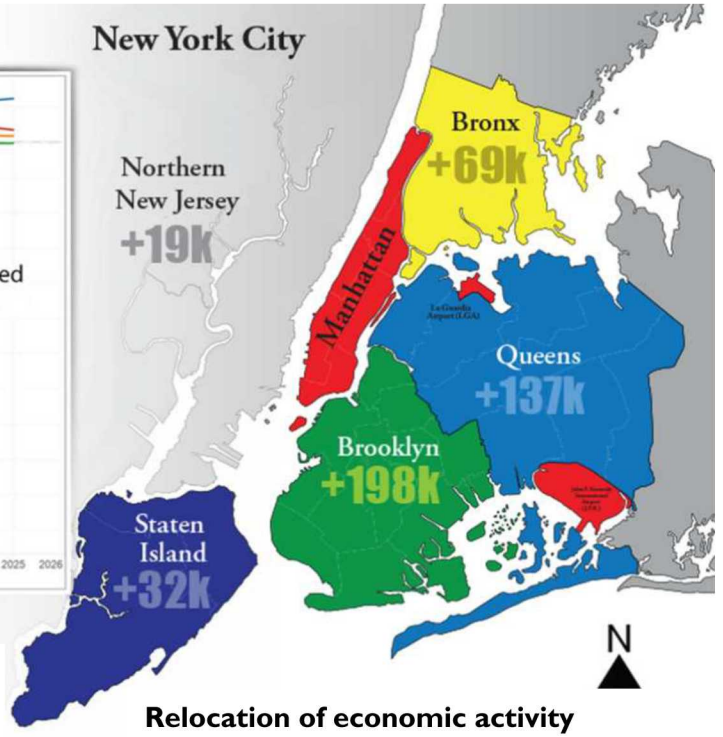


Output generates employment, employment generates income, income generates demand for and spending on new output, new output generates new employment, *and so on*.

Output (GDP) contributed by activity



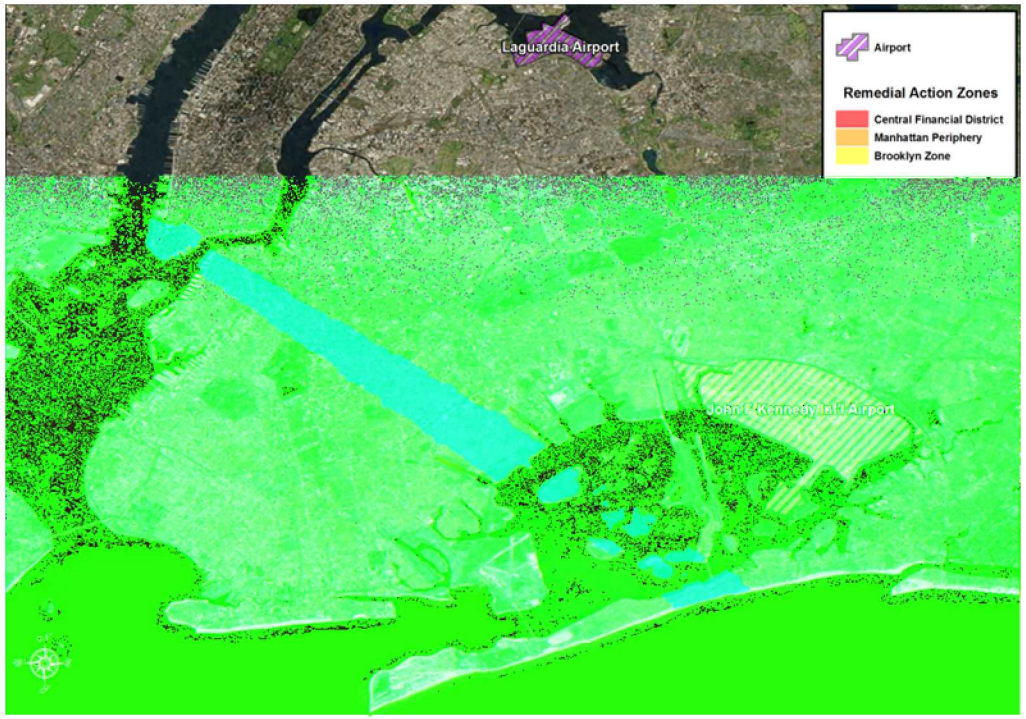
***Recovery efforts are likely to be funded by federal government spending, resulting in increases in output.**
**** Perception is based on tourism patterns observed post-Fukushima.**



Relocation of economic activity within the NYC MSA. It is assumed businesses and employees will behave similar to observed post 9/11 relocation patterns.

GDP impacts are not intuitive.
They can be negative or positive, but all represent economic disruption.

The insights are as important as the consequence numbers



Cost and human impact:

- Evacuation deaths could be significant.
- Perception and avoidance largest economic impact.
- Modeled low interior contamination levels reduced demolition significantly.

Regional/national effects:

- Regional impacts vary tremendously.
- Multi-year analysis showed recovery possible.
- Limited national effects found in the analysis.

Scenario/analysis factors:

- Wind direction and speed.
- Different city with less redundancy and resilience.
- Other business types that are difficult to relocate.
- Delays in remediation actions.
- Lower contamination action level.

Would the U.S. maintain its world financial standing after an RDD attack in lower Manhattan?

The Category III Scenario

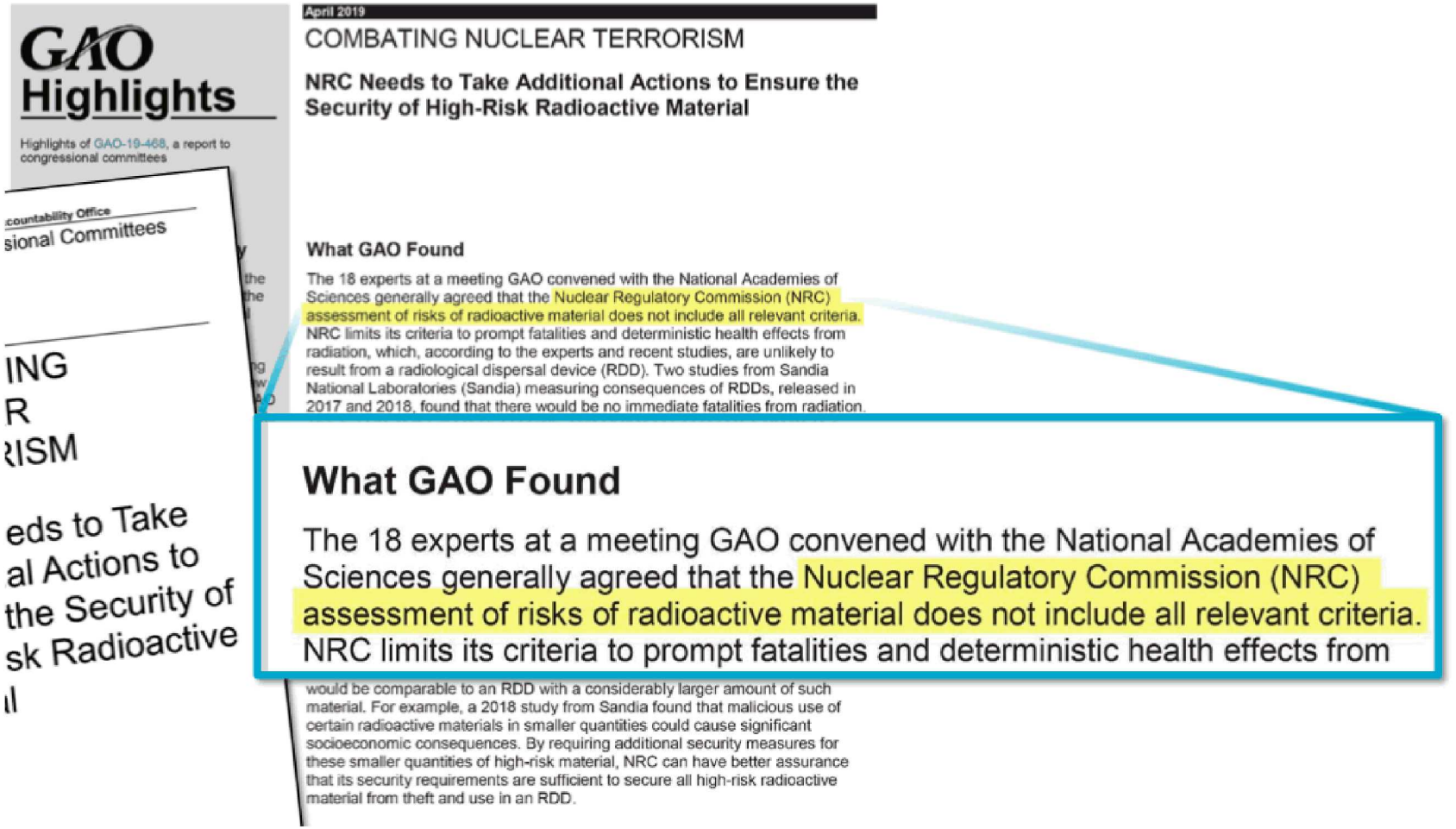
Motivation
Approach
The NYC 2017
The Category III S
The California 201
Overall Conclus

Second study: As part of a GAO study, SNL was asked to examine an RDD scenario with a relatively small, Category III source.

In 2018 time frame, GAO visited SNL as part of a study on security standards for radioactive material.

As security requirements are partially based upon material quantity, GAO desired to know more about effects of a relatively small release. Sandia was asked to repeat the NYC scenario with a small, Category III source.

Sandia performed a quick study leveraging the NYC 2017 Study.



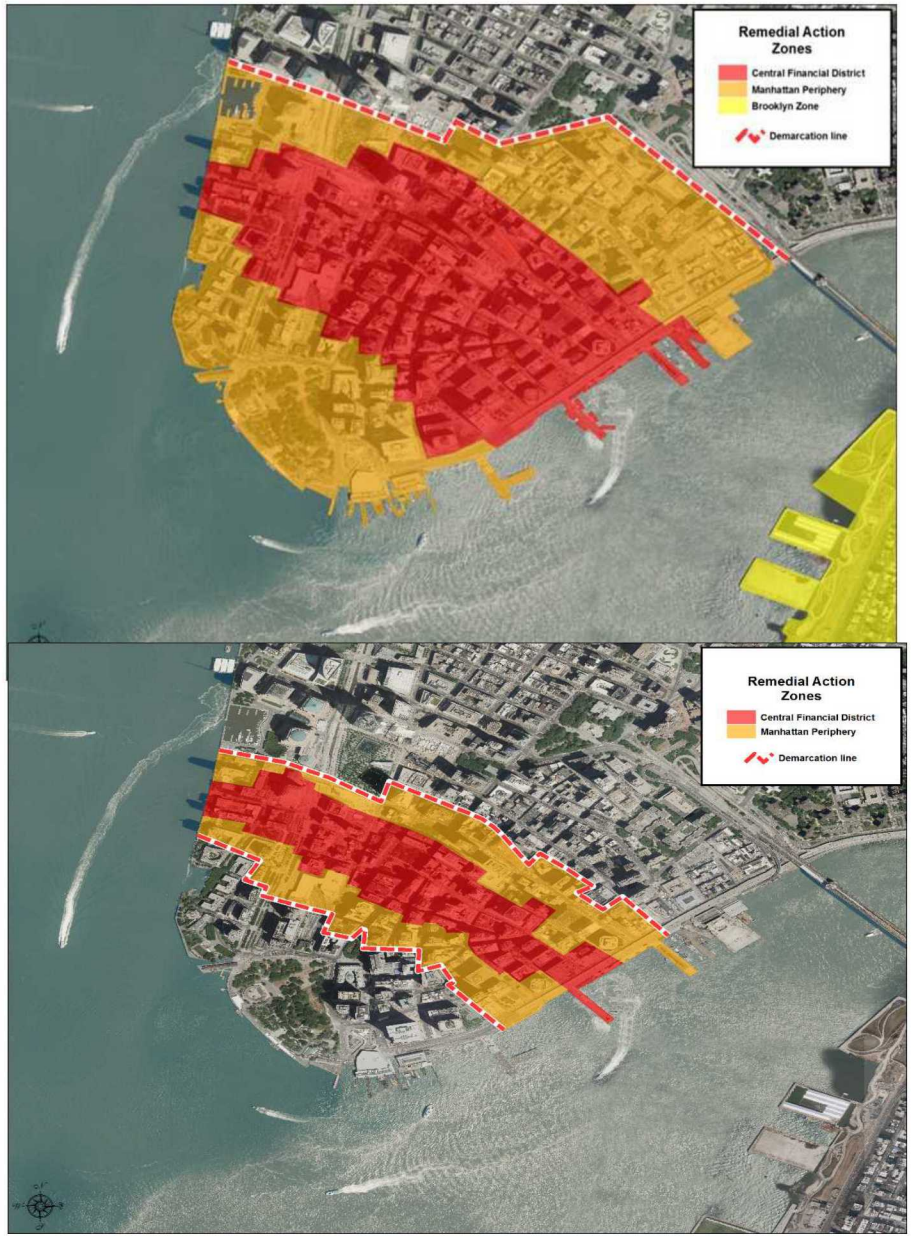
The Category III Scenario is an excursion on the NYC Scenario.

An excursion was performed on the NYC scenario to examine the effects of a smaller release.

A much smaller RDD was employed in a scenario identical in other respects to the 2017 NYC study.

A reduction of > 90% in released material only produced a reduction in GDP effect of 20%.

Psychosocial effects predominated.



The California 2019 Study

Motivation

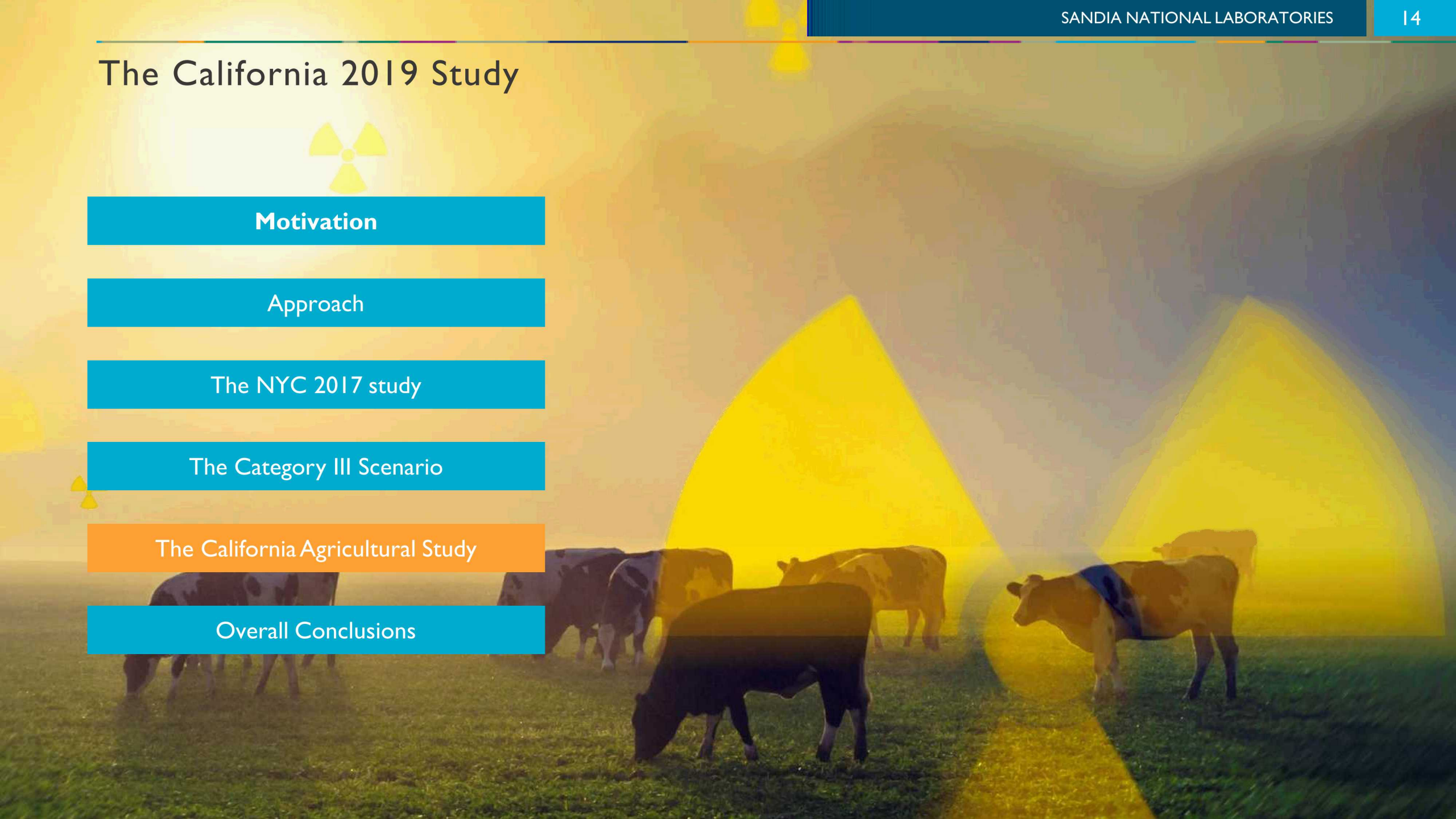
Approach

The NYC 2017 study

The Category III Scenario

The California Agricultural Study

Overall Conclusions



Third study: A deep dive into a scenario of a rural area event.

Scenario

- An RDD scenario in a rural area, targeting the agricultural industry.

Key Features

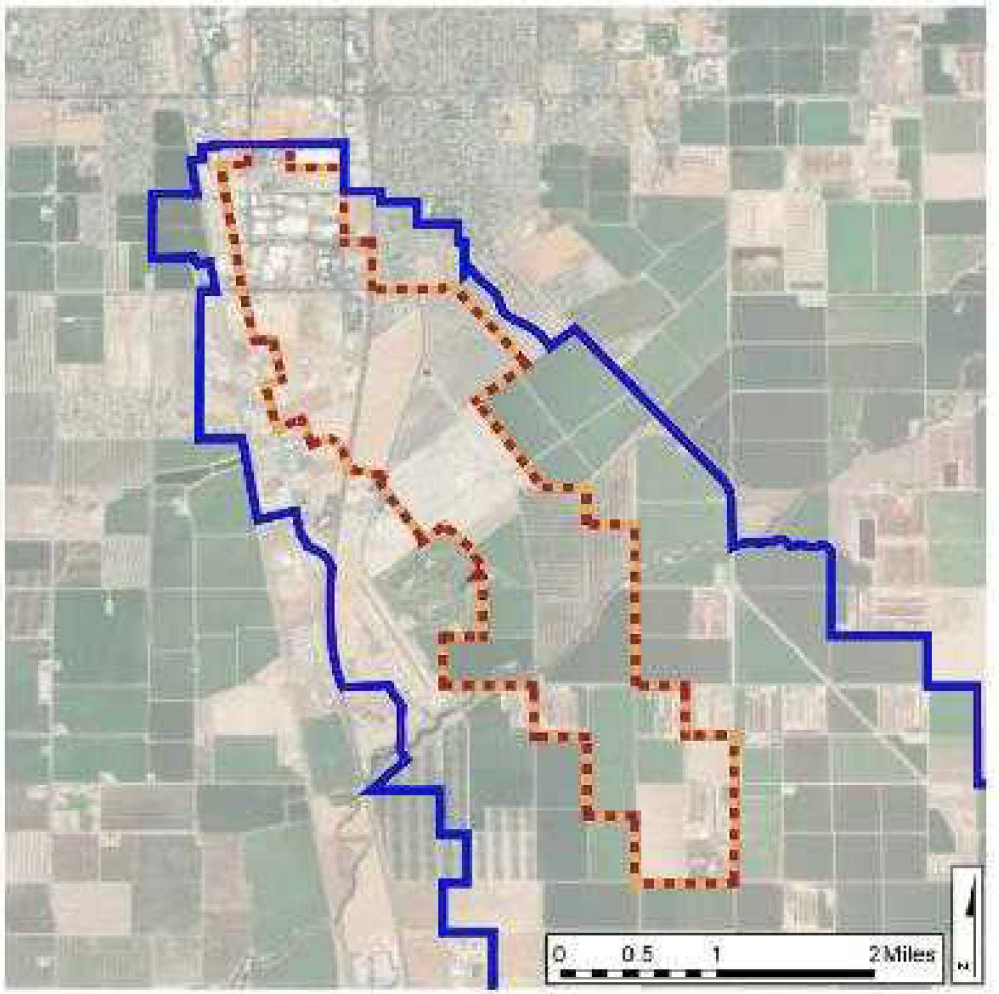
- A rural, not an urban target
- Based upon Ca State input, the key factor is protecting California's agriculture brand.
  - Response levels below the Environmental Protection Agency Protective Action Guidelines (PAGs)
  - Below the Food and Drug Administration Derived Intervention Levels (DILs)
- Exports and tourism would be affected
- There would be significant efforts to reassure the public.

Remediation emphasized preventing spread of contamination

Action: Prevention of fomite and cultural spread

- Soil Removal Zone
  - Soil was removed to a depth of 6 inches.
  - Ground cover was planted.
  - All structures were demolished, roads and vegetation removed.
- Soil Remediation Zone
  - All vegetation was removed.
  - Soil was plowed and ground cover planted.
- Cultivated Land Fallow Zone
  - Land was left to go fallow.
- Non-Cultivated Land Fallow Zone
  - Entrance was restricted.

Buildings in the Fallow Zone will be demolished



Overall Conclusions

- **Motivation**
- Approach
- The NYC 2017 study
- The Category III Scenario
- The California 2019 Study
- Overall Conclusions

Overall Conclusions

An RDD event can have a serious economic impact, whether in urban or rural areas.

The effects go well beyond the actual contaminated area.

The impact does not necessarily scale according to the size of the release.

Psychosocial effects can govern the impact.

Preparedness and resilience efforts can limit the impact.

"Risk comes from not knowing what you're doing." - Warren Buffet

BACKUPS

PRESENTED BY

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

Response Summary

A 10-year process witho

Emergency

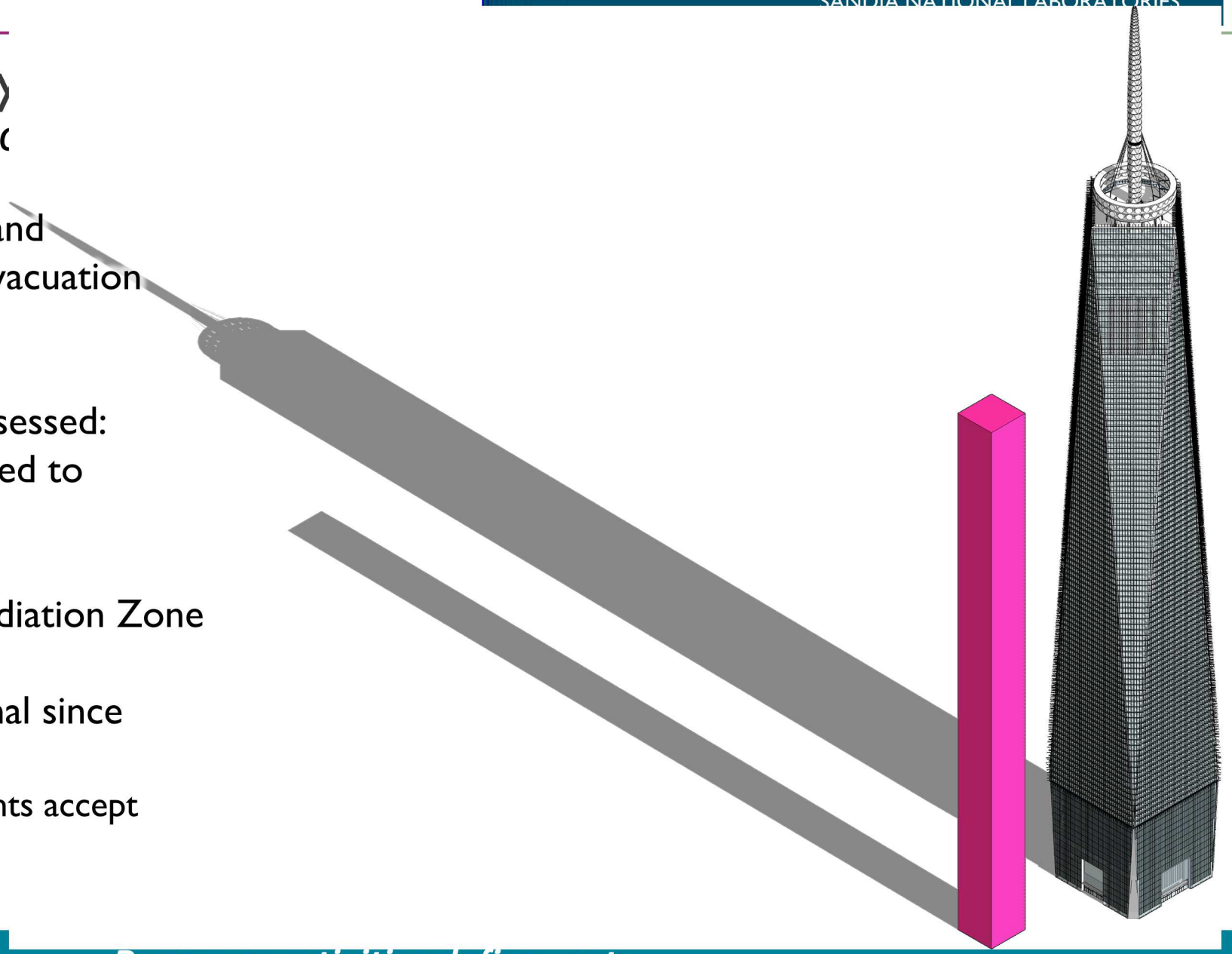
- 195k people sheltered and evacuated: significant evacuation deaths

Stabilization

- Contaminated zones assessed: Major remediation limited to Manhattan.

Recovery

- Manhattan Major Remediation Zone cleanup is extensive.
- Brooklyn cleanup minimal since below PAG threshold.
  - Will Brooklyn residents accept this?



Response activities define costs.