



# Assessing Economic Consequences of Biological Events

Adam Rose

Center for Risk and Economic Analysis of  
Terrorism Events

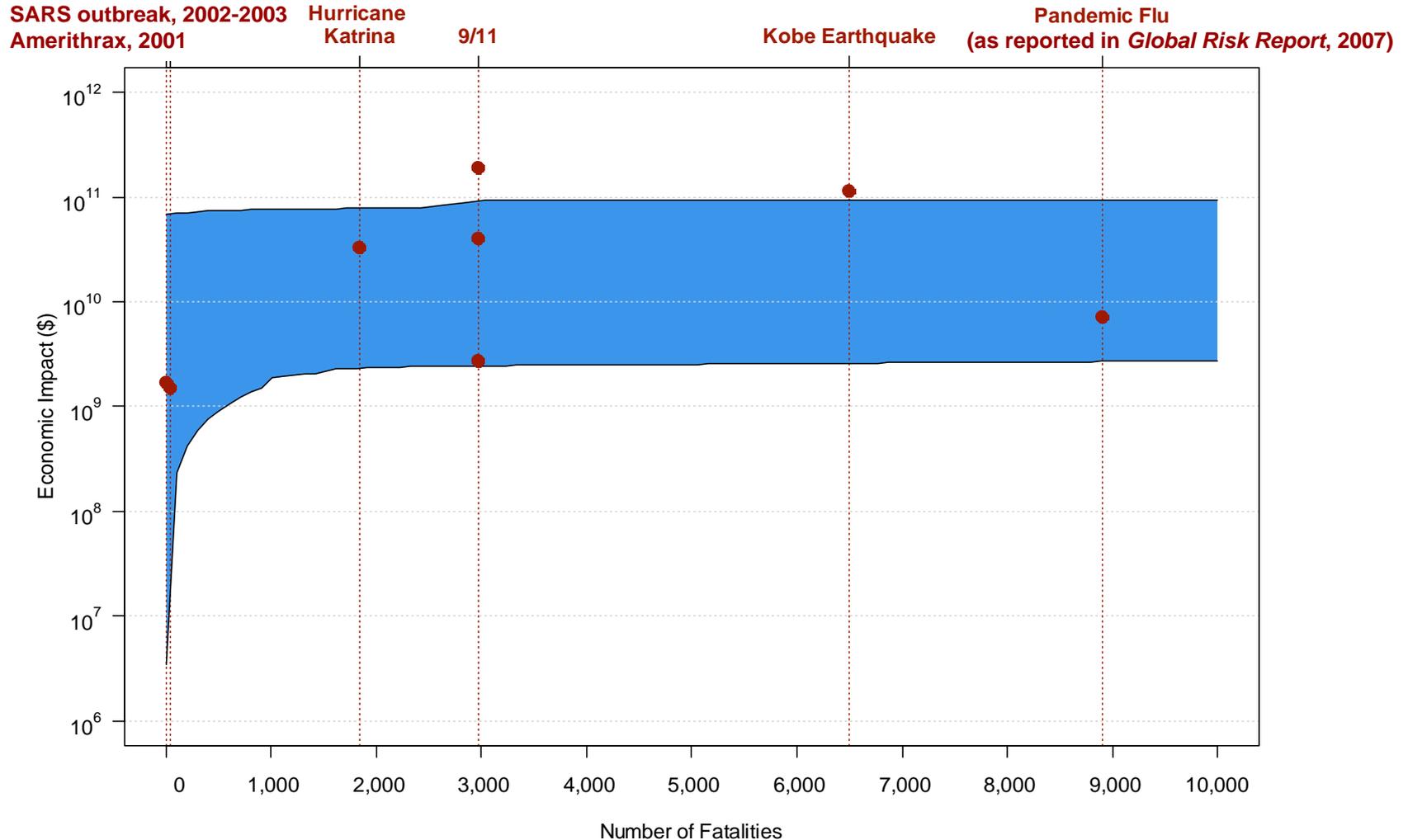
University of Southern California



# Economic Consequence Analysis

- Key element in evaluating terrorism risk
- Requires adaptation for bioterrorism:
  - insidious nature of the threat
  - prominence of behavioral considerations

# Notional BTRA results in comparison with other economic impact assessments





# Objectives

- Develop appropriate analytical framework
- Advance state of the art in special aspects
- Develop practical methods for software
- Develop SOA tool for widespread use

# Research Team

- USC:

Peter Gordon  
James Moore

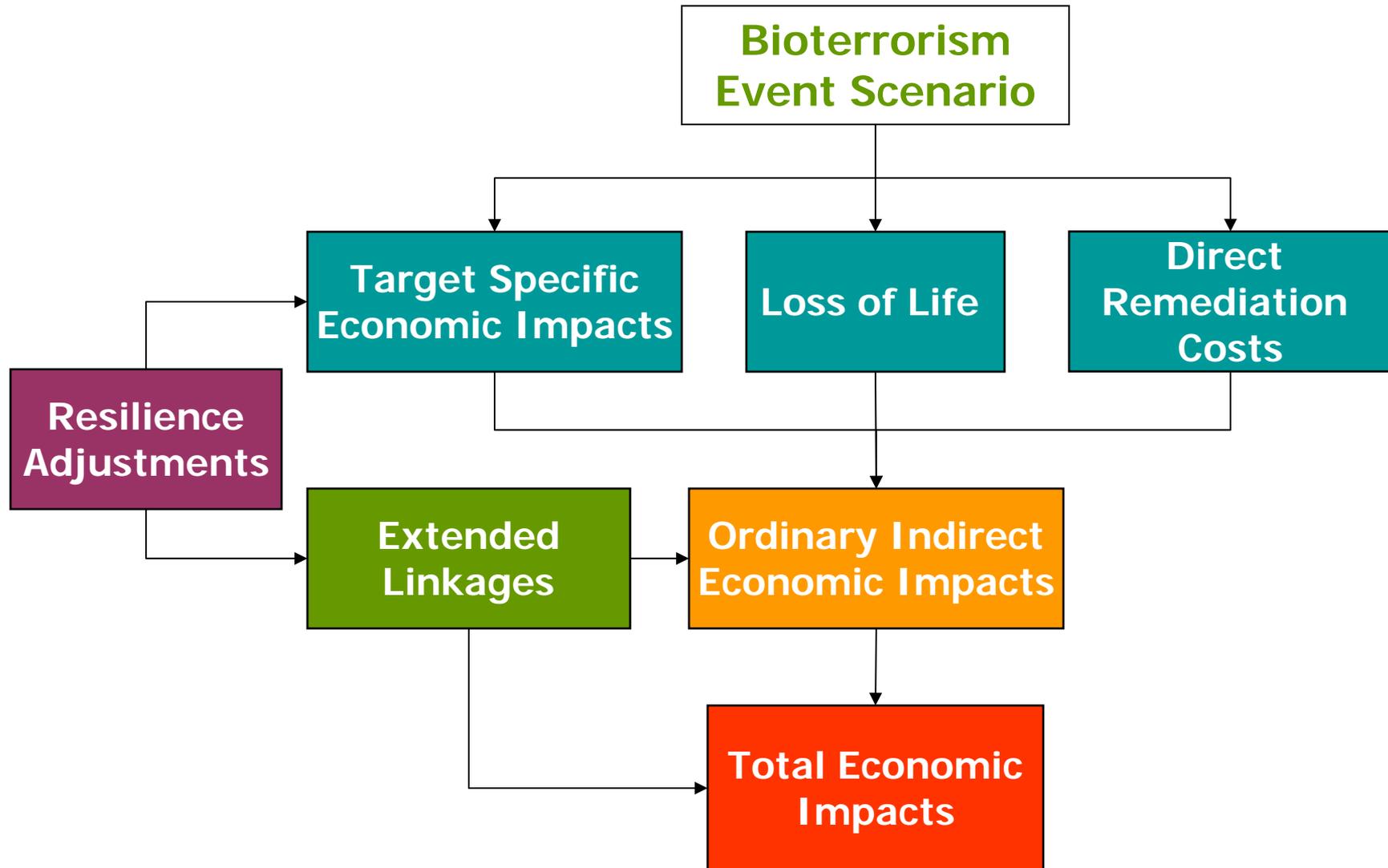
Adam Rose  
Bumsoo Lee

- Battelle:

Ketra Schmitt  
Dave Winkel

Nancy McMillan  
Tim Pivetz

# Analytical Framework Overview



# Methodology Phase I: I-O Analysis

- Most widely used tool of impact analysis
- Definition: Static, linear model of all purchases & sales between sectors of an economy, based on tech relationships in the production of goods & services.
- Obvious strengths & limitations

## SOME ECONOMIC CONSEQUENCES OF BIOTERRORISM

(in billions of 2007 dollars)

Type of Attack	Loss of Life	Ordinary BI	Extended Linkage	Resilience	Total <sup>a</sup>
Stadium	-57.2	-0.5	-16.2	8.5	-73.3
Urban Center	-2.2	-8.2	--	4.4	-6.0
Airport	-1.0	<sup>b</sup>	-440.0	119.5 <sup>c</sup>	-321.5
Lettuce	-.054	-.024 <sup>d</sup>	--	<sup>d</sup>	-.077

<sup>a</sup>Total includes sum of row elements plus net remediation stimulus.

<sup>b</sup>Less than \$50 million.

<sup>c</sup>Recent estimate.

<sup>d</sup>Resilience is considered to offset domestic consumption, such that ordinary BI estimates represent only the decrease in export sales.

# Causes of Variations in Impacts

- Concentration of people & ability to escape
- Concentration of attack agent & proximity
- Fear of replication on this or related targets
- Vulnerability of the target
- Perceived ability to mitigate future attacks
- Resilience (relocation, subs, rescheduling)

## Methodology II: CGE Analysis

- State of the art tool of impact analysis
- Definition: a model of the entire economy based on decisions by individual producers & consumers in response to price signals within the limits of available capital, labor & natural resources.
- Captures best features of I-O & overcomes most of the limitations (e.g. behavioral)

# Behavioral & System Linkages

- Definition: considerations unique to disasters that cause indirect impacts to be orders of magnitude greater than ordinary multipliers.
  - extreme precautions (evacuation, quarantine)
  - “fear factors” (demand drop, avoidance behavior)
  - cascading failures (interdependent infrastructure)
- Characteristics:
  - risks amplified
  - systems overwhelmed
  - resilience eroded

# Modeling Behavioral Linkages

- Overview
  - systems dynamic model (feedback loops)
  - surveys & experiments to calibrate
  - data transfer to fill in gaps
- Economic module
  - CGE based on utility & production functions
  - bounded rationality (alternative objectives, heightened risk aversion)
  - use empirical work to calibrate parameters

# Bounded Rationality

- Intersection of economics & psychology -- movement away from rational optimization
  - Heuristics & “rules of thumb”
  - Intuition, reasoning & reference dependence
- Modeling & risk perception
  - Alternatives to maximizing behavior
  - Safety constraints
  - Reference utility & loss aversion

Systems Dynamic Model tracks risk perception evolution

CGE Model predicts direct & indirect economic impacts

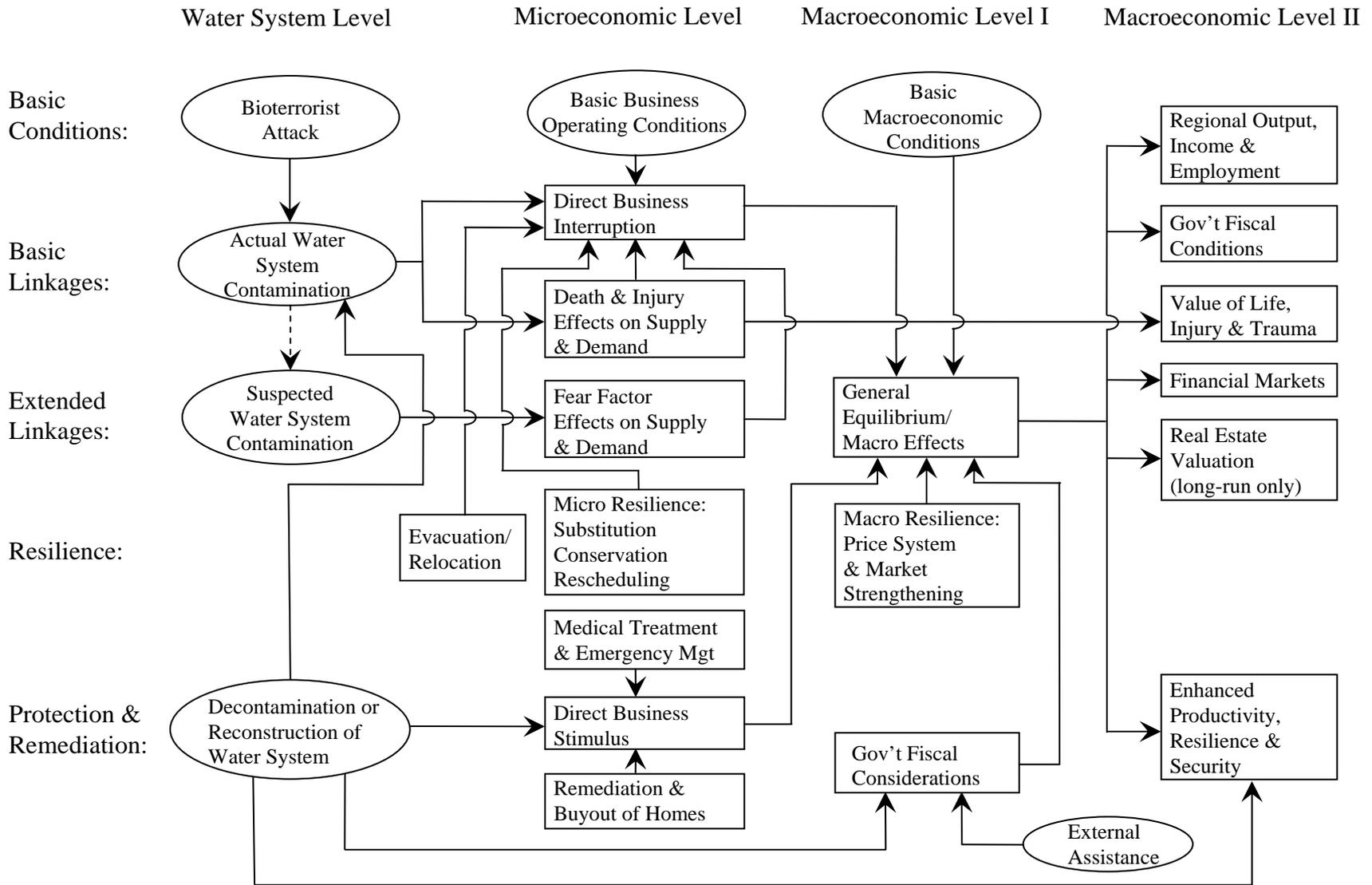


Figure 2. Estimating the Total Economic Impacts of a Bioterrorist Attack on a Municipal Water System

# Summary

- Developed a comprehensive framework
- Developed a computerized Phase I Model
- Results support reasonable hypotheses
- Phase II research will provide a better basis for the evaluation of behavioral responses