Complex Infrastructure Risk Assessment & Management:

Resilience & Sustainability of Critical Infrastructure Systems in the Sacramento – San Joaquin Delta Region

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ABSTRACT

Contemporary infrastructure, the systems necessary to provide sustainable services within the nation's power, transportation, waste management, water, and telecommunication sectors, has become very complex; that is adaptive, interdependent, unpredictable, nonlinear, and dynamic. This research seeks to discover new fundamental methods (through interdisciplinary research) to assess and manage the resilience and sustainability of such complex systems (termed 3ICIS). These methods will facilitate the characterization of both resilience and sustainability by addressing multi-infrastructure, multi-physics, multi-scale (spatial, temporal), and multi-resource phenomena that impact the likelihood of these systems failing to achieve acceptable resilience and sustainability, as well as the associated consequences.

WHY STUDY THE DELTA?

- Rich interdependent mix of physical, social-legal and ecological infrastructures
- Transportation Networks
  - Highways, pipelines, railroads, electricity transmission lines, and deep water ports
- Vulnerable to a variety of dynamic hazards of global and local scale
  - Climate change (e.g., sea-level rise, droughts)
  - Earthquakes (e.g., liquefaction)
- Failure could be catastrophic for the state of California and the United States
  - Drinking water for 23 million people
  - $4 billion annual GDP
  - 700 native species
  - 400,000 residents
- Wealth of data sets publicly available through the state of California
- Timely: Can positively influence state and federal risk mitigation decisions with respect to the Delta by collaborating with ongoing efforts

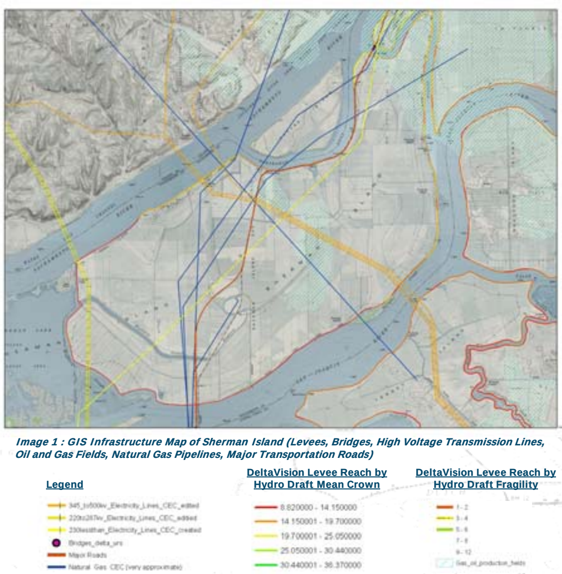


Image 1 : GIS Infrastructure Map of Sherman Island (Levees, Bridges, High Voltage Transmission Lines, Oil and Gas Fields, Natural Gas Pipelines, Major Transportation Roads)

SYSTEM DEFINITIONS

Image 2: Conceptual Model of the Complex Infrastructure in the Delta

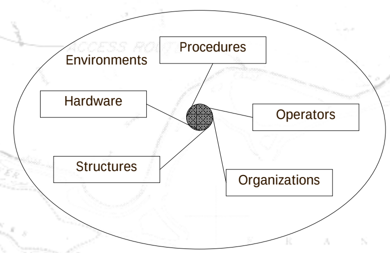


Image 3: Six Interactive QMAS Infrastructure System Modules

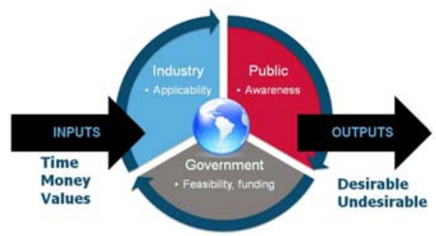
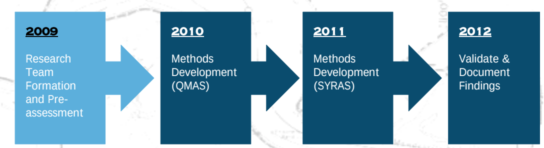


Image 4 : Critical Infrastructure Delivery Model

METHODOLOGY (QMAS++)

1. System Definition and Conceptualization
2. Domain Expert / Key Informant Assessment Team Identification and Formation
3. Identification of the key vulnerabilities or chokepoints (aka Factors of Concern)
4. Failure Scenario Development
5. Detailed Qualitative and Quantitative Risk Assessment and Management that accounts for 3ICIS spatial variability, temporal variability (historical, current, future), and non-linearity (SYRAS++)

TIMELINE



YEAR 1: Group Formation and Organization

Learn how to think about the research problem from an interdisciplinary unbounded systems-based perspective. Learn how to work effectively as a unified research team instead of separate discipline "silos." Ensure that the correct problem is addressed precisely and that a precise solution to the wrong problem (E3 Error) is avoided.

YEAR 2 & 3: Methods Development

Starting with the QMAS© and SYRAS© assessment instruments, identify and develop GIS-enhanced methods through scientific literature reviews, expert solicitations, and pilot investigations to assess and manage resilience and sustainability of an 3ICIS.

YEARS 4: Validation & Documentation

Perform internal and external validation of methods developed by "scaling-up" the pilot investigation and applying them to a larger spatial system.

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