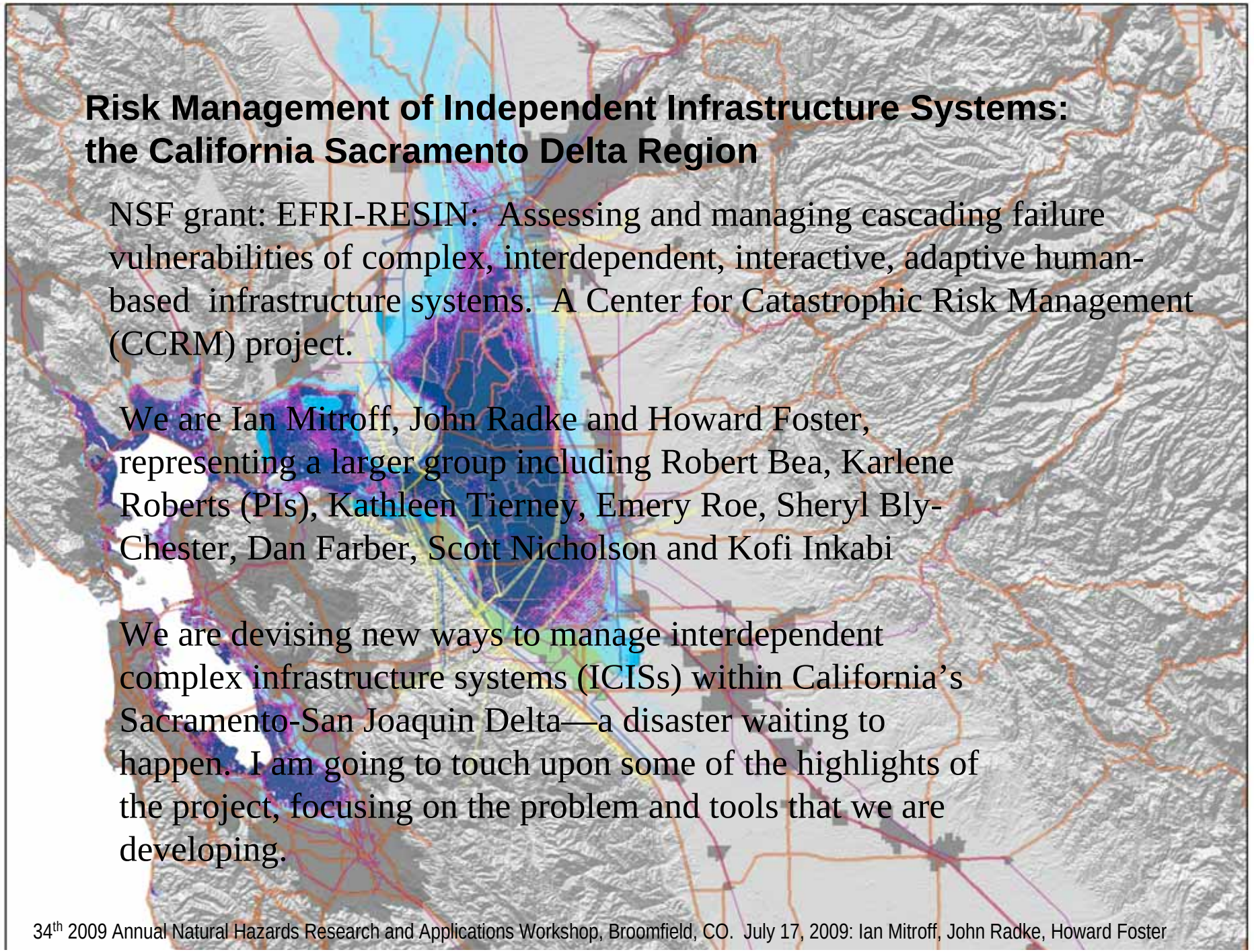
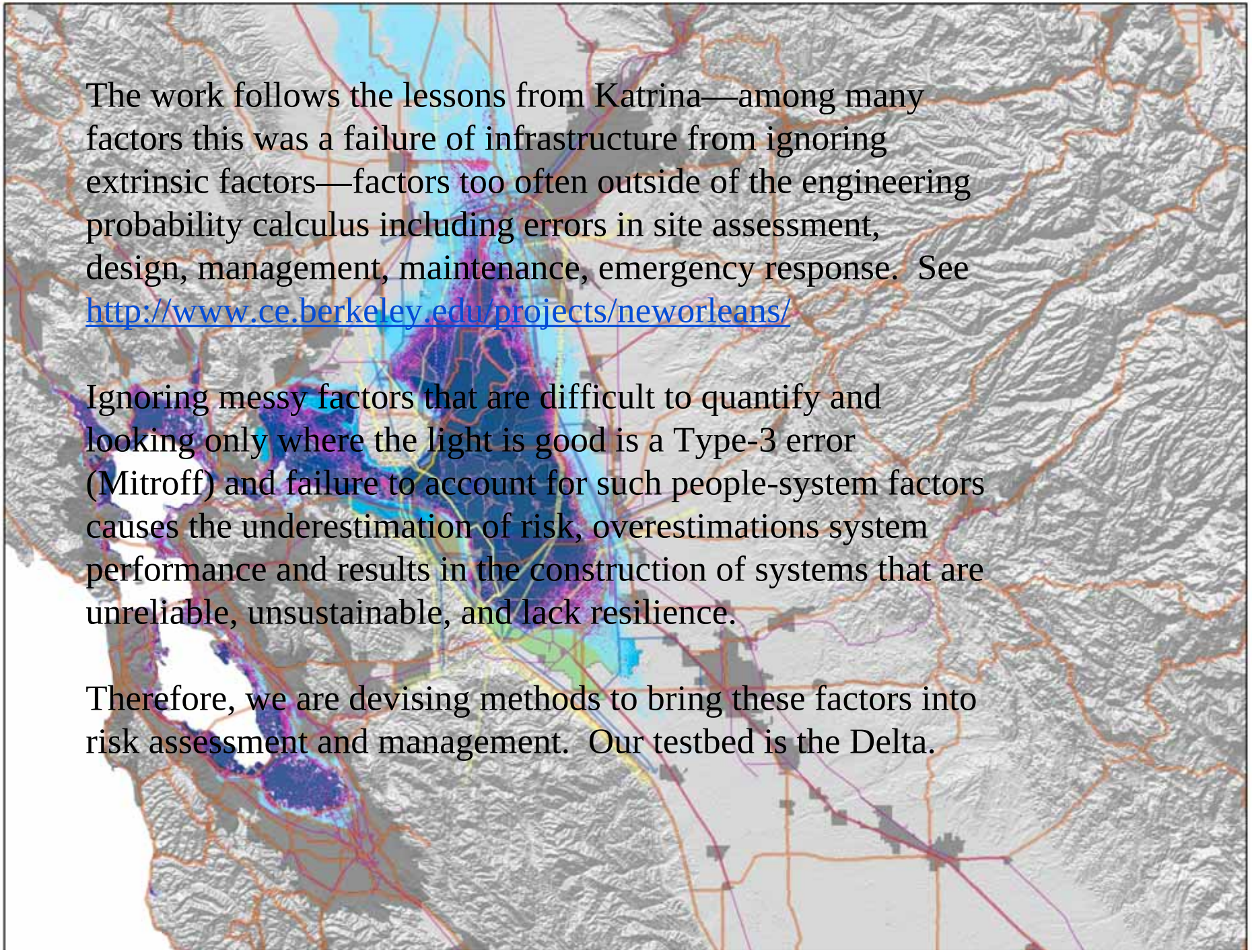


Risk Management of Independent Infrastructure Systems: the California Sacramento Delta Region

NSF grant: EFRI-RESIN: Assessing and managing cascading failure vulnerabilities of complex, interdependent, interactive, adaptive human-based infrastructure systems. A Center for Catastrophic Risk Management (CCRM) project.

We are Ian Mitroff, John Radke and Howard Foster, representing a larger group including Robert Bea, Karlene Roberts (PIs), Kathleen Tierney, Emery Roe, Sheryl Bly-Chester, Dan Farber, Scott Nicholson and Kofi Inkabi

We are devising new ways to manage interdependent complex infrastructure systems (ICISs) within California's Sacramento-San Joaquin Delta—a disaster waiting to happen. I am going to touch upon some of the highlights of the project, focusing on the problem and tools that we are developing.



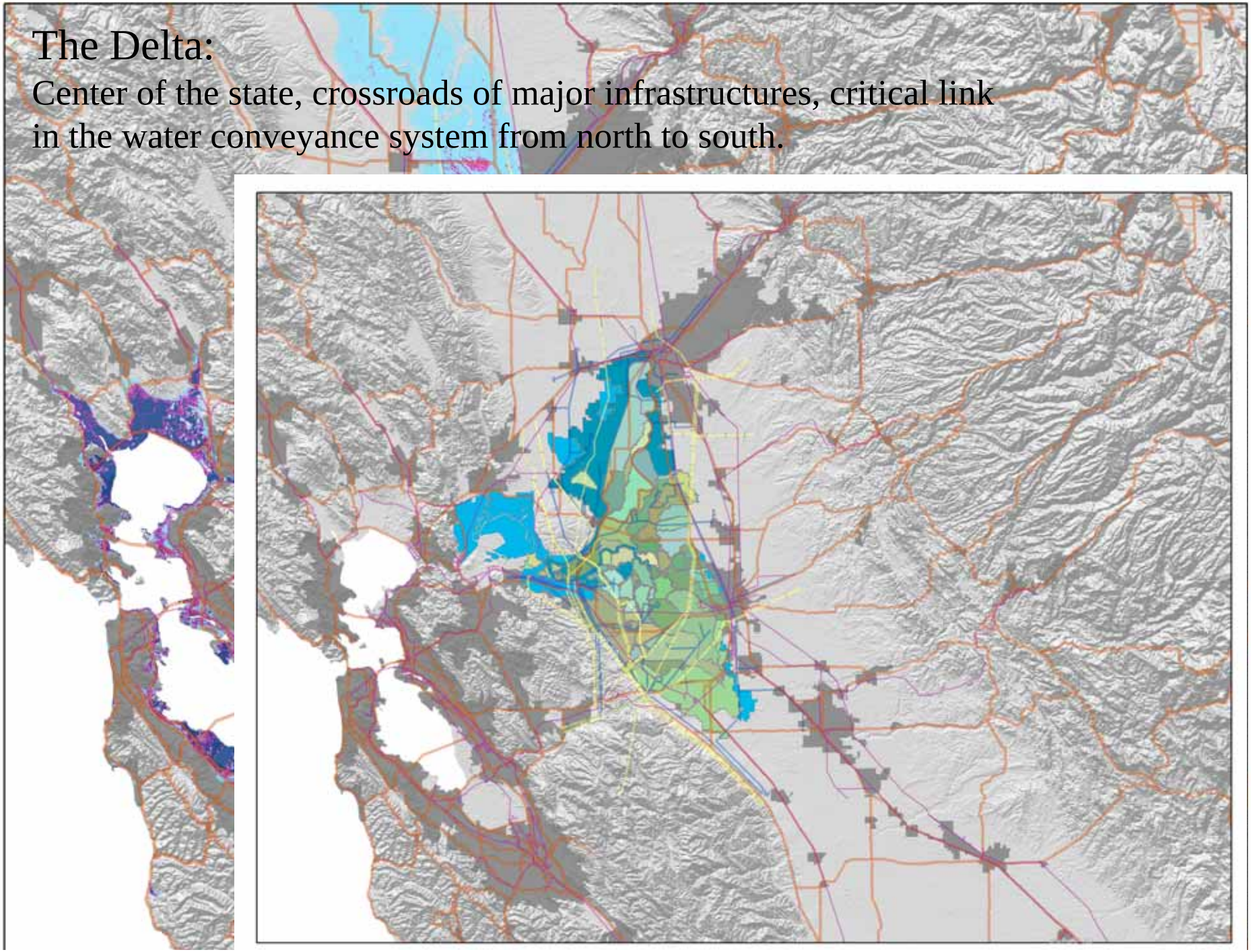
The work follows the lessons from Katrina—among many factors this was a failure of infrastructure from ignoring extrinsic factors—factors too often outside of the engineering probability calculus including errors in site assessment, design, management, maintenance, emergency response. See http://www.ce.berkeley.edu/projects/neworleans/

Ignoring messy factors that are difficult to quantify and looking only where the light is good is a Type-3 error (Mitroff) and failure to account for such people-system factors causes the underestimation of risk, overestimations system performance and results in the construction of systems that are unreliable, unsustainable, and lack resilience.

Therefore, we are devising methods to bring these factors into risk assessment and management. Our testbed is the Delta.

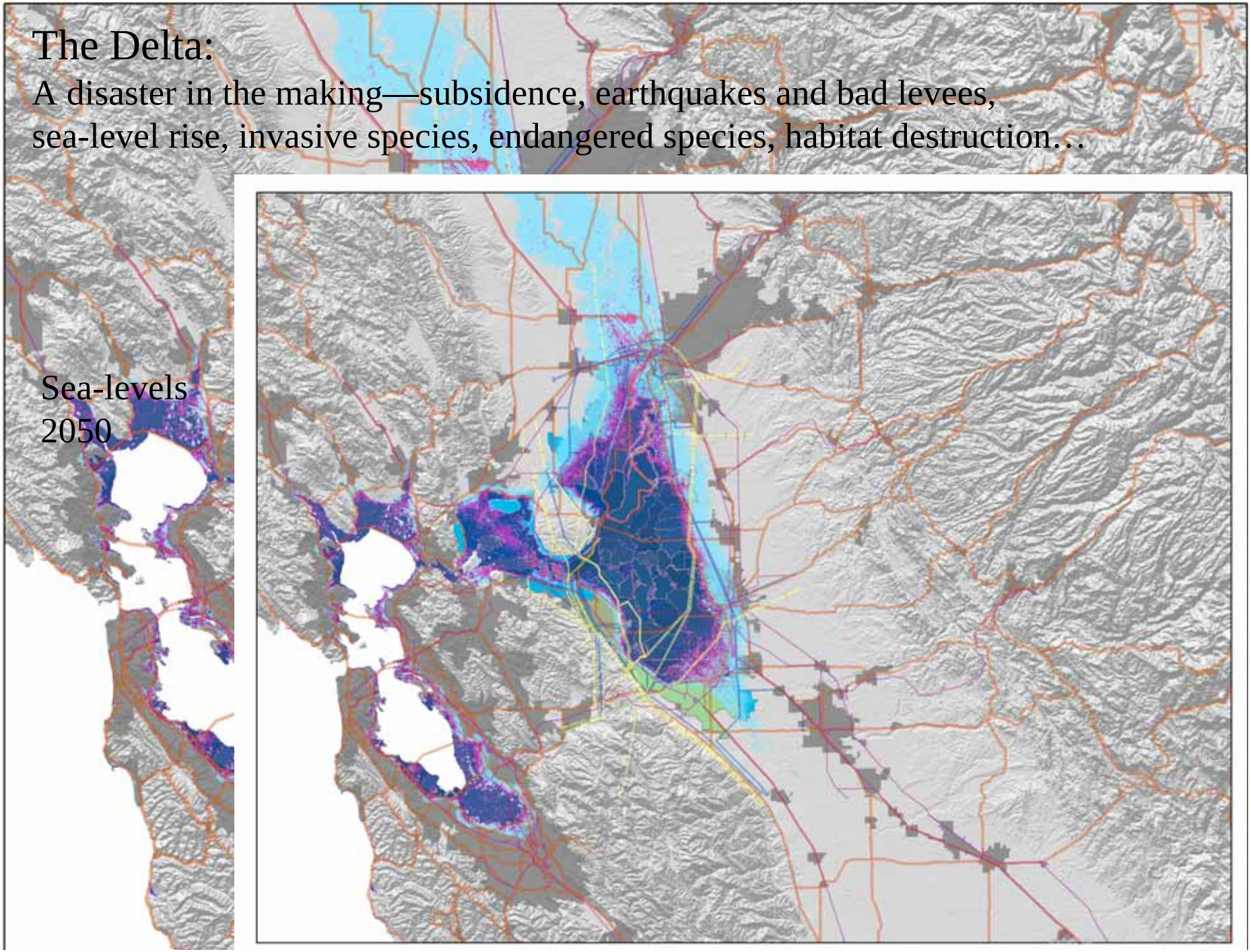
The Delta:

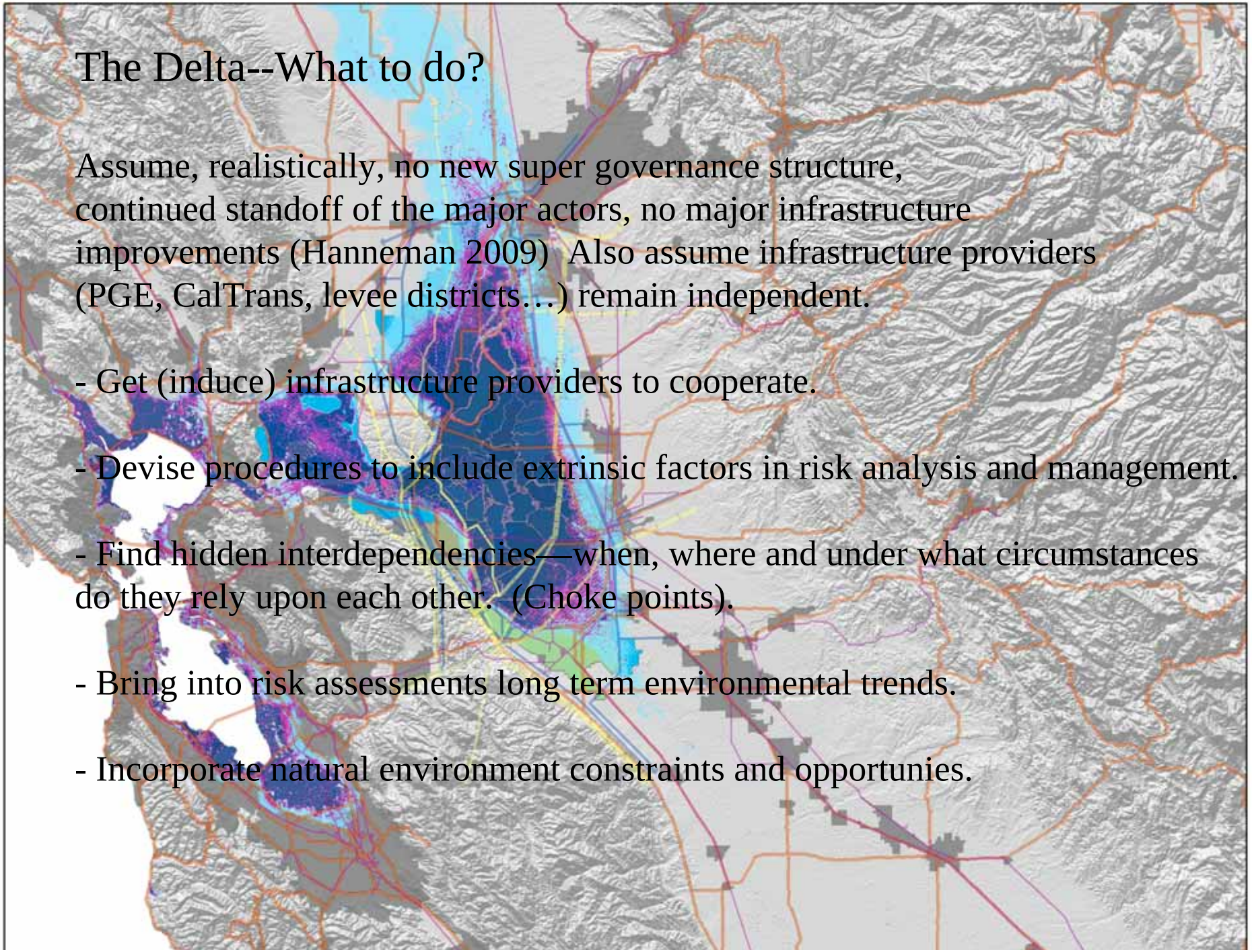
Center of the state, crossroads of major infrastructures, critical link in the water conveyance system from north to south.



The Delta:

A disaster in the making—subsidence, earthquakes and bad levees, sea-level rise, invasive species, endangered species, habitat destruction…





The Delta--What to do?

Assume, realistically, no new super governance structure, continued standoff of the major actors, no major infrastructure improvements (Hanneman 2009) Also assume infrastructure providers (PGE, CalTrans, levee districts…) remain independent.

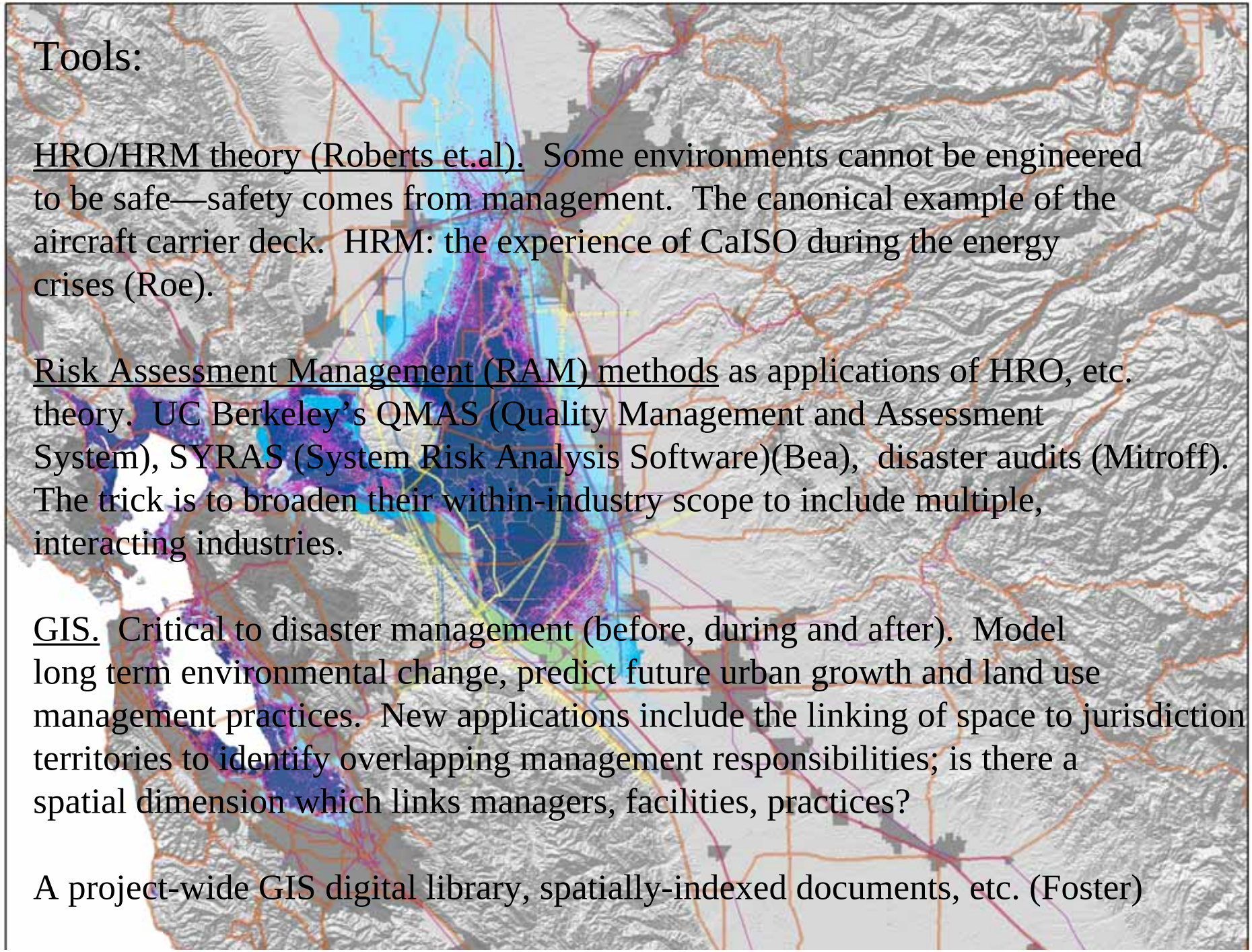
- Get (induce) infrastructure providers to cooperate.

- Devise procedures to include extrinsic factors in risk analysis and management.

- Find hidden interdependencies—when, where and under what circumstances do they rely upon each other. (Choke points).

- Bring into risk assessments long term environmental trends.

- Incorporate natural environment constraints and opportunies.



Tools:

HRO/HRM theory (Roberts et.al). Some environments cannot be engineered to be safe—safety comes from management. The canonical example of the aircraft carrier deck. HRM: the experience of CaISO during the energy crises (Roe).

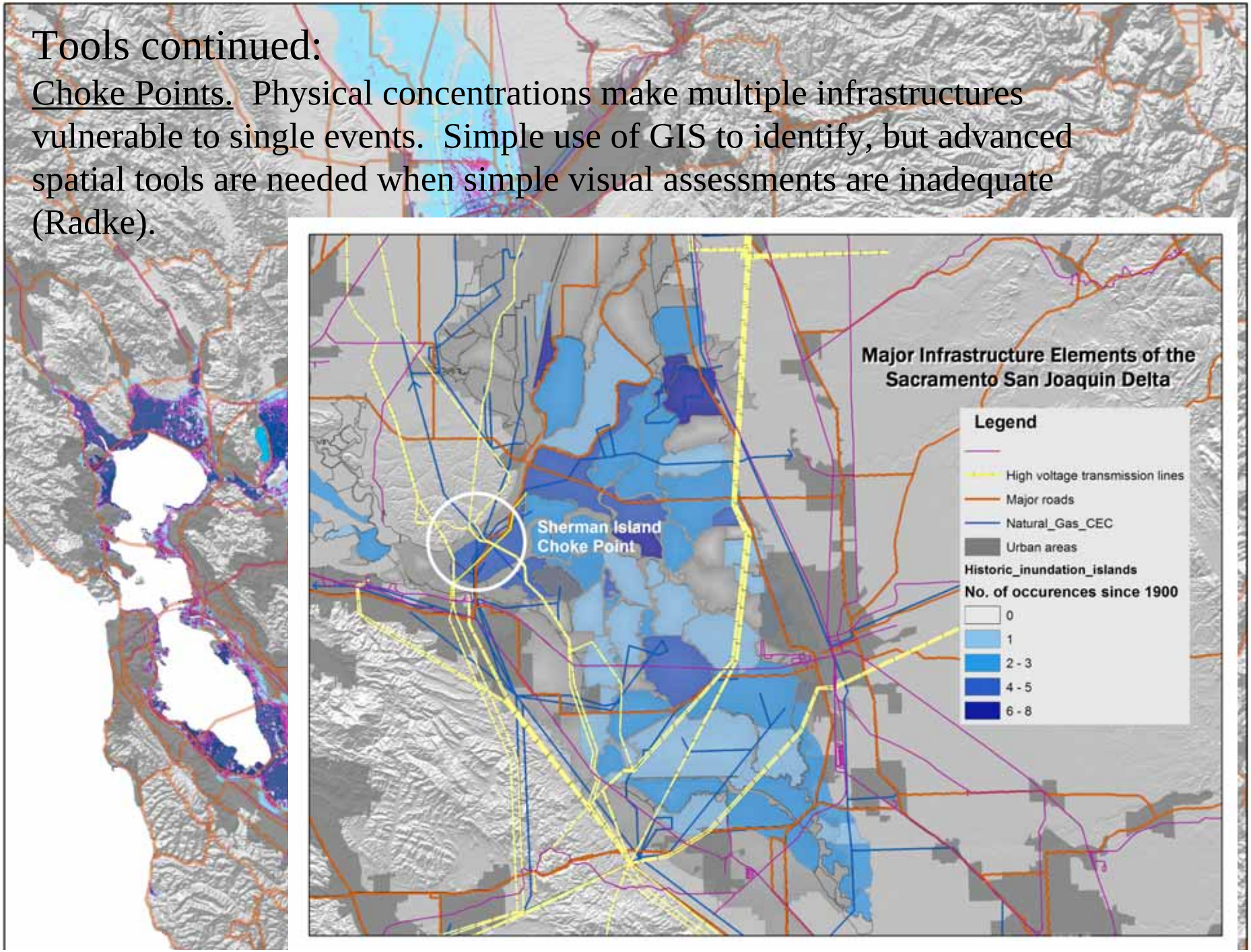
Risk Assessment Management (RAM) methods as applications of HRO, etc. theory. UC Berkeley's QMAS (Quality Management and Assessment System), SYRAS (System Risk Analysis Software)(Bea), disaster audits (Mitroff). The trick is to broaden their within-industry scope to include multiple, interacting industries.

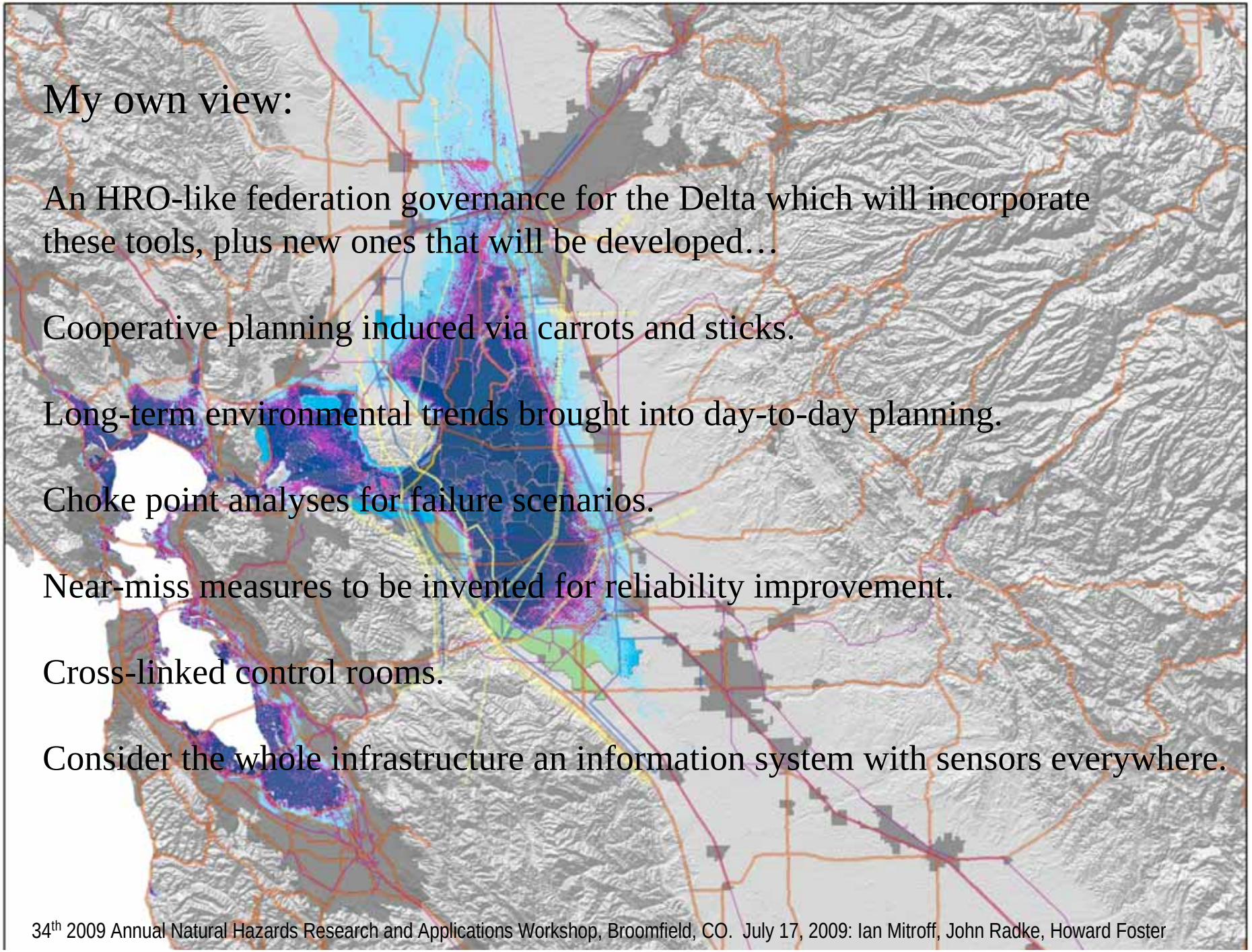
GIS. Critical to disaster management (before, during and after). Model long term environmental change, predict future urban growth and land use management practices. New applications include the linking of space to jurisdiction territories to identify overlapping management responsibilities; is there a spatial dimension which links managers, facilities, practices?

A project-wide GIS digital library, spatially-indexed documents, etc. (Foster)

Tools continued:

Choke Points. Physical concentrations make multiple infrastructures vulnerable to single events. Simple use of GIS to identify, but advanced spatial tools are needed when simple visual assessments are inadequate (Radke).





My own view:

An HRO-like federation governance for the Delta which will incorporate these tools, plus new ones that will be developed…

Cooperative planning induced via carrots and sticks.

Long-term environmental trends brought into day-to-day planning.

Choke point analyses for failure scenarios.

Near-miss measures to be invented for reliability improvement.

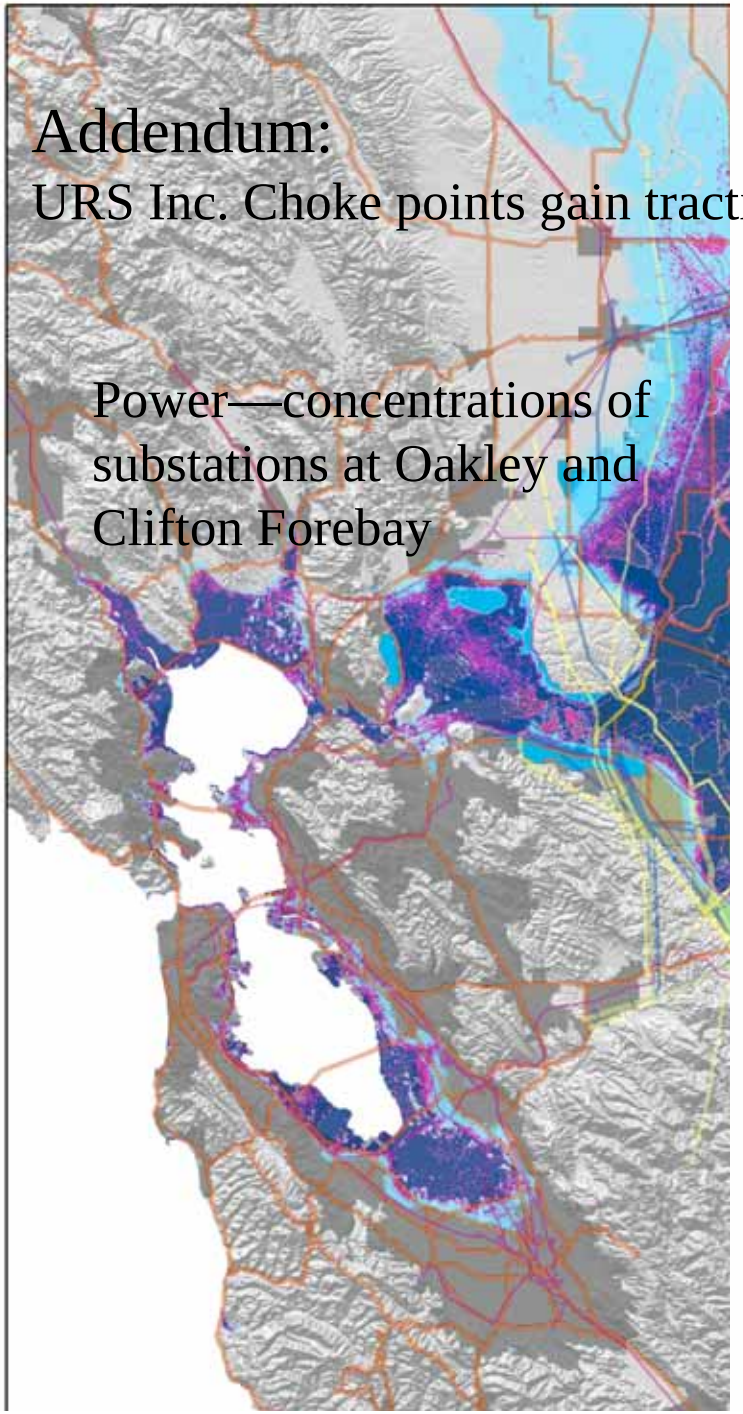
Cross-linked control rooms.

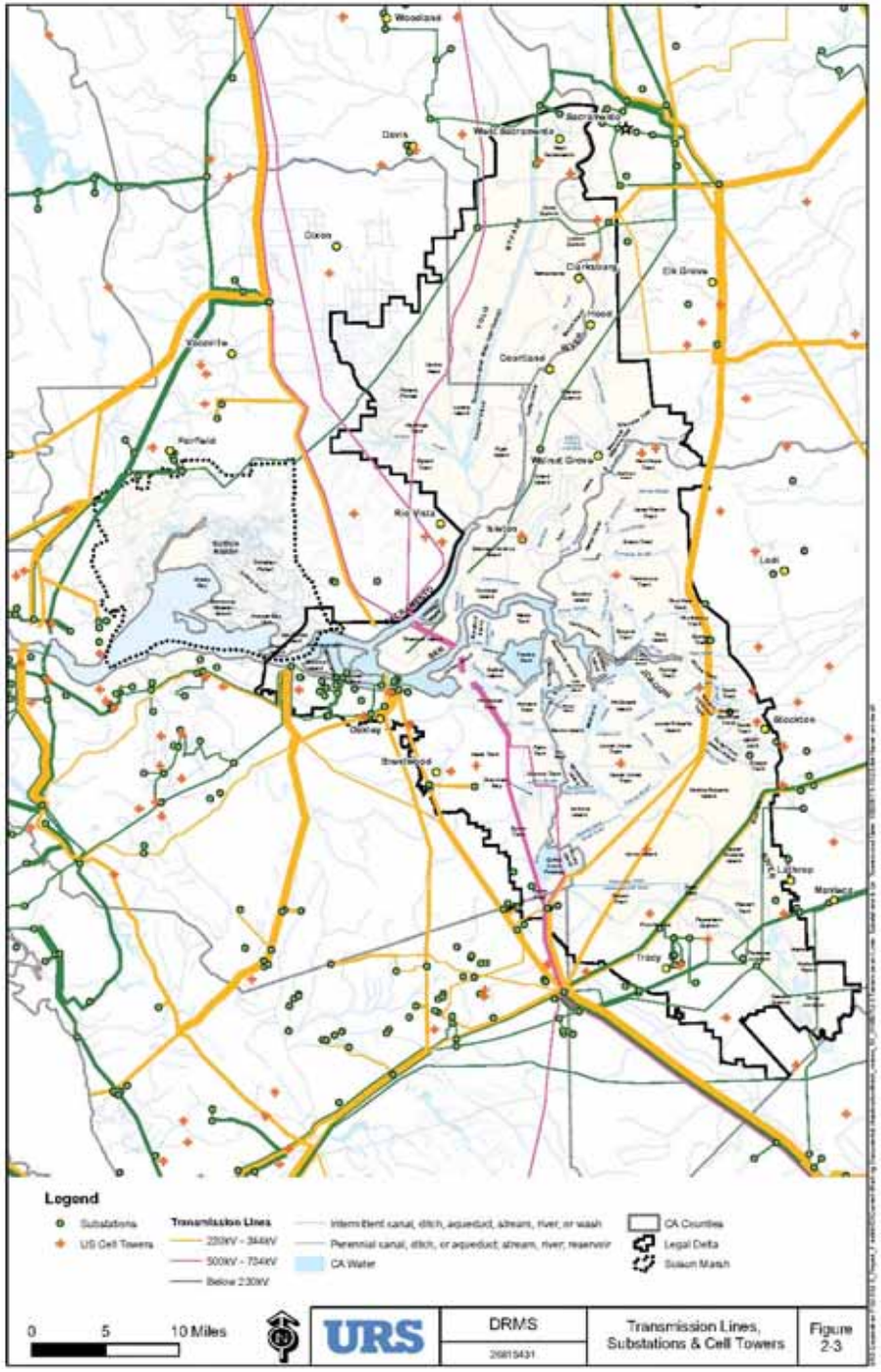
Consider the whole infrastructure an information system with sensors everywhere.

Addendum:

URS Inc. Choke points gain traction.

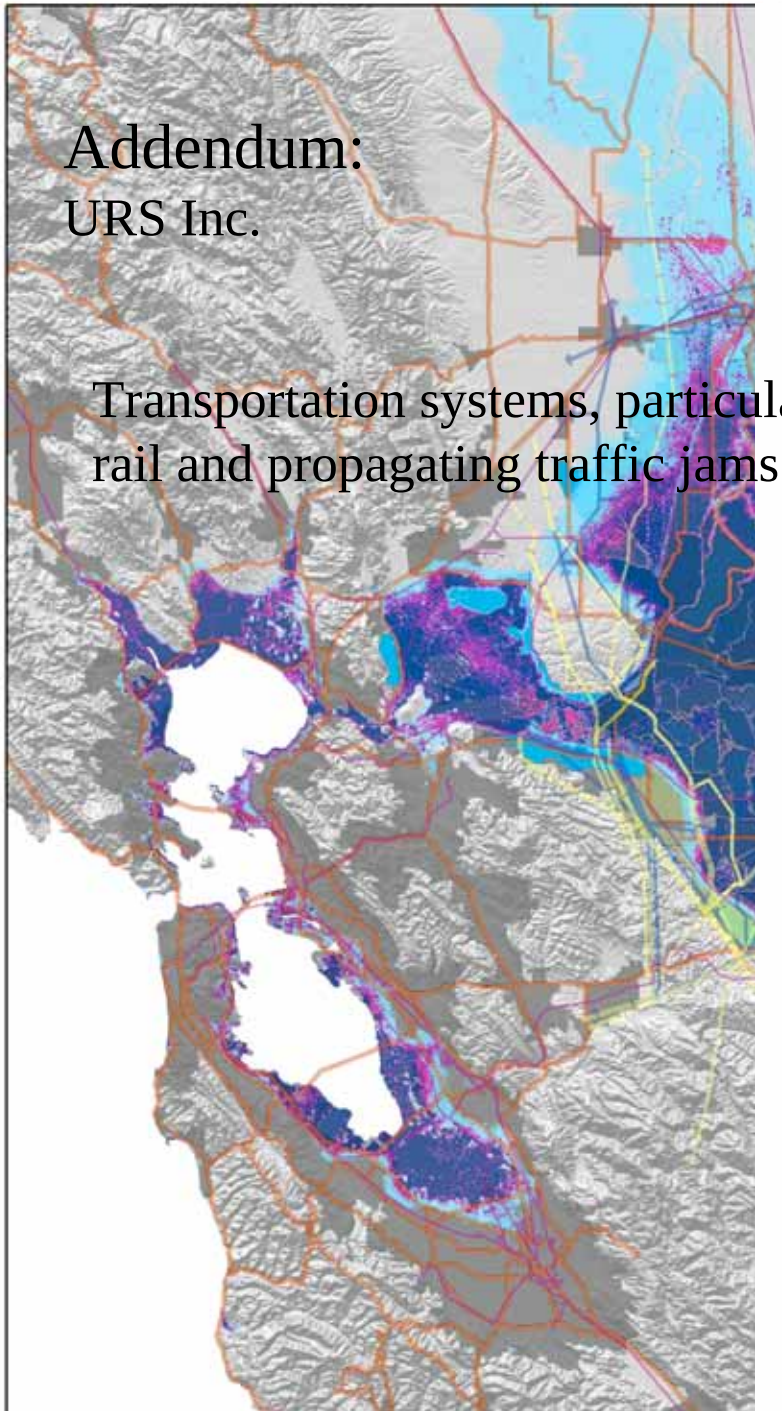
Power—concentrations of substations at Oakley and Clifton Forebay

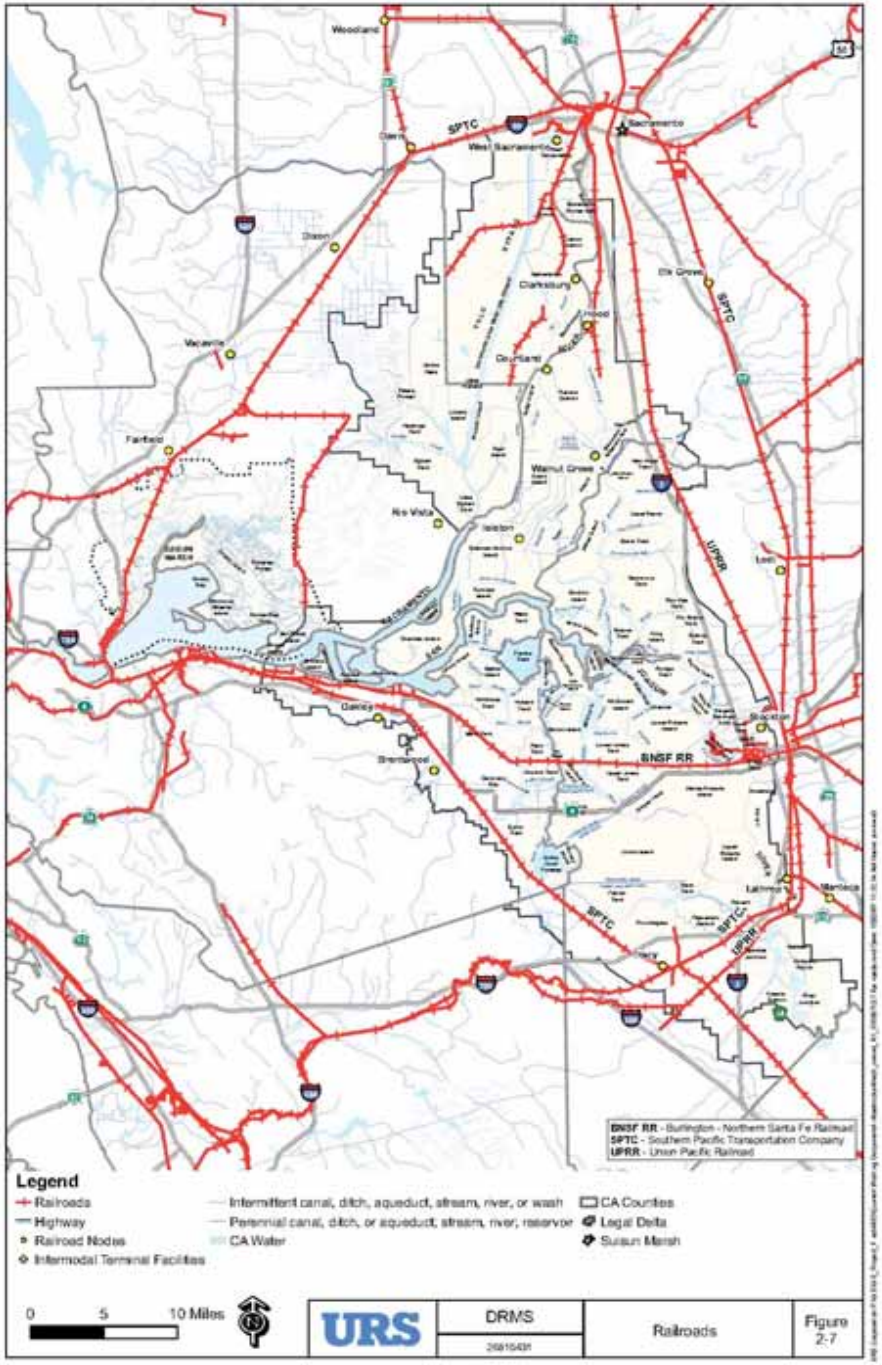


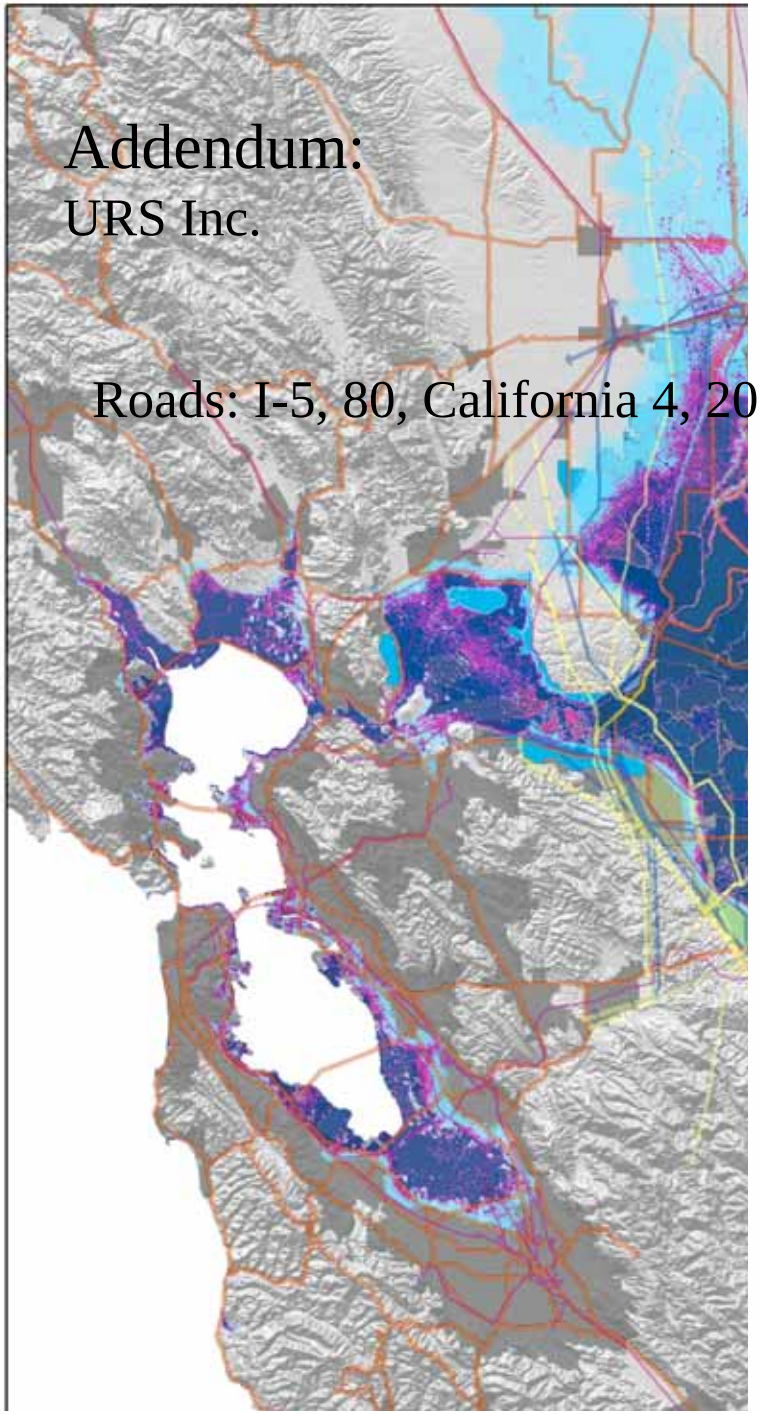


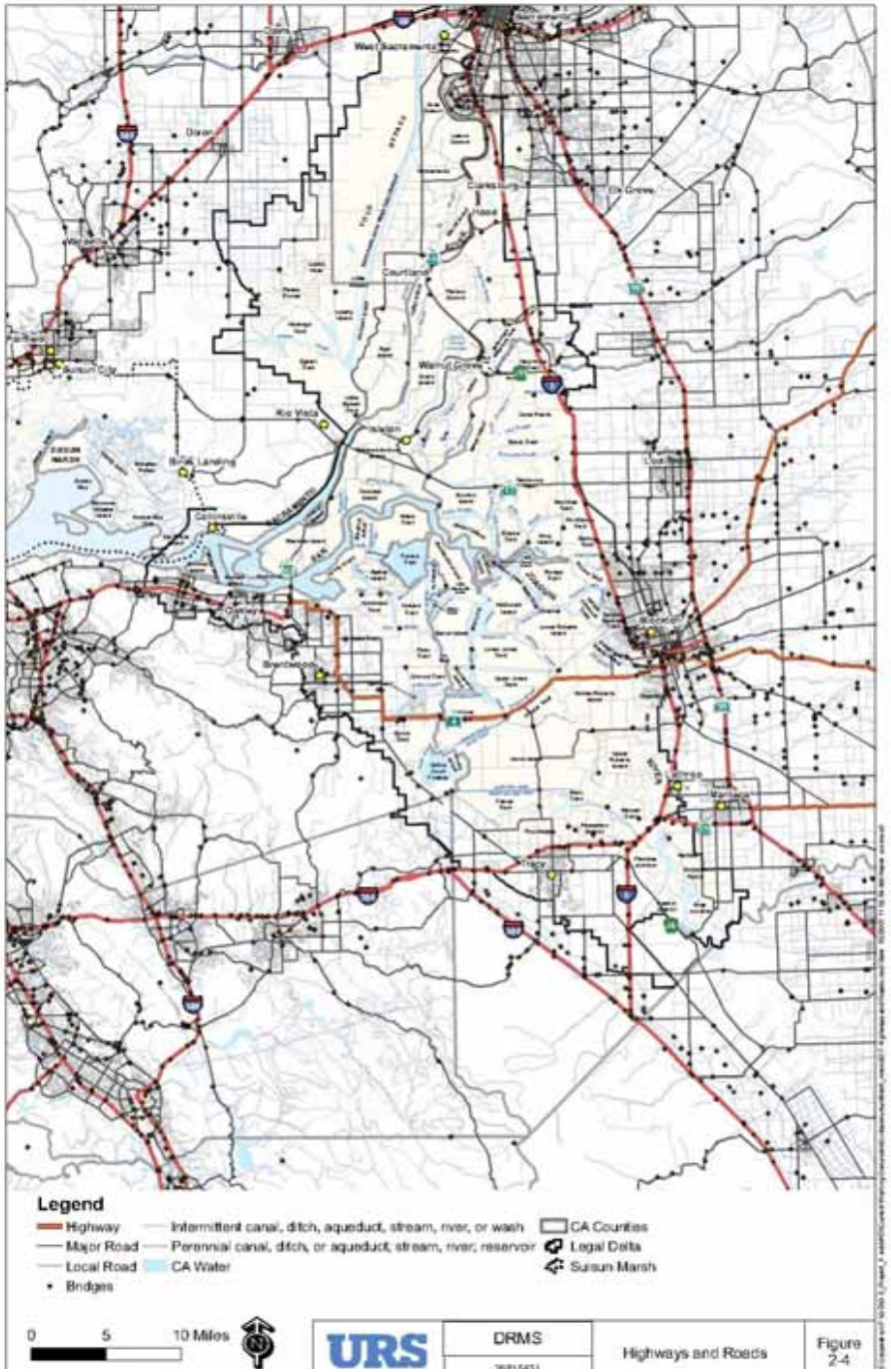
Addendum:
URS Inc.

Transportation systems, particularly rail and propagating traffic jams






Addendum:
URS Inc.
Roads: I-5, 80, California 4, 205


Legend
Highway
Major Road
Local Road
Bridges
Intermittent canal, ditch, aqueduct, stream, river, or wash
Perennial canal, ditch, or aqueduct, stream, river, reservoir
CA Water
CA Counties
Legal Delta
Suisun Marsh
0
5
10 Miles
URS
DRMS
Highways and Roads
Figure 2-4