

Infrastructure Resilience, Climate Shocks and Sea-Level Rise Incidents:  
Managing Uncertainty and the Role of a Marine Exchange Extreme Climate Resilience Desk

Paul Schulman

Research Associate

Center for Catastrophic Risk Management

[p.schulman@northeastern.edu](mailto:p.schulman@northeastern.edu)

- Scott's Question: *“what are the key factors to consider when designing a resilience-focused operational desk for the maritime domain, especially in the face of unpredictable events like those in 2017?”*
- Some thoughts to keep in mind:
  - “Knowing how something works is not the same thing as knowing how it can fail.” Giandomenico Majone, “Technology Assessment in a Dialectic Key.”
  - “History Teaches us that a crisis often causes problems to correlate in a manner undreamed of in more tranquil times.” Warren Buffet
  - “These infrastructures are more interconnected than we can imagine.”  
Don Boland, Former Director, California Utilities Emergency Association
  - “An important aspect of resilience is the ability to manage the unexpected.”  
Karl Weick and Kathleen Sutcliffe, *Managing the Unexpected*

- A recent article, “When floods hit the road: Resilience to flood-related traffic disruption in the San Francisco Bay Area and beyond.” (G. Kasmalkar *et al.*, *Science Advances*. Eaba2423. 6. August 2020) concluded with the following statement:
  - “*These [flood] challenges raise questions about whether there are common themes to indirect [urban] impacts that extend beyond the context of a specific hazard or location.*”
  - This suggests that the dynamics of *vulnerability* could well be a topic in itself worthy of study and appraisal apart from hazardous natural events in specific domains.
  - Vulnerability is about more than the physical ability of an external event to harm, it involves the susceptibility to be harmed.
  - And one “common theme” of flood disruptions is the vulnerability of critical infrastructures, beyond their own assets, *to the failure of other infrastructures.*
  - A challenge for planners, policy-makers, emergency managers, infrastructure managers as well as the Marine Exchange Resilience Desk, is how to anticipate and mitigate, if possible, this vulnerability.
  - It is also an important but different challenge to achieve, in the face of actual inter-infrastructure disruptions, infrastructure service restoration as rapidly as possible. Facilitating this process could also be an important role for the Resilience Desk.

- It turns out that major events such as floods can shift the character of infrastructure interdependencies, making previously independent infrastructures suddenly dependent on one another for the mutual restoration of their service.
- A road atop a levee and the levee itself may have little normal interconnection in their operation and management.
- But a levee leak can suddenly lead to an active functional interdependence in fixing the leak
- The road becomes of great importance because it becomes the only landside repair route to the levee and allows the transport of repair crews as well as fill material (such as “rip rap” -- rocks and stones) often necessary to make the repairs.
- The road can also allow pumps and generators access to de-water flooded areas.
- Restoring electricity can be an essential for many other critical infrastructures to restore their own service. Yet achieving electric service restoration may depend on telecommunications functions as well as road or helicopter access to transmission lines.

- In normal times individual infrastructure managers are so preoccupied with managing their own systems they don't often think about or maintain contact with one another in relation to their latent mutual dependency in the case of a major event, and its importance to achieve infrastructure service restoration.
- My colleague, Emery Roe and I have studied infrastructures and their interconnectivity for years in electricity grids, marine and air transport, and telecommunications.
- Our interviews of a number of infrastructure managers, operators and maintenance personnel have indicated to us that for many of them, in major natural events, a clarity can emerge at their levels in perceptions of urgency, functional needs and specific actions required for service restoration.
- Here, the experience, imagination and ingenuity of key players can be crucial, as is their collaborative capacity to achieve *mutual* clarity and action across those infrastructures that may now have overlapping dependencies for service restoration as a result of the emergency.
- Also, from our interviews we have seen the distinct possibility that higher-level emergency management officials and planners may not fully appreciate the precision and utility of this clarity at the level of operations and maintenance, in the now interconnected critical infrastructures.

- A major challenge is one of being prepared for uncertainty and likely surprise in the unfolding events of natural disasters including shifting interconnectivity and latent dependencies, suddenly made manifest, among critical infrastructures.
- These are conditions under which reliability as a performance standard needs to be supplemented by resilience as an inter-organizational capacity.
- There is a difference between modelling failure possibilities among infrastructures in a major flooding event and the ability to put failed infrastructures back into operation.
- For this latter function it may be increasingly important to rely on personnel who operate and maintain the systems and have nuts and bolts experience with them, as well as ingenuity to create options to put broken infrastructure systems back together.
- This is a backbone of infrastructure resilience and it suggests several roles for a Marine Exchange Resilience Desk.
- The Resilience Desk can be an information clearing house demonstrating to Exchange members interconnections and their potential shifts that can occur in flood events and in the recovery from them. The Desk can be a partisan for resilience in conveying the potential for surprises in latent inter-infrastructure dependencies, and in supporting an *infrastructure of inter-infrastructure network resilience* including:
  - the development of robust inter-infrastructure cross-communications through collaborative projects in contingency planning as well as table-top exercises and emergency simulations, and
  - supporting strategies of infrastructure interoperability in maintenance and restoration processes, with compatible communications and data software, tools and even some crew sharing between them.