Recent US Black Sky Events and Lessons Learned

Frank Koza

EIS Council

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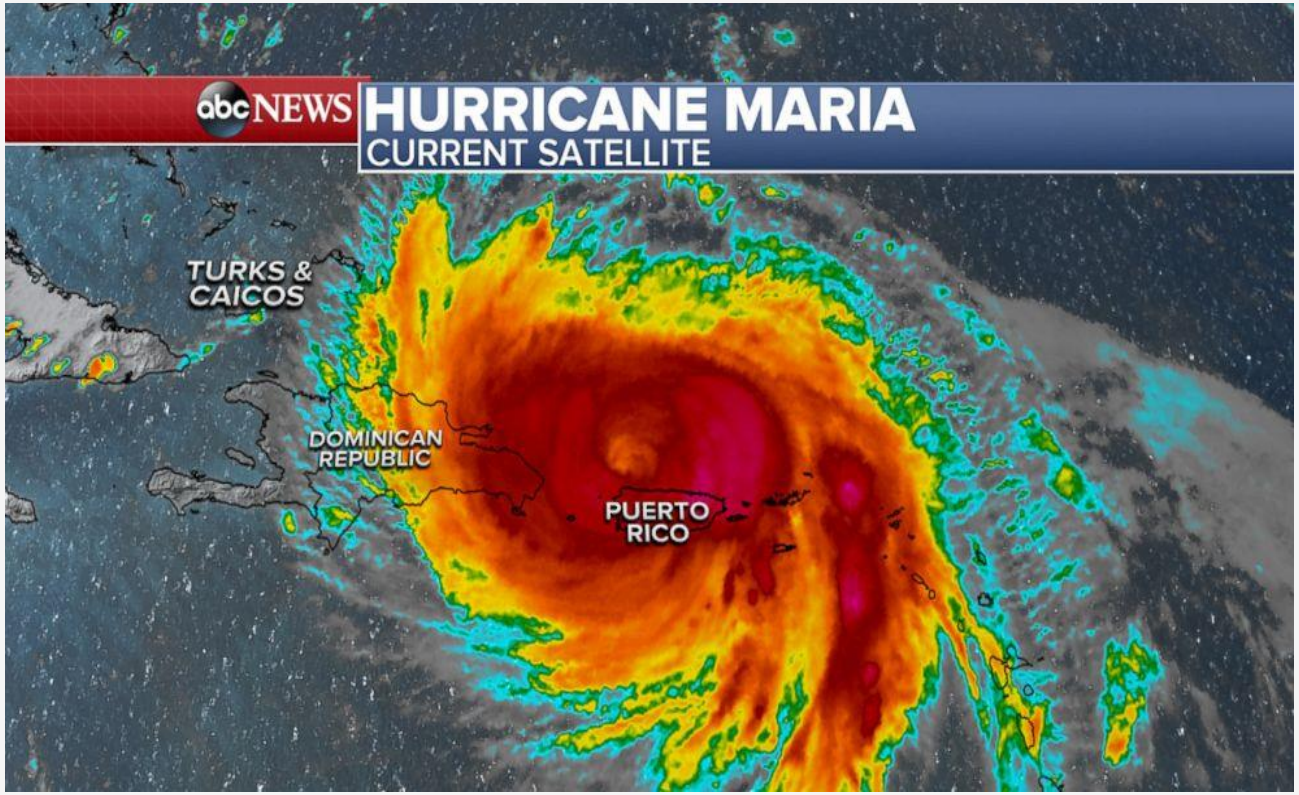
Puerto Rico—Hurricanes Irma and Maria (2017)



Timeline

Sept 6	Hurricane Irma skirts the island. 4 people are killed. Electricity is lost to 2/3 of the island and water is lost for 1/3 of the island.
Sept 20	Hurricane Maria makes landfall with 155 mph (249 km/hr) sustained winds, with parts of the island receiving 30 inches of rain in one day.
Sept 23	Port and airport reopen on a limited basis. Prediction that electrical restoration could take 6-8 months. Communications have been largely destroyed.

Hurricane Maria Response Problems

7 days after landfall

- 44% of population does not have drinking water
- 15% of hospitals are open

- More than 10,000 shipping containers full of food and supplies lay stranded in the Port of San Juan. They can't be shipped to the island's interior due to a lack of fuel, labor, and working roads. Governor Roselló says that only about 20 percent of Puerto Rico's truckers have been able to work.

Hurricane Maria Lessons Learned – Hospital Operations

Source: Journal of Graduate Medical Education, August 2018

1. Maintain open lines of communications with staff
2. Use all available means of communications and message delivery—verbal, messenger, sat phones, etc.
3. Keep an inventory of supplies, medication and supplies on hand to sustain operations for at least 2 weeks.
4. Maintain a 2 week supply of food and water for staff at the hospital.
5. Prior to the event, cancel surgeries and discharge as many patients as possible.
6. Do disaster drills regularly.
7. Impact of limited communications and the important role of social media was underestimated.
8. The “old way” may be the best way in the absence of technology (cash, hard copies, books, blackboard, bikes).

Hurricane Maria Lessons Learned – Medical Communications

Center for Disease Control (CDC) Lesson Learned

1. Develop Key Messages in Advance—CDC developed messaging prior to the event
2. Identify New Communication Channels—With traditional communications out of service, alternate methods were employed (text,print, loudspeakers, etc.)
3. Create Culturally Appropriate Materials—Messages needed to be delivered in Spanish with careful interpretation
4. Partner Up—Other Federal agencies and local institutions were used to deliver information
5. Boots on the Ground—All available people were deployed to meet in person with as many groups as possible

Hurricane Maria Lessons Learned – Pharmaceutical Delivery

- PUERTO RICO'S BIOSCIENCE INDUSTRY BY THE NUMBERS
- 3.3 million: Population of Puerto Rico
- 38,000: Number of bioscience employees on the island
- 2%: Proportion of total U.S. biopharmaceutical employees who are located in Puerto Rico
- 30%: Proportion of Puerto Rico's GDP that came from biosciences in 2016
- 5: Number of the world's top 10 selling biologic drugs manufactured in Puerto Rico
- 11: Number of world's top 20 pharmaceutical products manufactured in Puerto Rico

<u>Puerto Rico is a critical component of the global pharmaceutical supply chain—almost all facilities were back in service within 2 weeks!</u>

1. Upgrade Communications –Satellite phones, high frequency radios, microwave technology, and satellite dishes
2. Upgrade Power Systems – Additional diesel generators, cogeneration plants
3. Port logistics – Improved planning in conjunction with government
4. Adjustment to business continuity plans – off island backup supplies
5. Employee preparedness – home generators, food and water

Source: Chemical and Engineering News, Sept 2019

Hurricane Maria Lessons Learned – FEMA Perspective

1. Revise operational plans to emphasize stabilization of critical lifelines and coordination across critical infrastructure sectors
2. Promote federally supported, state-managed, locally executed logistics operations
3. Increase FEMA readiness stocks outside the continental US
4. Build and maintain a national incident workforce that include emergency managers from state, local, tribal, and territorial governments
5. Drive outcome-based recovery through expanded use of the Stafford Act
6. Develop a more comprehensive of local, regional, and national supply chains, as well as stronger relationships with critical private sector partners

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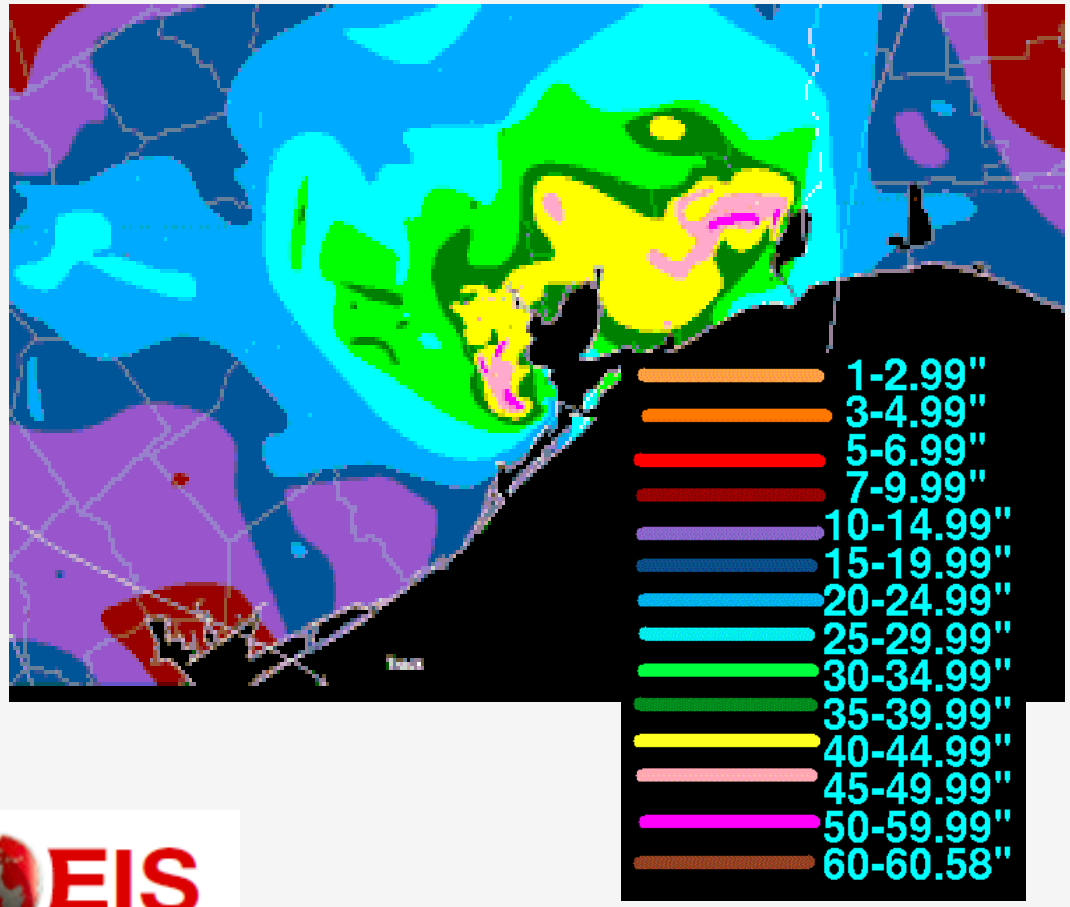
Texas Flooding –Hurricane Harvey (2017)



Hurricane Harvey was a Category 4 storm which made landfall in south Texas, but then stalled, resulting in record rainfall for a period of several days (Metro Houston got 30-60 inches (~1500mm) of rain!)

Texas coastal areas are home to 25% of the US oil refining capacity and 50% of the downstream chemical capacity and most were shut down in anticipation of the storm as well as pipelines that deliver product to the interior US.

Hurricane Harvey Lessons Learned – Chemical Industry

Shell Technology Center

- Communication with employees during the year about the new hurricane preparedness plan
- Practice the plan via tabletop exercises and subsequent lessons learned debriefs

Jacob Sterns & Sons

- Practice of the emergency plans and preparations minimized disruptions

Huntsman

- Anticipatory shutdown is critical; don't focus on what you can't produce, but focus on how quickly can you recover
- Previous experience with storms taught them to raise controls and instrumentation to higher elevations

Source: American Oil & Chemists Society, INFORM, March 2018

Hurricane Harvey Lessons Learned – Houston Area Government

- Need for capital projects – additional reservoirs, buyout homes in the flood pool, acquire greenspace
- Streamline FEMA rules – inspection before debris removal, owner dropoff debris rules, permit to rebuild
- Better floodplane planning
- Expedite the buyout process
- Increased warnings and communications--2,418 social media posts, 650 media interviews, 259 news releases, and 25 news conferences were not enough!
- Increased sheltering capability – sheltering 20,000 people was not enough!

Source: Testimony to the US House Committee on Homeland Security, April 2018

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Common Themes

- Planning
- Cross Sector Coordination
- Communications
- Training
- Drills

EIS Council Activities—Resilience Guidelines

Guideline Concepts

- Provide guidance to the electric industry for the development of black sky response and restoration plans—not provide all the answers, but at least provide all of the questions that need to be answered
- Provide assistance for electrical industry to further their maturity in emergency planning—recognizing that each organization is in a different place with different needs and resources

Underlying belief: Utilities are already pretty good at emergency response and restoration for gray sky events, but black sky events will provide challenges that utilities are only beginning to think about

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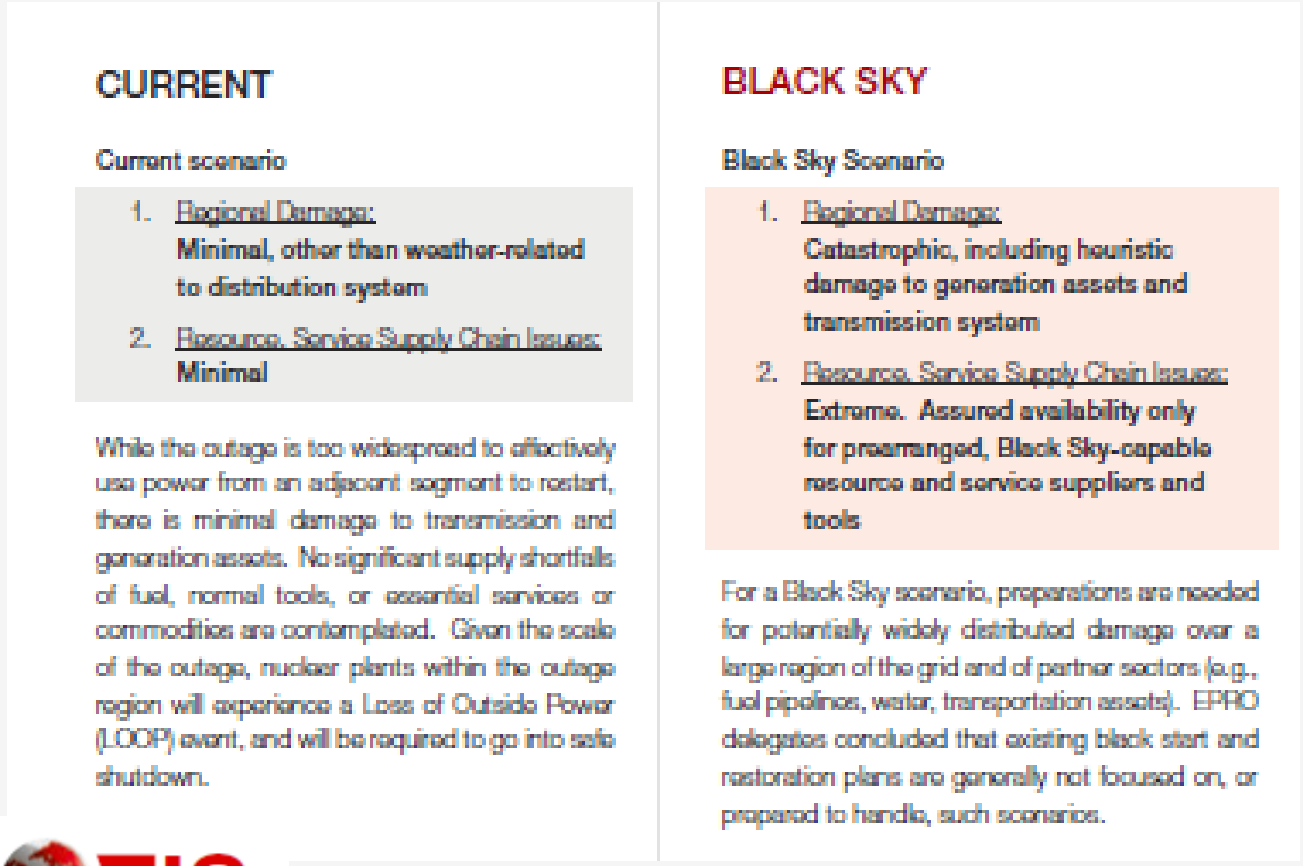
Guidelines Content



CURRENT

Current scenario

1. Regional Damage:
   Minimal, other than weather-related to distribution system
2. Resource, Service Supply Chain Issues:
   Minimal

While the outage is too widespread to effectively use power from an adjacent segment to restart, there is minimal damage to transmission and generation assets. No significant supply shortfalls of fuel, normal tools, or essential services or commodities are contemplated. Given the scale of the outage, nuclear plants within the outage region will experience a Loss of Outside Power (LOOP) event, and will be required to go into safe shutdown.

BLACK SKY

Black Sky Scenario

1. Regional Damage:
   Catastrophic, including heuristic damage to generation assets and transmission system
2. Resource, Service Supply Chain Issues:
   Extreme. Assured availability only for prearranged, Black Sky-capable resource and service suppliers and tools

For a Black Sky scenario, preparations are needed for potentially widely distributed damage over a large region of the grid and of partner sectors (e.g., fuel pipelines, water, transportation assets). EPRO delegates concluded that existing black start and restoration plans are generally not focused on, or prepared to handle, such scenarios.

- Personnel Preparedness
  - Assessment of Personnel Needs/Capabilities
  - Logistical Support to Personnel
  - Internal/External Communications
  - Response Organization and Leadership
- Cross Sector Planning
- Restoration Prioritization
- Government Cooperation and Support
- Supply Chain Issues
- Resilience Investment

EIS Council Activities--BSX Communications

EIS conducted a three-year requirements development and industry search effort

BSX Requirements

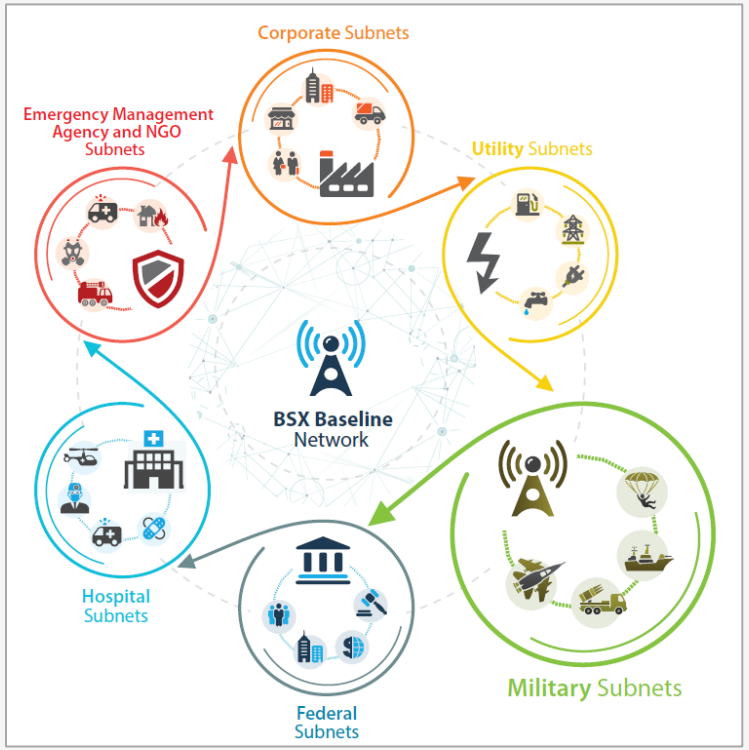
Backup system: Independent of the nation's telecom backbone

Unlimited scalability: For national scale deployment to interconnect all emergency communications systems

Self-forming network, easily interoperable with all emergency communications:

- Powered by facility emergency power during grid outage

Ability to survive adversary attacks: Built-in, robust protection against the full range of malicious hazards. Independent of GPS networks



BSX Communications Status

Possible Near Term, 2019: Dominion Energy BSX Block I Project

- **Acquire, integrate, and test a BSX-BNET network at key grid control facilities**
- May include relays to bring communication nodes to key organizations in Washington D.C. and PJM Headquarters in Valley Forge

Long Term Vision, 2019 - 2021: Deploy Sparse, Nationwide Network

Block II - III: Add connectivity to interdependent sector facilities (Richmond, Valley Forge, and Washington D.C.)

- Expand emergency network up and down the East Coast

Block IV: Deploy a basic Black Sky emergency network on the West Coast (grid assets and partner sectors)

Block V: Deploy a "belt" across CONUS - Connect the East and West Coast, spanning critical assets throughout the Midwest

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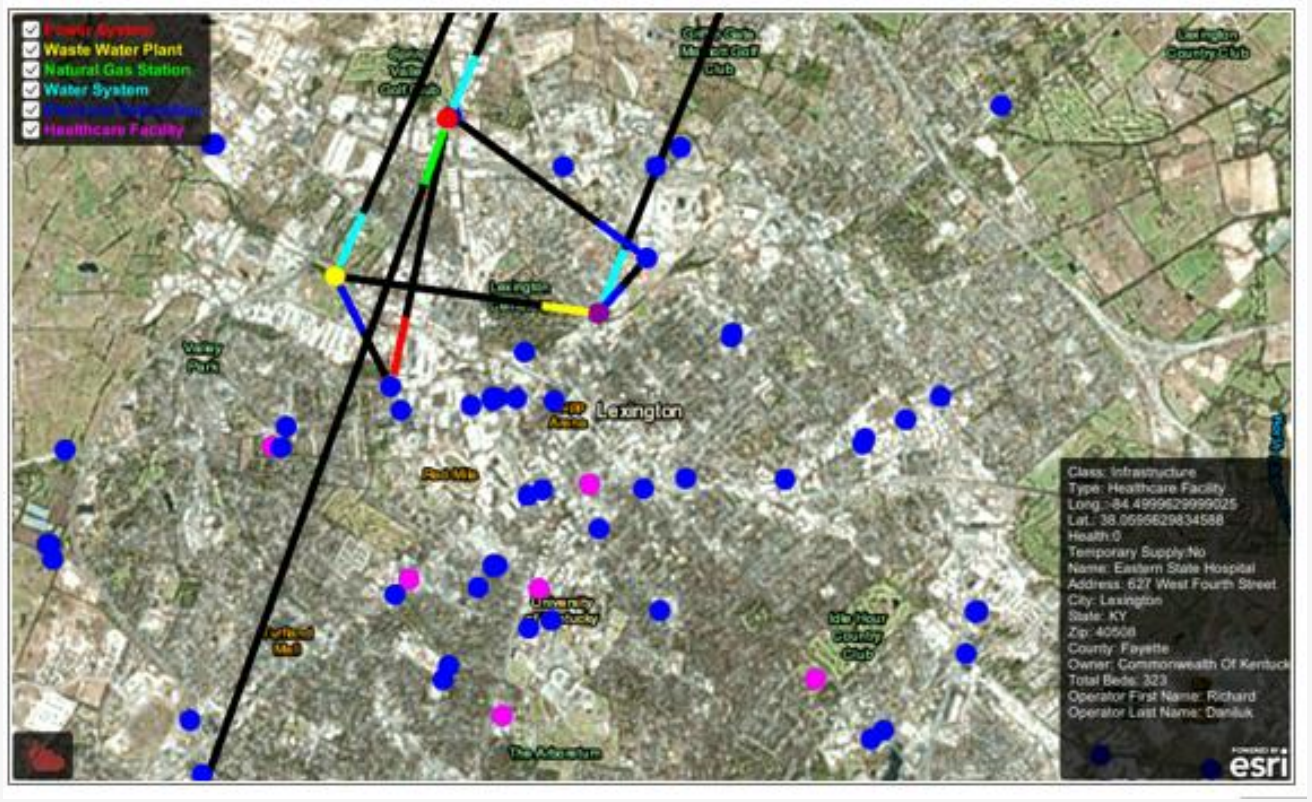
EIS Council Activities -- GINOM



Concept: Provide situational awareness across multiple critical infrastructures, for the purposes of planning, training, and emergency management

Technical Solution: Use of mapping tools and multiple models that can be merged to provide a visual display as well as analytics, simulation, and forecasting to guide planning and execution

Status: Initial model development and hardware/software configuration is in progress

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EIS Council Activities – EarthEx

- Over 1,500 organizations and 10,000 individuals participated worldwide
- Provided in English, Spanish, and Hebrew (Spanish and Hebrew versions are still available)
- 39 lanes of participation
- Scenario was a terrestrial weather event