



Community Resilience and Critical Infrastructure Restoration: A Discussion

Climate Change-Driven Disasters: The New Reality

Restoring the Critical Community Lifeline Capabilities





Things to Think About

- The Threats
- Resilience
- The World Today
 - Interconnected and Electrified
- Response and Restoration
- EARTH EX
- Lessons Learned
- Building Your Program



Black Sky Hazards

Natural

- Geomagnetic Disturbance (GMD)
- High-Magnitude Earthquakes
- Severe Weather Events

Malicious

- High-Altitude Electro Magnetic Pulse (HEMP)
- Intentional Electro Magnetic Interference (IEMI)
- Cyber Terrorism
- Coordinated Physical Attack

Other

- Self-Organized Criticality
- Institutional Failure



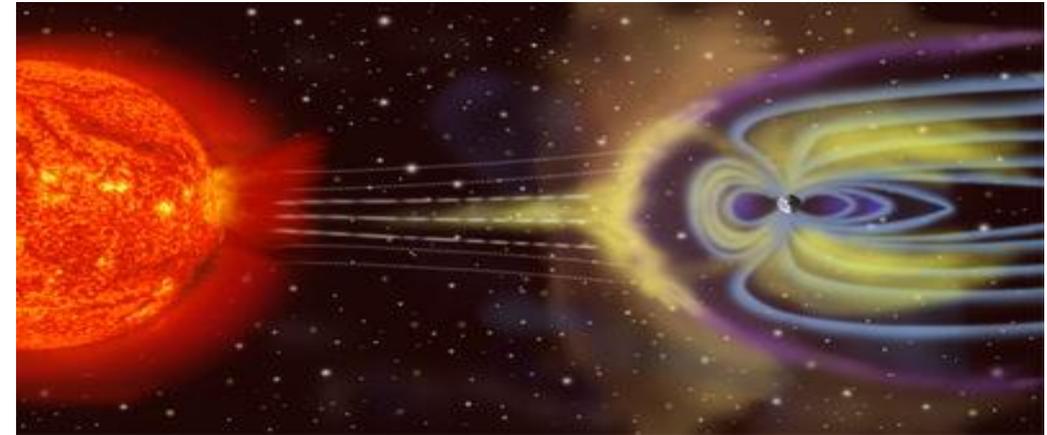
Geomagnetic Disturbance (GMD)

Definition

A GMD is caused by a very efficient transfer of energy from solar wind into the Earth's magnetosphere. Solar wind shockwaves result from a solar flare that is followed by coronal mass ejections (CMEs) of charged and magnetized particles into space. Magnetosphere dynamics create geomagnetically induced currents (GICs). https://en.wikipedia.org/wiki/Geomagnetic_storm

Examples

- Carrington Event (1859)
- Vietnam War Mine Explosions (1972)
- Quebec Blackout (1989)
- London Olympics Near Miss (2012)
- Grid Related: <http://www.spaceweather.gc.ca/tech/se-chr-en.php#year1989>



Threat

- Carrington-level: 0.46 to 1.88% per decade

Consequences

- Damage to High and Extremely High Voltage Transformers
- Voltage Instabilities
- Damage to Electronic Equipment
- Disrupt Communications

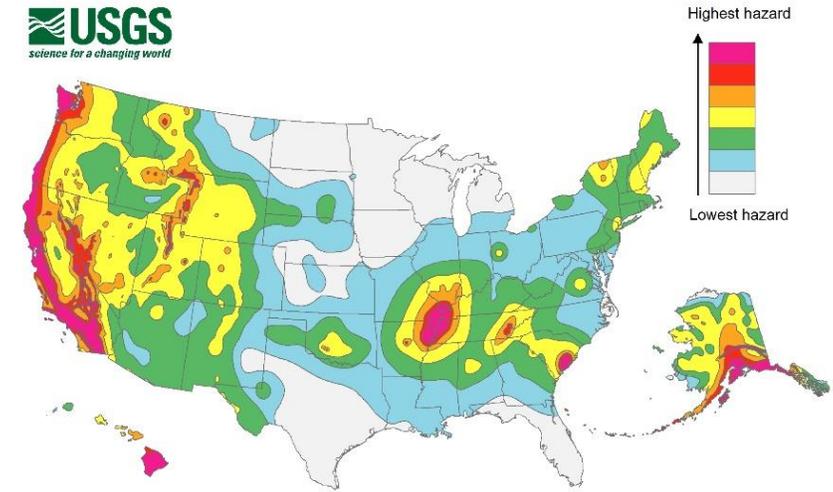
High-Magnitude Earthquakes

Definition

The shaking of the surface of the Earth, resulting from the sudden release of energy in the Earth's lithosphere that creates seismic waves. Propagation of seismic wave causes widespread: shaking and ground rupture, soil liquefaction, landslides, fires, tsunamis and floods.

Examples

- Alaska (1964): 9.2
- Cascadia (1700): 8.7-9.2
- New Madrid (1811-12): 7.2-8.1
- Tōhoku earthquake and Tsunami (2011): 9.0
- Haiti (2010): 7.0



Threat

- Shaking, Liquefaction, Tsunami, Flood, Landslides
- New Madrid
- Cascadia

Consequences

- Damage to Electric Grid
- Severe Damage to Water/Wastewater, Transportation Infrastructures
- Severe Damage to Facilities

Definition

A large terrestrial weather-caused event. These events present as extreme atmospheric conditions with low-probability of return.

Examples

- Hurricane Katrina (2005)
- Hurricane Harvey (2017)
- Hurricane Maria (2015)
- Hurricane Matthew (2016)
- Southeast Tornadoes (2017)
- Derecho (2012)
- Kentucky Ice Storm (2009)

Threat

- Flooding
- Wind
- Wildfires
- Ice

Consequences

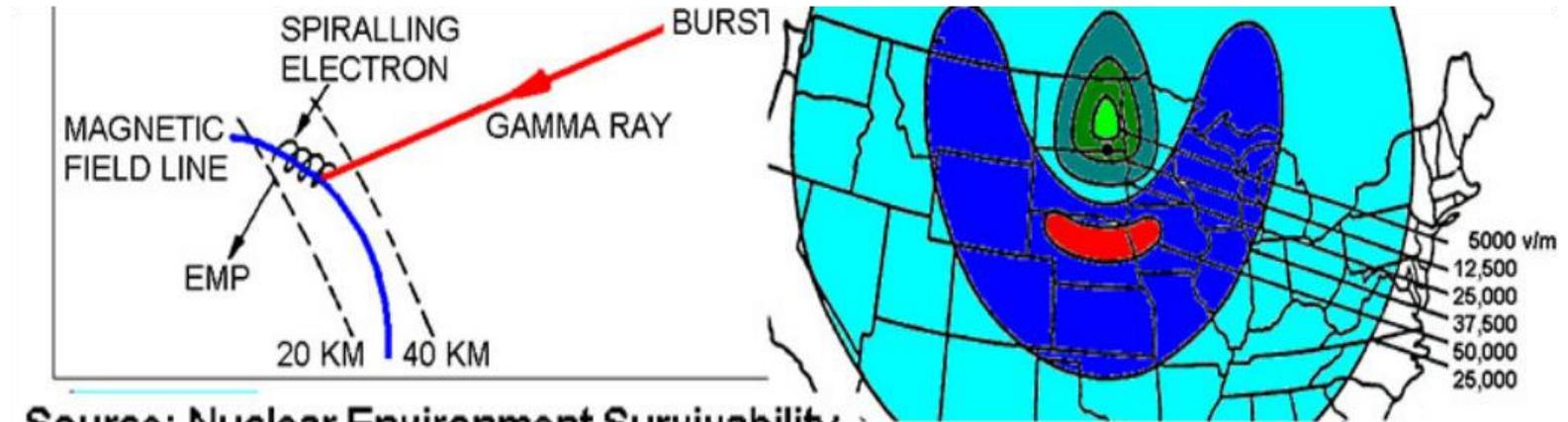
- Damage to Towers and Transmission Lines
- Severe Damage to Water/Wastewater, Transportation Infrastructures
- Severe Damage to Facilities



High Altitude Electromagnetic Pulse (HEMP)

Definition

A burst of electromagnetic radiation created by a high-altitude nuclear explosion. The resulting rapidly varying electric and magnetic fields may couple with electrical and electronic systems to produce damaging current and voltage surges.



Source: Nuclear Environment Survivability, U. S. Army, report AD-A278230 (1994)

Examples

- Starfish Prime (1961) Part of US Operation Fishbowl
- Soviet Test 184 (1962)

Threat

- China, North Korea, Iran, Russia

Consequences

- Severe Damage to Electric Grid
- Damage to All Electronics
- Disruption to Communications using Surviving Equipment

Definition

Intentional degradation of the performance of a device, transmission channel or system caused by weapons producing a high-intensity electromagnetic disturbance. These weapons create a pulse that can be higher in magnitude than HEMP, though affecting only localized point targets. They could be used in conjunction with a coordinated terrorist attack.

Examples

- USS Forrestal (1967)-accidental detonation that caused fire that claimed 134 lives
- May 2012 North Korean Attack



Applied Physical Electronics, LLC
100-KV/M HP RF Source

Threat

- China, North Korea, Iran, Russia
- Domestic Terrorists
- Criminal Operatives

Consequences

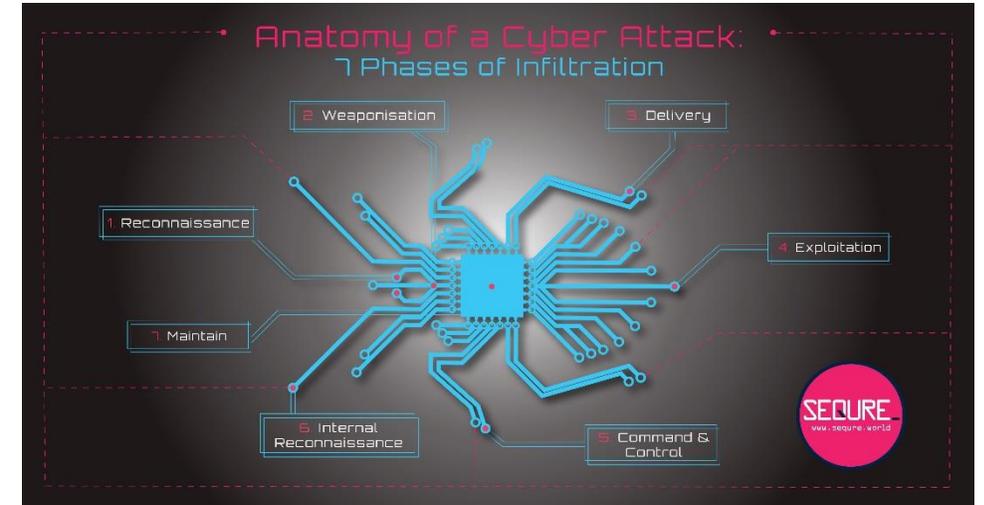
- Localized Damage to Electric Grid
- Localized Damage to Electronics
- Mis-Operation of Relays

Definition

Any type of offensive maneuver that targets computer information systems, infrastructures, computer networks, or personal computer devices. Goal is to disrupt critical infrastructures, through direct or cascading impacts.

Examples

- Ukraine (2015)
- Ukraine (2016)
- Rye Brook, NY, Dam Attack
- SWIFT Global Bank Messaging System (2015-2016)
- Wolf Creek Nuclear Operating Corp. (2017)



Threat

- Nation States
- Crime Syndicates
- Script Kiddies

Consequences

- Loss of Control over Grid and Critical Infrastructure Operations
- Damage to Critical Infrastructure Components, Computers and PLCs
- Lloyd's of London Economic Loss: \$243B /\$1T

Coordinated Physical Attack

Definition

A well-planned and coordinated set of physical attacks on the Electric Grid and other critical infrastructures conducted by inside or outside terrorist groups. The attack would target both vulnerable and highly-critical components of critical infrastructures.

Examples

- Metcalf Substation (2013)
- Utah Substation (2016)
- EPRI: 2,500 Attacks on Transmission Lines/Towers and 500 on Substations (1996-2006)



Threat

- Internal and External Terrorist Groups

Consequences

- Damage to Critical Components especially transformers
- Direct and Cascading Effects on other Critical Infrastructures

Definition

Institutional failure leading to ultimate partial or total collapse of critical infrastructures. Characterized by declining: institutional capacity, population, and/or resources.



Using Wastewater as Water Source
(Reuters)

Examples

- Venezuela
- Puerto Rico
- Flint Michigan
- Rural North Carolina

Threat

- Loss of Institutional Capacity
- Insufficient Resources

Consequences

- Deterioration of Infrastructure
- Hunger and Disease
- Mass Population Flight
- Loss of Community Resilience
- Internal Strife/Civil War

Self-Organized Criticality



Definition

A property of dynamical systems that have a critical point as an attractor. The system, effectively, tunes itself as it evolves towards criticality. Systems at criticality can collapse suddenly, by even a slight disturbance. Once a system reaches critical state, there is no correlation between the 'before' and 'after' of the initiating event. (see the Abelian Sandpile)

Examples

- Northeast Blackout (1965)
- Northeast Blackout (2003)
- Mayan Collapse (2d Century AD) ?
- Mayan Collapse (9th Century AD) ?

Threat

- Increased Complexity
- Evolutionary Incremental Improvements, in Search of Optimization

Consequences

- Sudden Grid Collapse
- Slow Recovery

Initial evidence for self-organized criticality in blackouts

Ben Carreras & Bruce Poole
Oak Ridge National Lab

David Newman
Physics, U. of Alaska

Ian Dobson
ECE, U. of Wisconsin

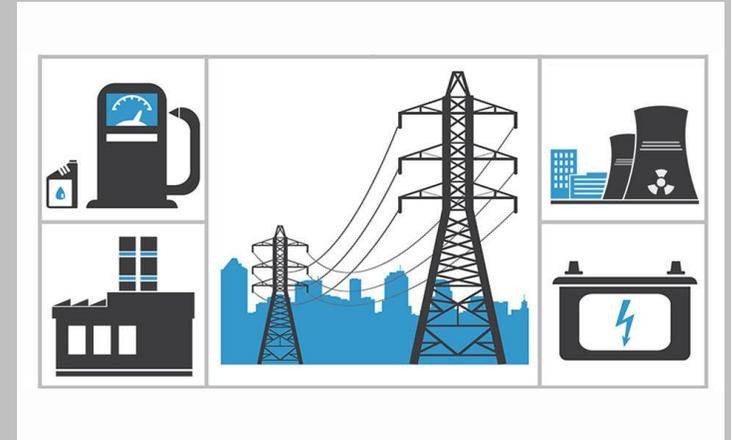


Complex Catastrophes – Black Sky Events

The Evolving Definition of Critical Infrastructure



Critical infrastructure is the body of systems, networks and assets that are so essential that their continued operation is required to ensure the security of a given nation, its economy, and the public's health and/or safety.



ENERGY



HEALTH



TRANSPORT



FINANCIAL



ICT



WATER



FOOD



PUBLIC & LEGAL
ORDER AND
SAFETY

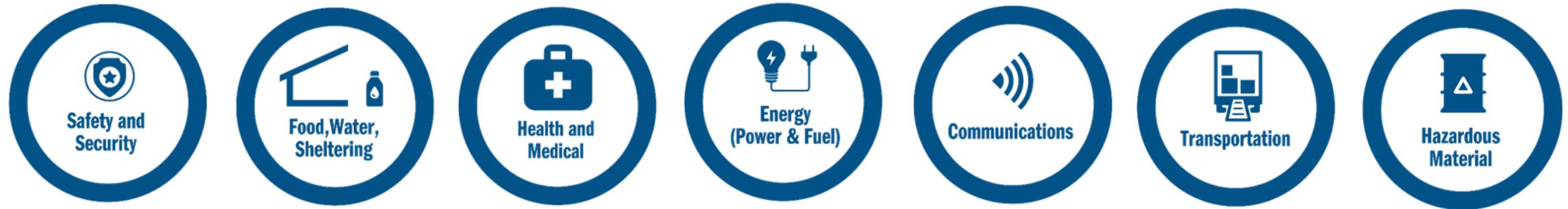


CHEMICAL &
NUCLEAR
INDUSTRY

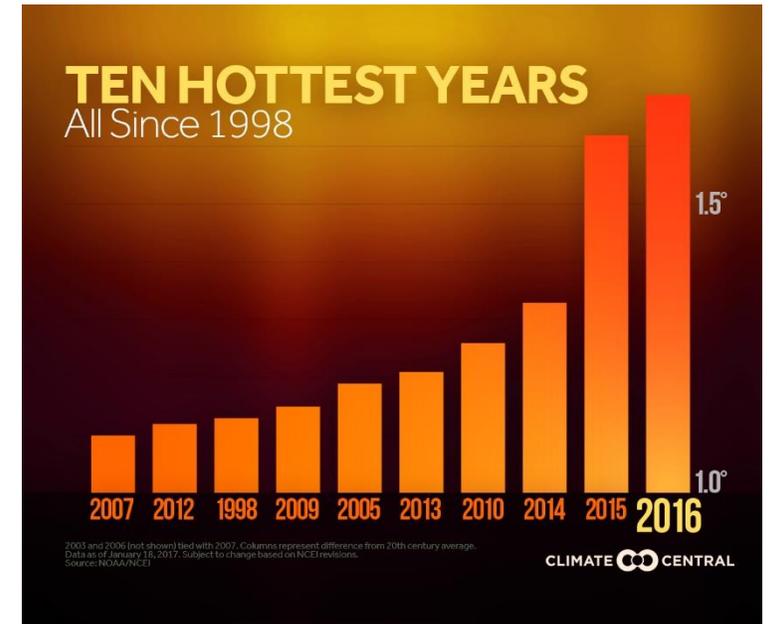


SPACE AND
RESEARCH

Community Lifelines



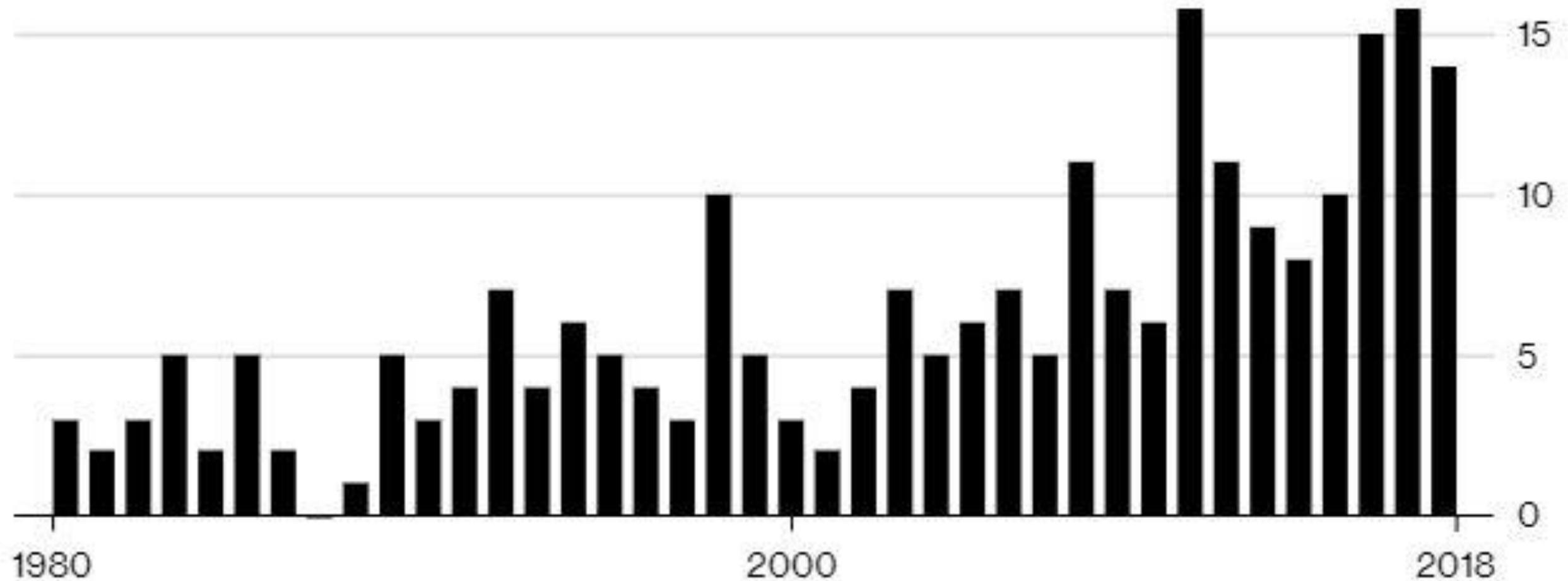
The most critical public/private services and infrastructure to help prioritize, sequence, and focus response efforts.



Climate Driven Disasters An Evolutionary Catastrophe

Billion-Dollar Weather Disasters on the Rise

U.S. events sustaining losses of at least \$1 billion

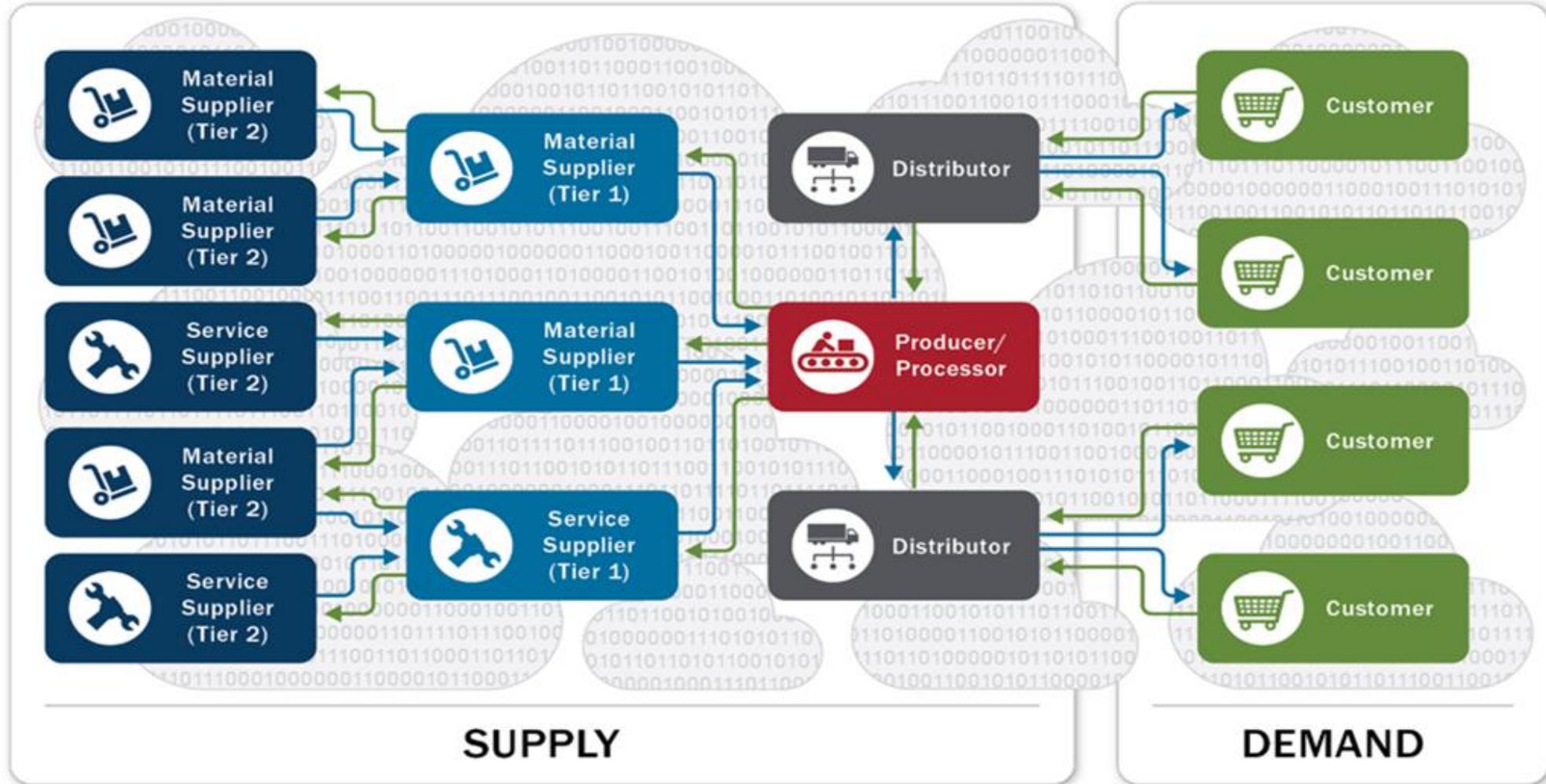


Source: [NOAA National Centers for Environmental Information](#)

Note: Costs are adjusted for inflation.



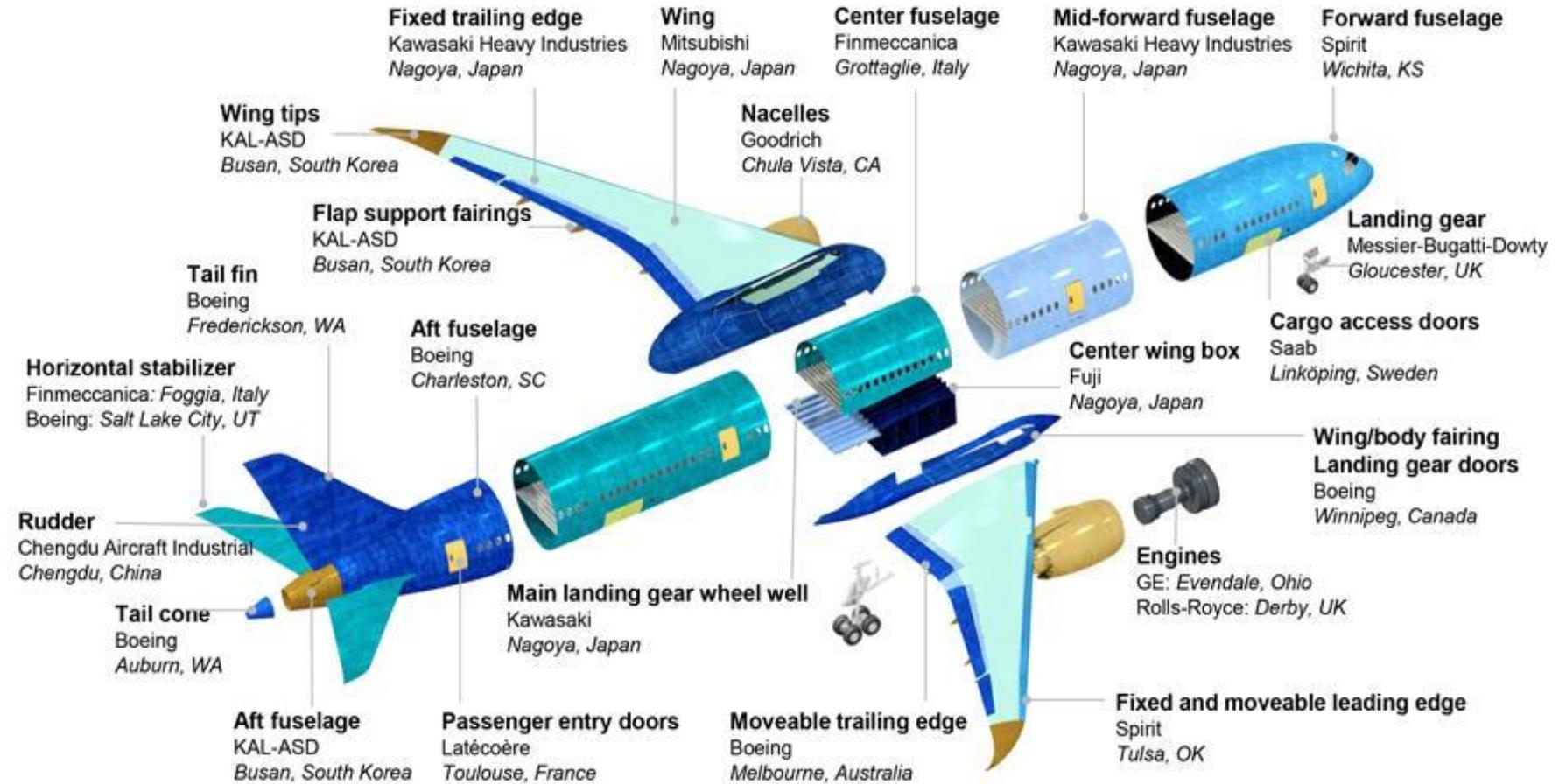
Supply Chain Basics



Global Supply Chains have Global Implications



Global Implications



Global Implications - Discussion



International Business Continuity Plans



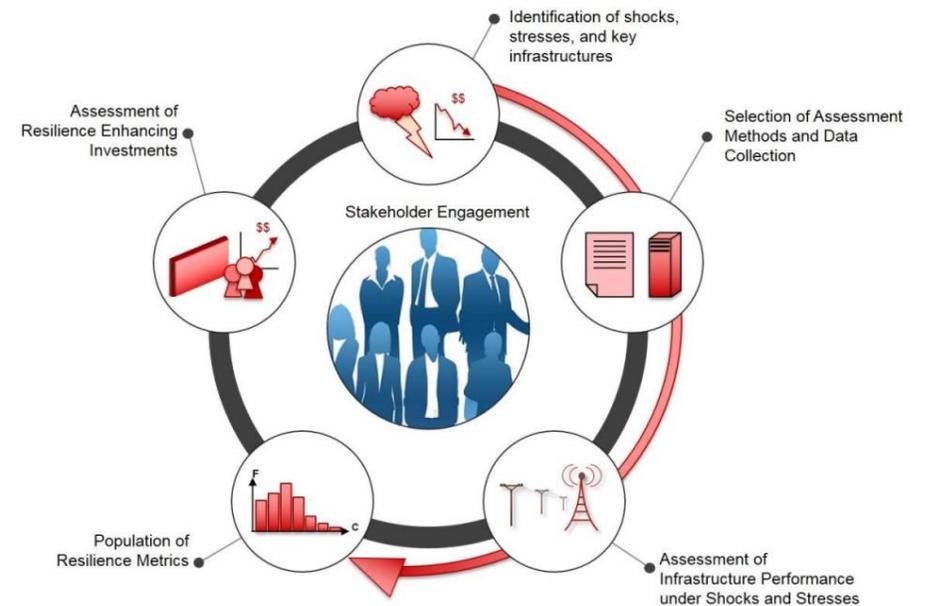


ESF 14 – How how is that going to work?

Business Led and Government Supported

Coordinated Actions

- Action is the Key Word
- Community Resilience
 - Resilience Investments



Complex Catastrophes – Black Sky Events

- Long Duration Power Outages
- Dependent Systems Fail/Substantially Degraded
- External Resources Are Likely Not Available Using Normal Processes
- Resource Chains Fractured/Stressed
- Command and Control – Government/DOD/Private Sector Difficult
- Overwhelming Support Requests & Requirements
- Enormous Need For Self-Activation (Plans and Planning)
- Actions Require Synergy and Coordination/Resource Shortages
- Check Points and Sync Points Required
- Effective Public Messaging Essential to Maintain Trust in Government
- Coordinated Actions Required to Save Lives/Protect Property
- Restoration Actions Must be Efficient and Effective

Complex - the state or quality of being intricate or complicated.





EARTH EX[®] III/19

Situation Report

- Situation: Record setting rainfall over the last two weeks has resulted in widespread flooding across Iowa.
- Injuries: 312
- Deaths: 17 +
- Missing: 23
- Displaced: 32,000
- Sheltered: 4,600
- Roads Closed: I-80, I-35
- Rail: All shut down
- River: No traffic
- Utilities:
 - Electric- Many distribution outages
 - Water- Boil Orders in many towns
 - Wastewater- Many are flooded
 - Communication- Some outages
 - Natural Gas- Adequate supplies



Situation Report

- Private Sector

- Fuel: Some localized shortages
- Food: Some localized shortages
- Water: Widespread shortages
- Financial: A number of ATMs down
- Retail: Some are cash only
- Manufacturing: A few shutdowns
- Agriculture: Major impacts

- Government

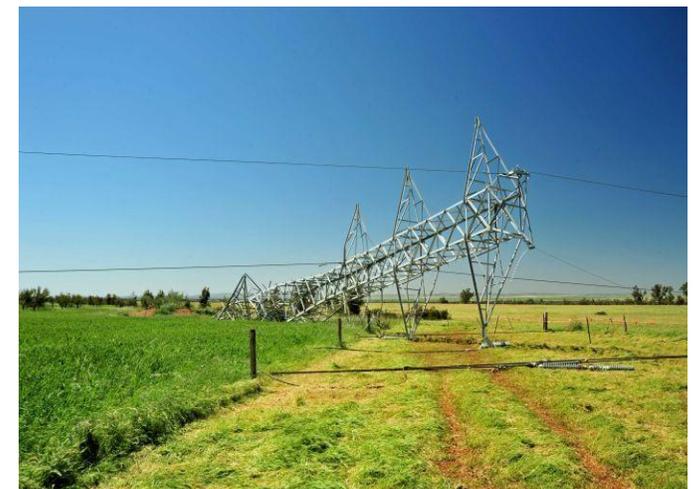
- Local, Regional and State EOCs open
- Disaster declarations local and state
- Federal disaster pending
- Responders are fatigued
- Equipment shortages
- Some looting reported
- Medical system at capacity
- Rescue Teams in short supply



Situation Report



- Situation: Record setting rainfall over the last two weeks was followed by a severe straight line wind event last night with some tornados that caused serious damage including damage to miles of electric transmission lines across Iowa. Widespread power outages. Communications are seriously degraded.
- Injuries: Over 1000
- Deaths: 31 confirmed
- Missing: Unknown
- Displaced: Unknown
- Sheltered: 6000+
- Roads Closed: All Major Interstates
 - Many local roads due to trees and lines down
- Rail: All shut down
- River: No traffic
- Utilities:
 - Electric- Many distribution outages
 - Multiple transmission lines down
 - Water- Boil orders in many towns- No power
 - Wastewater- Many are flooded- No power
 - Communication- Many outages
 - Natural Gas- Reduced pressure and supplies



Situation Report 2



- Private Sector
 - Fuel: Widespread shortages
 - Food: Few stores open- shortages
 - Water: Widespread shortages
 - Financial: Almost all ATMs down
 - Retail: Most are cash only- Few are open
 - Manufacturing: Mostly shutdown
 - Agriculture: Severe impacts
 - Power outage is impacting all
- Government
 - Local, Regional and State EOCs open
 - Disaster declarations local and state
 - Federal disaster approved
 - Situational Awareness difficult
 - Communications Issues
 - Responders are fatigued/Rescue Teams overwhelmed
 - Equipment shortages and damage
 - Some looting reported
 - Medical system over capacity



Develop Situational Awareness

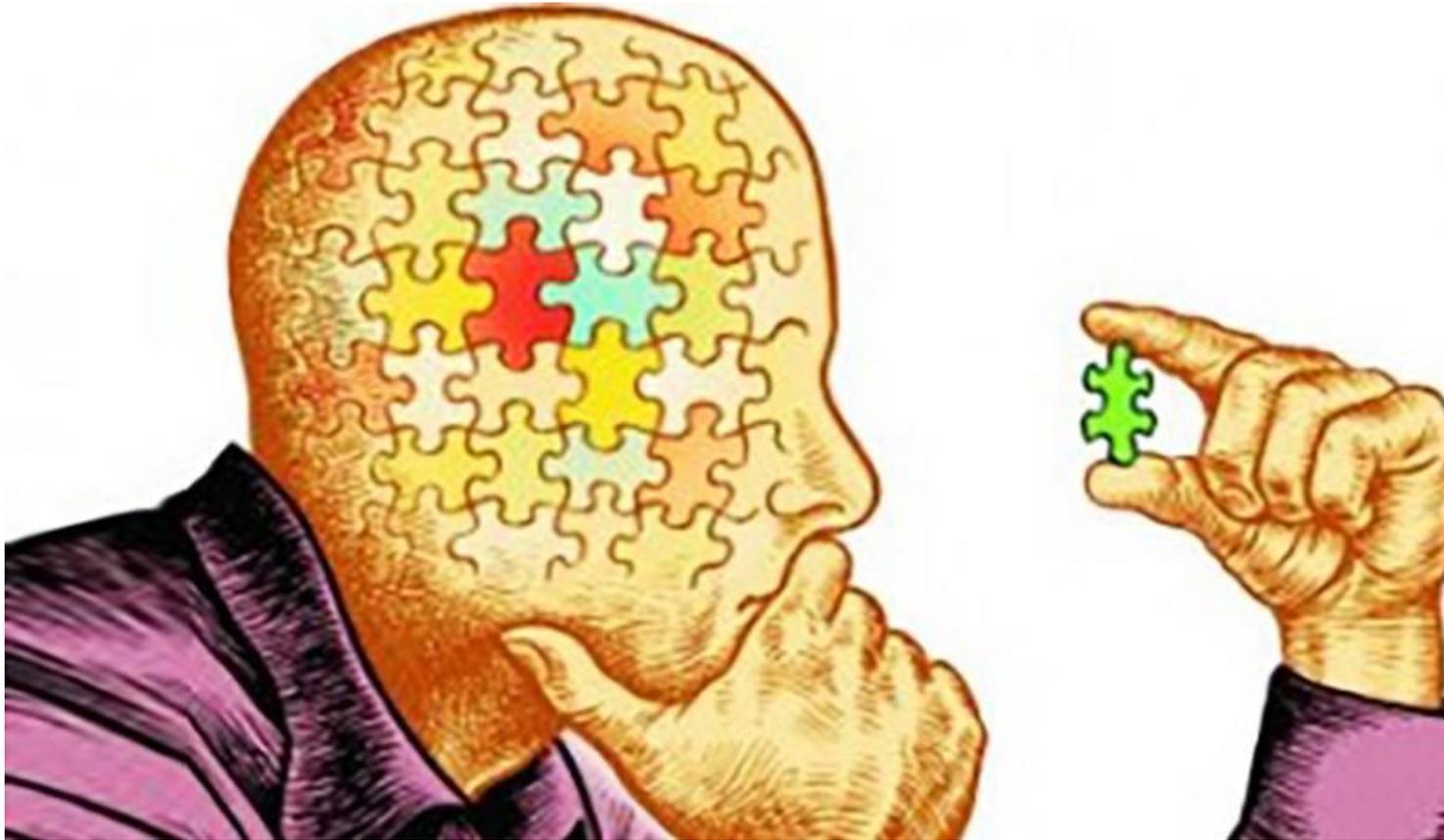
- What do you know?
- What do you need to know?
- What else?



Decision Making

- Establishing Priorities
- Internal priorities versus External priorities





- Time
- How will you prioritize?
- What will you prioritize?
- What are your metrics for success?

Critical Management Actions

Resource Management

- Most critical and essential supplies
- Resource solutions – Where to look
- Mutual Aid and EMAC



Decision Making Round Up



Priority Discussion

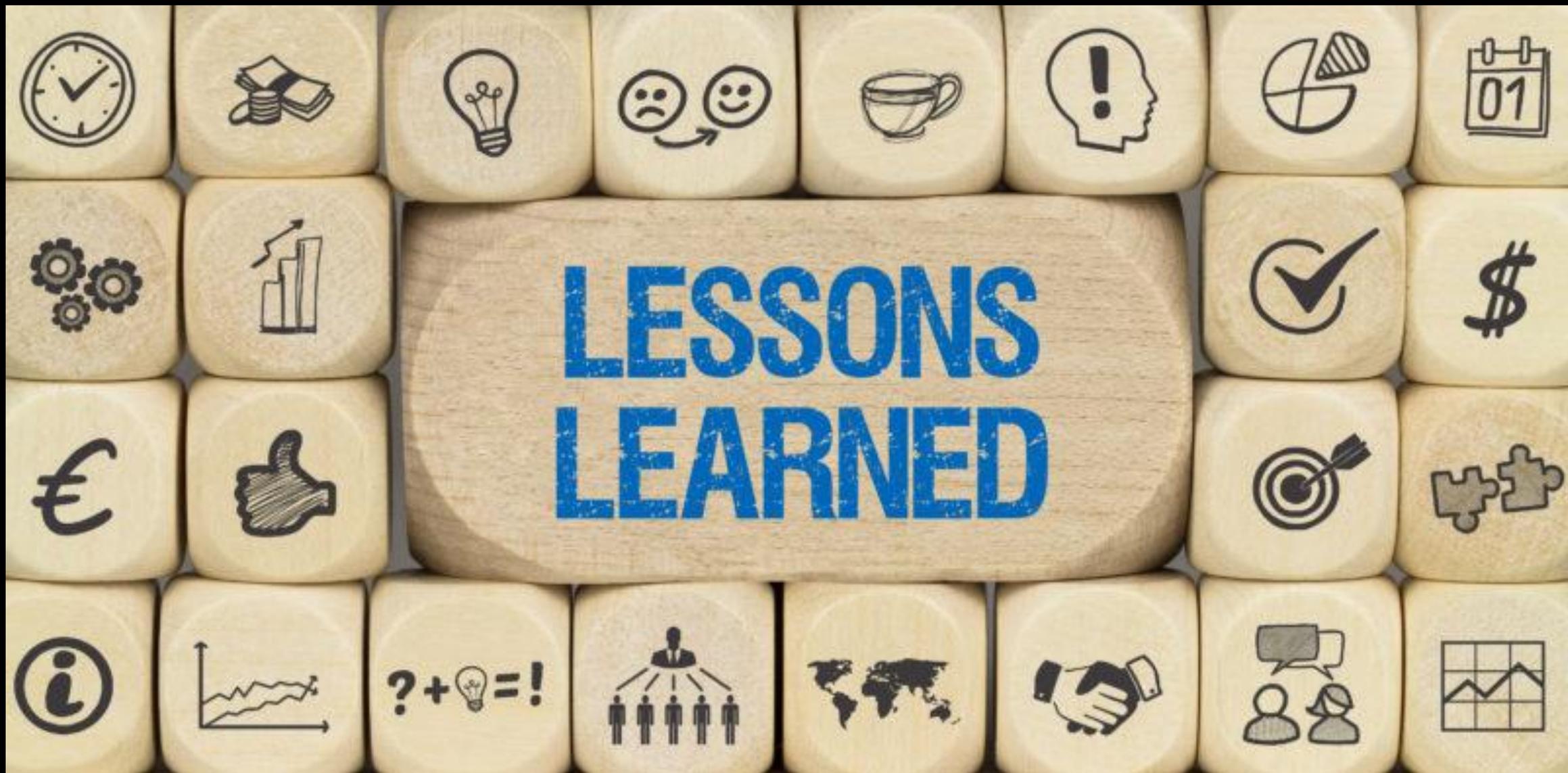
- How did you establish a clear priority?
- What would be the priority for your organization?
- What are the priorities for the state?

- What would you do differently?



A pair of hands, one light-skinned and one dark-skinned, are shown holding a small, colorful world map. The map is spread across the palms and fingers, with the word 'WORLD' printed on the left hand. The background is a soft, out-of-focus sky with light clouds. The text 'Resource Management Winners and Losers' is overlaid in white, centered between the hands.

Resource Management Winners and Losers



**LESSONS
LEARNED**



THANK
YOU