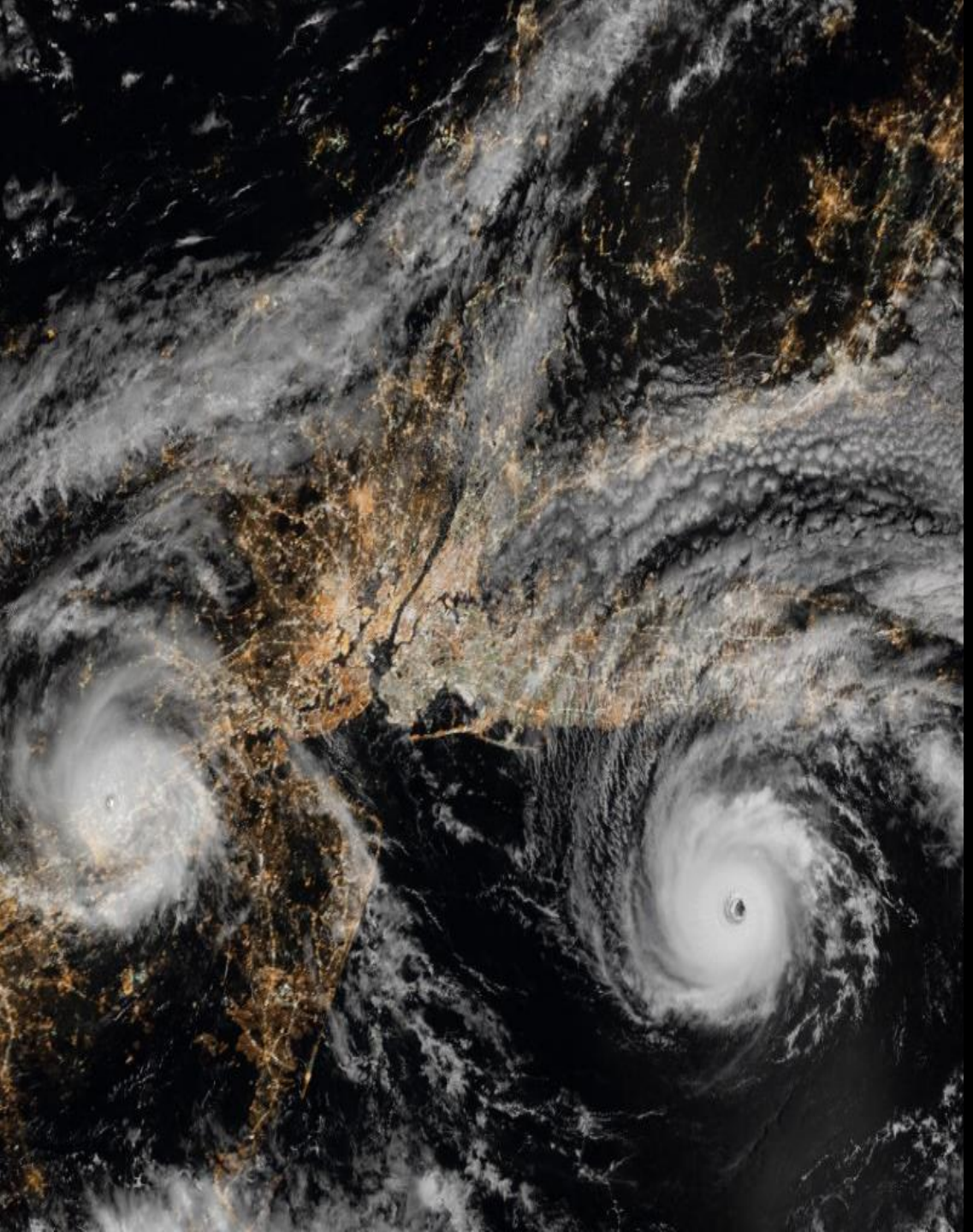

Stantec

Climate Risk and Resilience Portfolio Screening, Prioritization, On-Site Assessment, and Program Development

Case Studies in Climate Resilience Analysis

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Enterprise Consultant
Michael.Bilney@stantecgs.com
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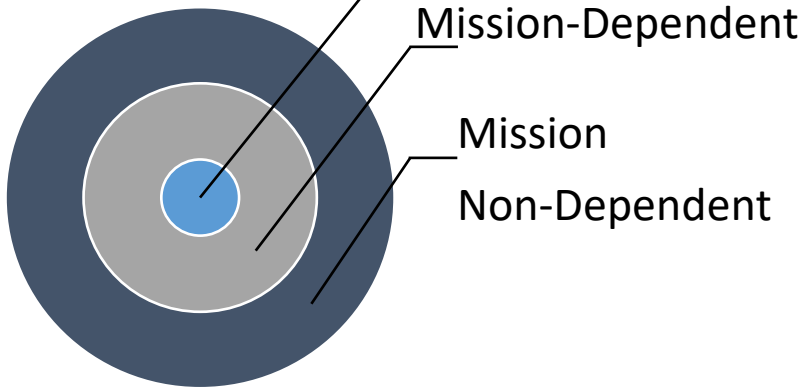
SAME Rhein-Main Post Resilience Presentation Topics

- Resilience Terms and Definitions
- Resilience Factors
- Resilience DOD Guidance
- Resilience Project Case Studies
- Resilience Program Development
- Resilience and the Future

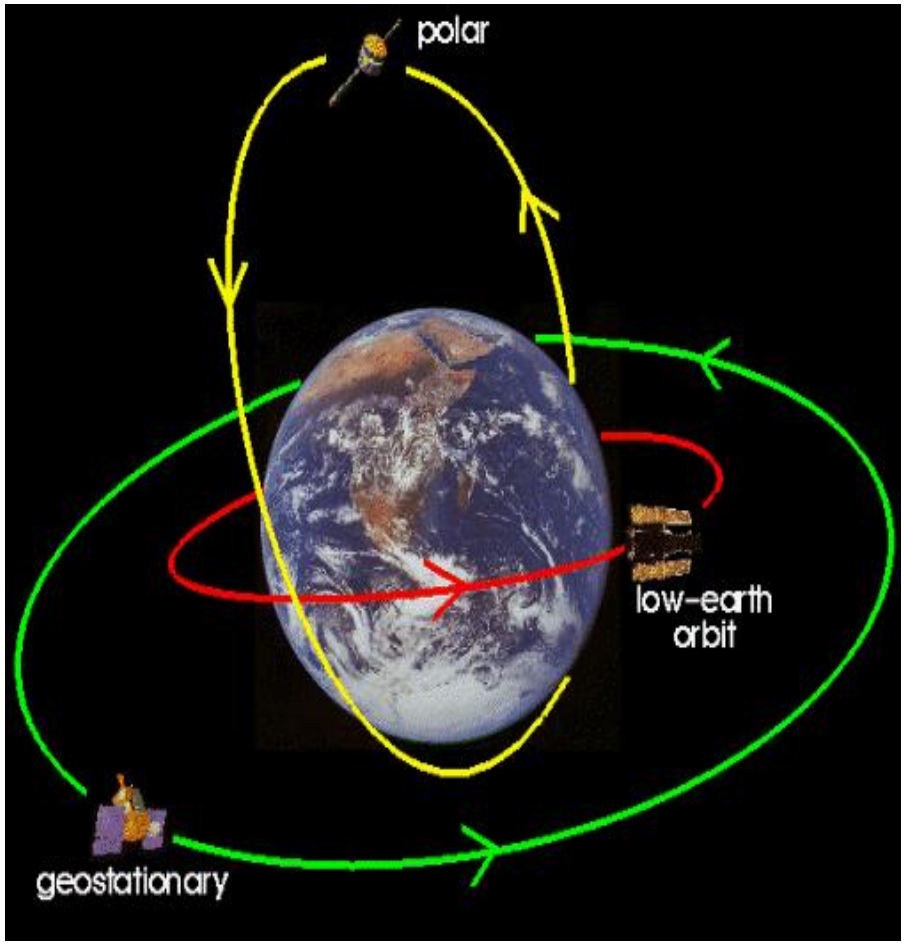
Case Study: NOAA Climate Risk and Resilience Analysis

- **Risk Analysis screened 3200 NOAA-owned and leased properties to:**
  - **Identify Top 10 NOAA-owned Mission-Critical properties at highest risk to climate change threats**
  - **Identified Top 40+ at highest risk – Beware the too few "Top X#"!**

- **Developed transparent risk-based prioritization method easily communicated to Leadership**
- **Identified the facilities most at risk to Climate Change threats**
- **Conducted site-specific analysis**
- **Identified Single-Points of Failure**
- **Developed site-specific Adaptation/Resilience Plans**
- **Developed standardized enterprise-wide assessment process**
- **Identified need for engagement in local and regional planning**



Why is Asset Criticality So Important?



- **If critical assets fail, they have a highly negative great effect on mission and business objectives**
- **The greater the negative effect the greater the criticality**
- **Critical-Asset Risk is determined by:**
  - **Likelihood of asset failure**
  - **Severity of consequences of failure**
  - **Likelihood x Severity = Risk**
- **Critical assets are supported and enabled by other assets and asset systems (Asset Interdependencies)**

Systematic Climate/Severe Weather Resilience Risk Analysis

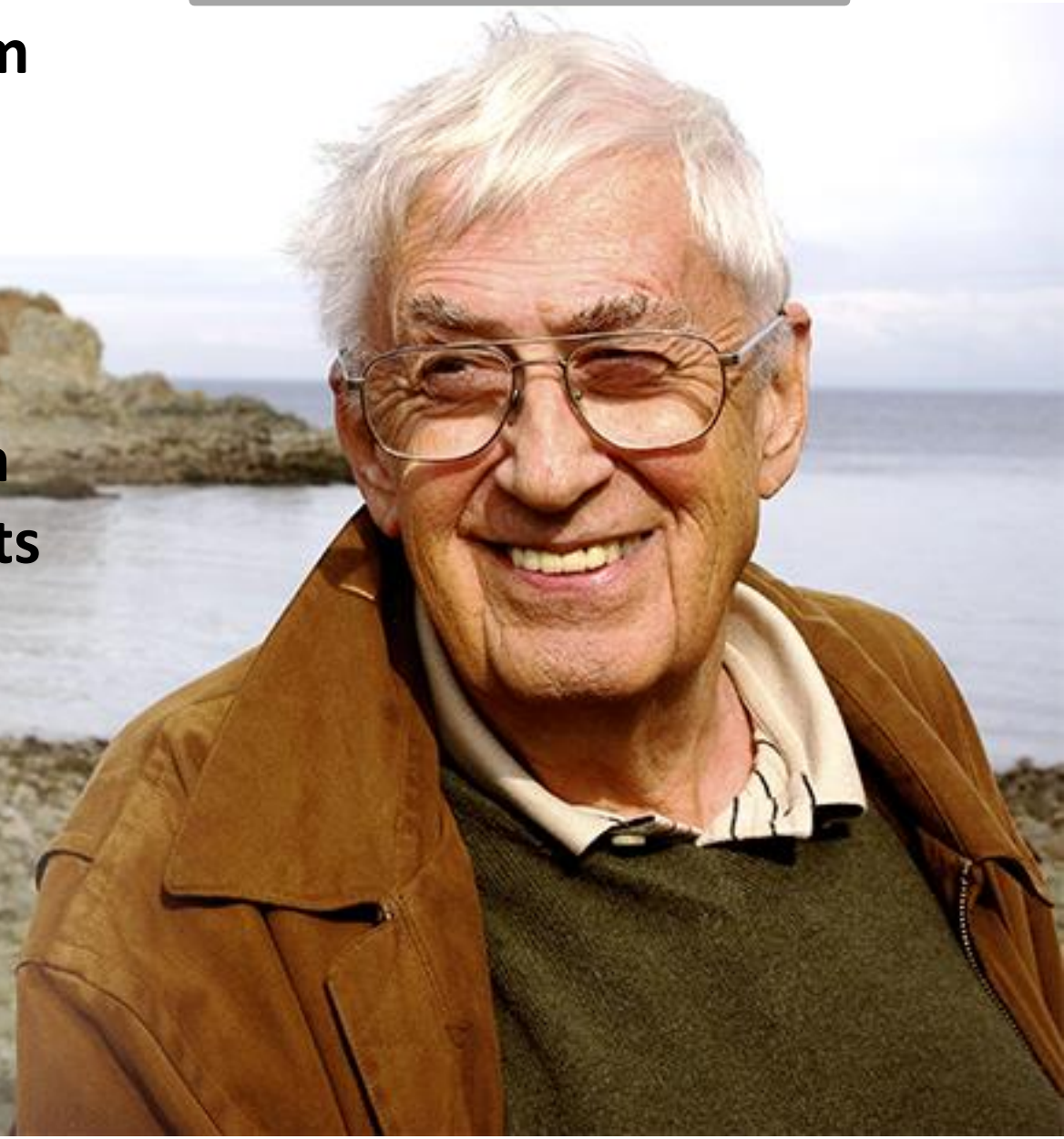
- Personnel
- Infrastructure
- Operations
- Assets
  - Equipment
  - Structures
  - Natural/Built
- Maintenance
- Supply Chain Logistics
- Security
- Emergency Response
- Energy, Water/Wastewater
- Communications, Cyber, IT
- Transportation
- Emergency Response
- Community/Region/Country Planning

What is Resilience?

RESILIENCE

“Resilience is the capacity of an ecosystem to respond to a perturbation (shock) or disturbance by resisting damage and recovering quickly.”

“Such perturbations and disturbances can include stochastic (random process) events such as fires, flooding, windstorms…”
(C.S. Holling 1973)

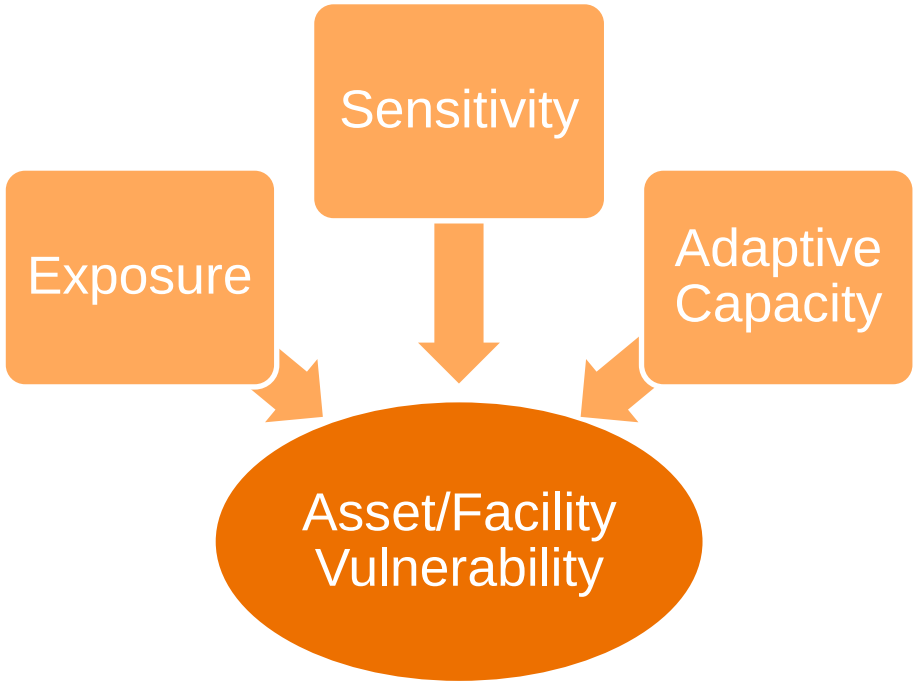


Shared Understanding of Terms and Definitions!

- **Resilience** - The ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions. (DoDD 4715.21)
- **Hazard** - A condition with the potential to cause injury, illness, or death of personnel; damage to or loss of equipment or property; or mission degradation. (DoD Dictionary, 2021)
- **Risk** – Probability and severity of loss linked to threats or hazards and vulnerabilities. (DoDD 3020.40)
- **Climate Change** - Variations in average weather conditions that persist over multiple decades or longer that encompass increases and decreases in temperature, shifts in precipitation, and changing risk of certain types of severe weather events. (DoD Directive 4715.21, 2016)
- **Weather** – "the state of the atmosphere at a place and time as regards heat, dryness, sunshine, wind, rain, etc." (Oxford Languages)

Adaptive Capacity & Other Key Terms & (Short) Definitions

- **Exposure**: Conditions or circumstances indicating Natural hazards are expected to occur
- **Sensitivity**: Degree natural hazards can negatively affect an installation and/or asset
- **Adaptive Capacity**: ability to adjust to negative affects of natural hazards, capture opportunities, manage consequences and learn
- **Vulnerability**: Conditions or circumstances that increase a location's risk of negative effects from Natural Hazards
- **Critical Assets**: asset failure has severe consequences on the mission or business objectives



Mission Critical Assets and Adaptive Capacity

Adaptive Capacity derives from Asset and Facility: Exposures, Sensitivity, *Location*, *Condition*, *Life-Cycle Status*, *Accessibility*, *Interdependency*, *Redundancy*, *Single Points of Failure*

Exposure to Natural Hazards (Causes)

- Severe Wind
- Water Stress
- Heat Stress
- Flood (Coastal, Riverine, Pluvial)
- Tsunami
- Earthquake
- Landslide
- Wildfire
- Volcano

Exposure

Low to High

Sensitivity

High or Low

Impacts (Effects/Consequences)

- Mission
- People
- Infrastructure
- Assets
- Supply Chain

- **Ability to adjust to impacts**
- **Capture opportunities**
- **Manage consequences**

Adaptive Capacity

High or Low

Organizational Capability to Anticipate, Detect, Protect, Prepare, Respond, Recover

Key Factors in Resilience

Key Resilience Factors – USACE and LEED-ND

Robustness

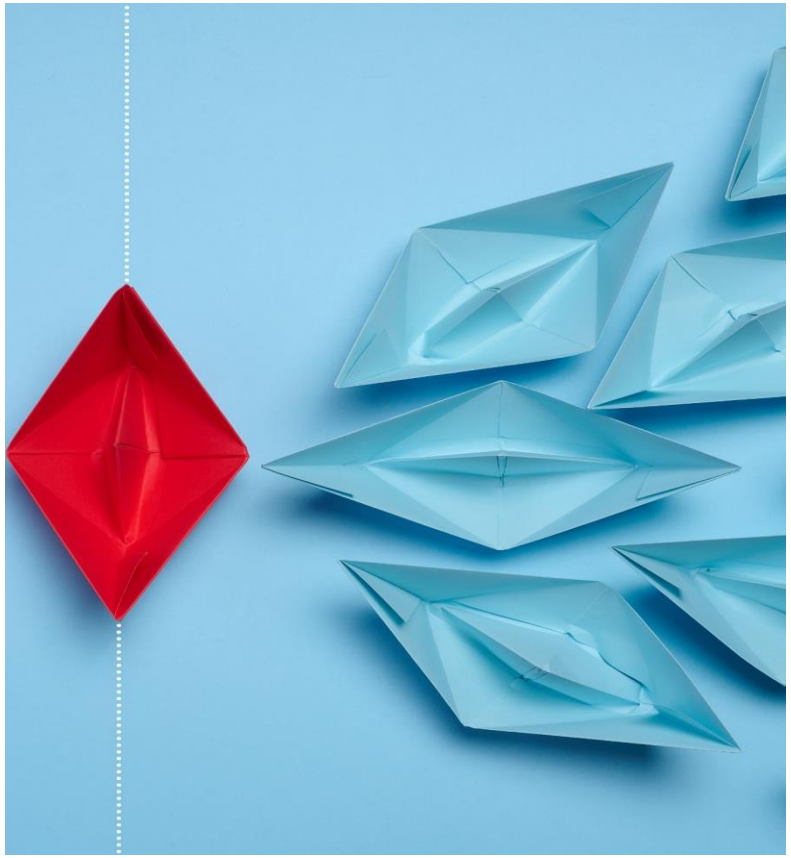
- **The extent to which a system can absorb and impact or prevent the impact from spreading to other parts of the system.**

Redundancy

- **The extent to which a system has excess capacity or a diversity of methods in which it can continue to provide the required level of service.**
- **(Multiple sources of energy, microgrids, expanded fuel storage, and backup water supplies are good examples of concepts that provide redundancy.)**

Resourcefulness

- **The extent to which a system can adapt when impacted during a risk event and speed with which it adapts.**



Key Resilience Factors – USACE and LEED-ND

Response

- **Both response and recovery aspects focus on the ability to activate systems during a risk event that mitigate impacts and enable systems to return quickly to a defined requisite level of operation.**

Recovery

- **Both recovery and response aspects focus on the ability to activate systems during a risk event that mitigate impacts and enable systems to return quickly to a defined requisite level of operation.**

DOD Resources and Case Studies

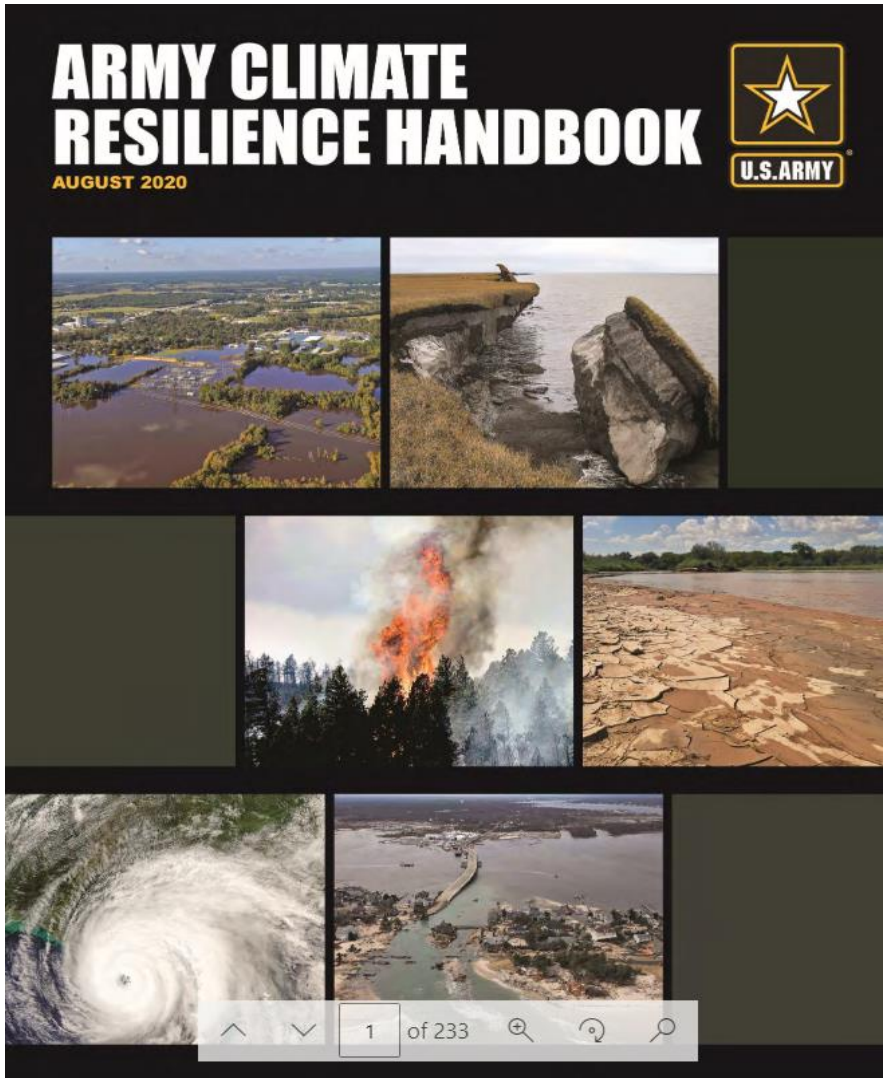
The Report on Effects of a Changing Climate to the DOD

- Department considers <u>resilience in the installation planning and basing processes to include impacts on built and natural infrastructure</u>.
- Includes consideration of environmental vulnerabilities in:
  - **Installation master planning**
  - **Management of natural resources**
  - **Design and construction standards**
  - **Utility systems/service**
  - **Emergency management operations**

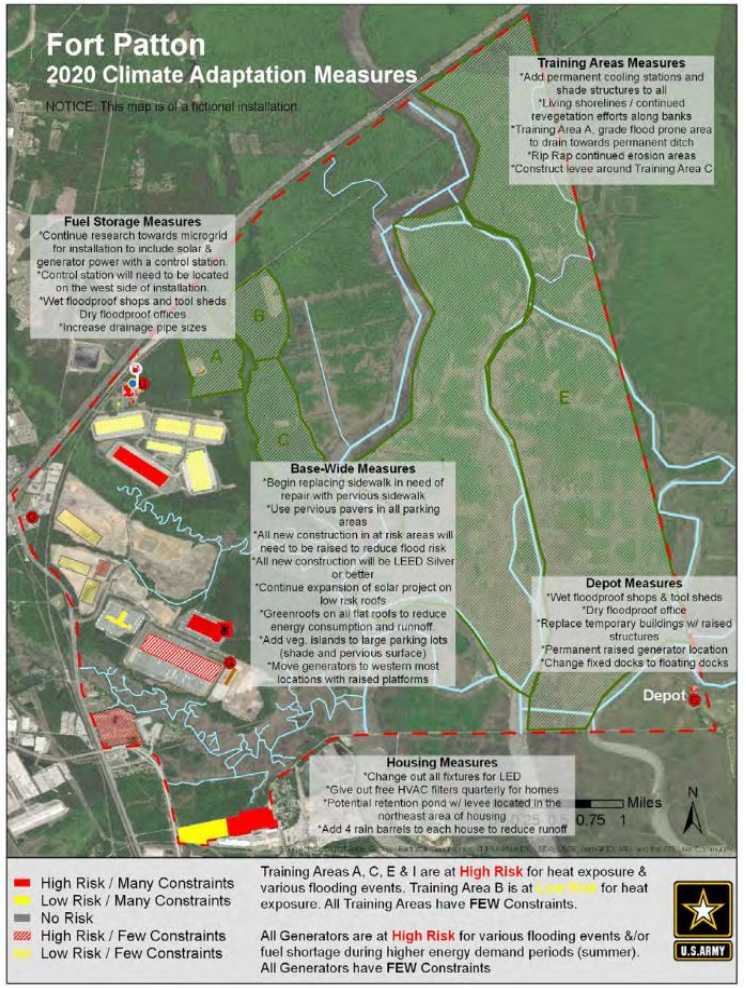
Office of the Under Secretary of Defense for Acquisition and Sustainment, January 2019, as required by Section 335 of the National Defense Authorization Act

Resources: Army Climate Resilience Handbook

Army Climate Resilience Handbook (ACRH)



Exposure, Vulnerability and Adaptive Capacity



Map is Notional

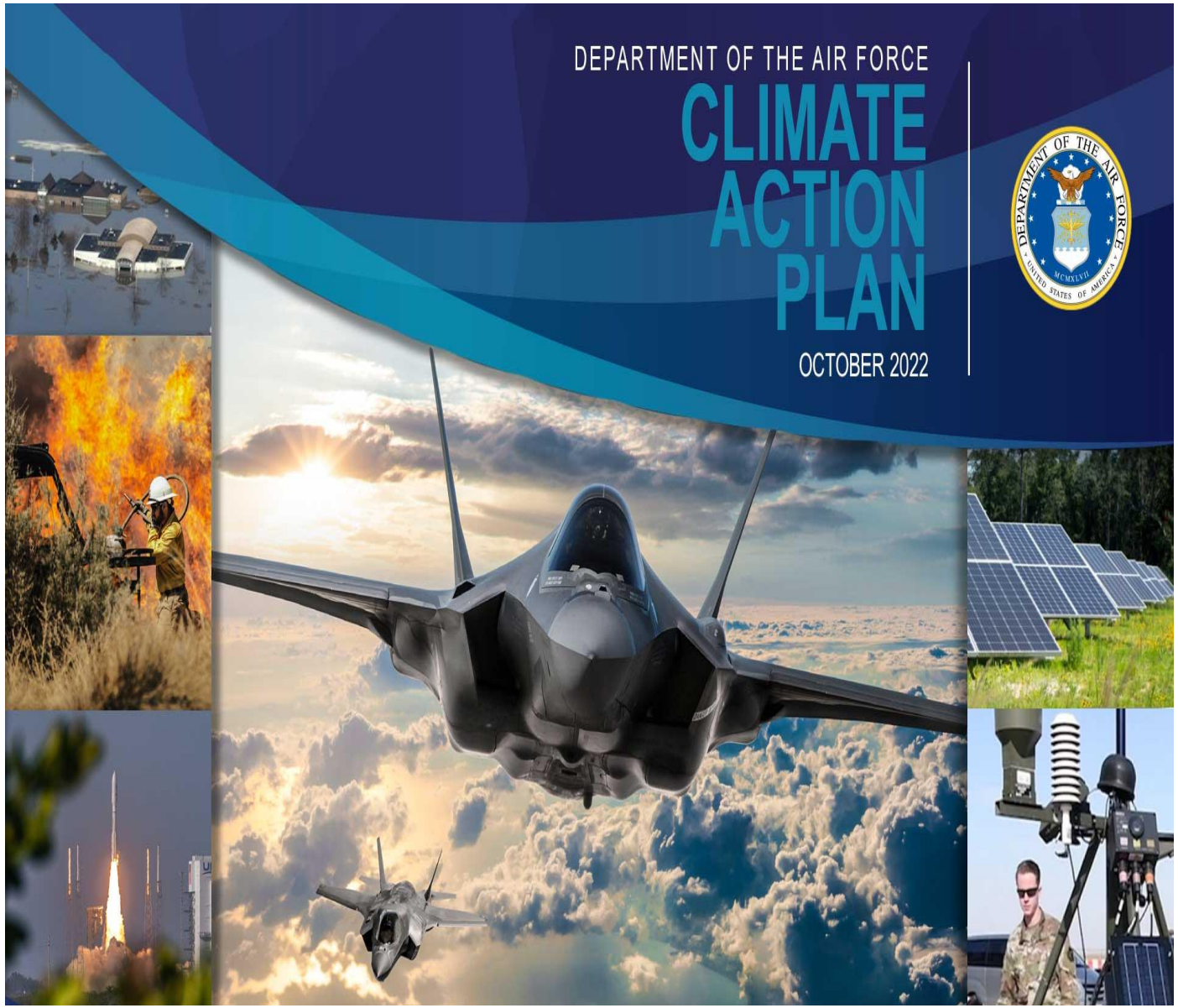
Case Study: Army Base Technical Flood Hazard Risk/Mitigation Study

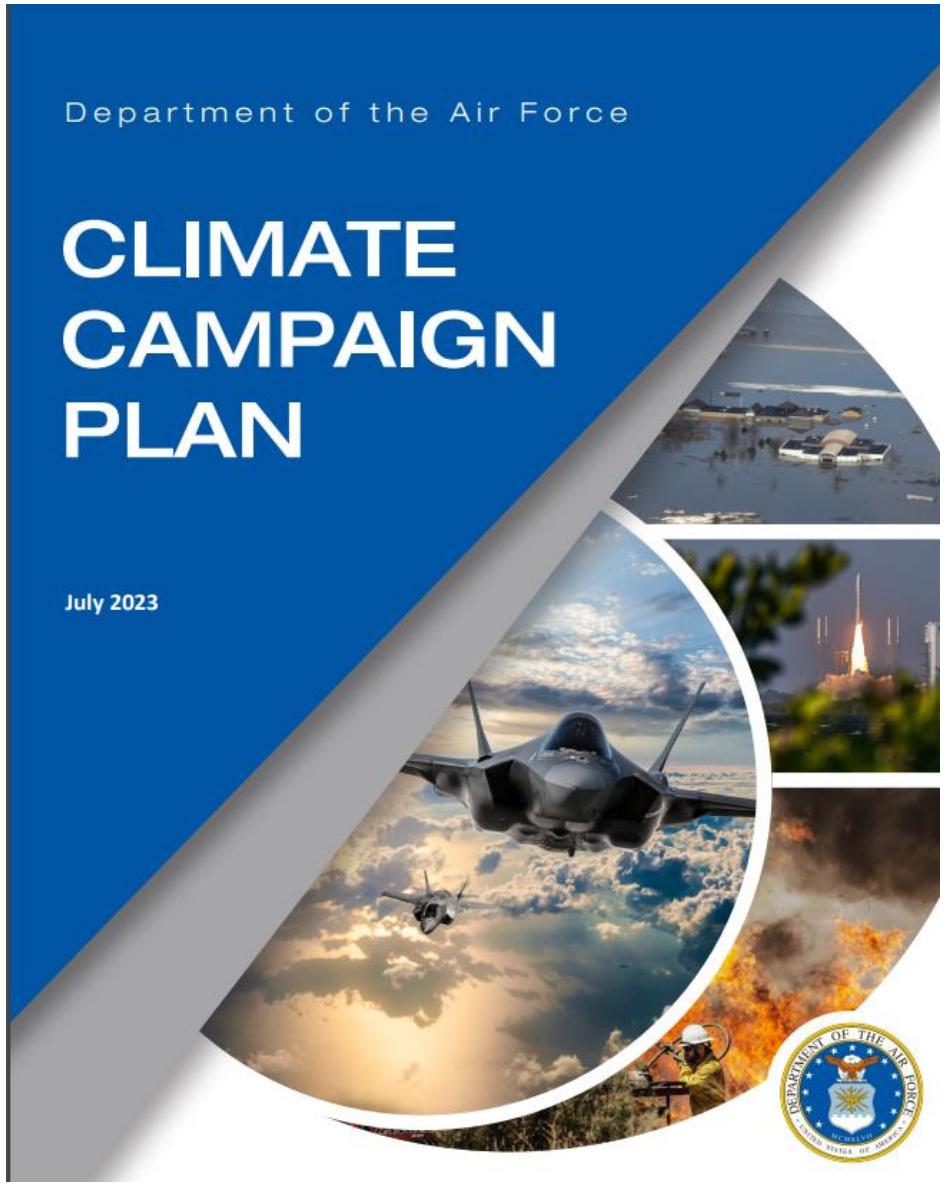
- **Project:** Stantec GS Flood Risk Study to inform follow-on EISs
- **Purpose:** Define risk management actions for current and predicted flooding and other severe weather events
- **Problem:** Effects of flooding negatively impacted operations
    - Flood impacts projected to increase with continued SLR
- **Focus:** Identify flood threats to infrastructure/operations and
    - Communicate mission impairment risk
    - Decision-support mission adaptation and investment
    - Improve mission readiness and installation resilience
    - Support Master Planning, EISs, ICRMPs

Analyzed Climate Change Vulnerabilities

- Evaluated climate change vulnerabilities to increasingly severe:
  - **Sea level rise**
  - **Precipitation**
  - **Flood**
  - **Wildfire**
  - **Drought**
- Developed **Installation Climate Resilience Plans (ICRPs)** as comprehensive summary of installations' vulnerabilities to flooding and other climate change risks
- SDDC used results of analyses in Environmental Impact Statements for Master Plan Implementation and Interrelated Master Planning
- Prepared two EISs incorporating study findings to support informed decision-making

Resources: Key Air Force Resilience Documents



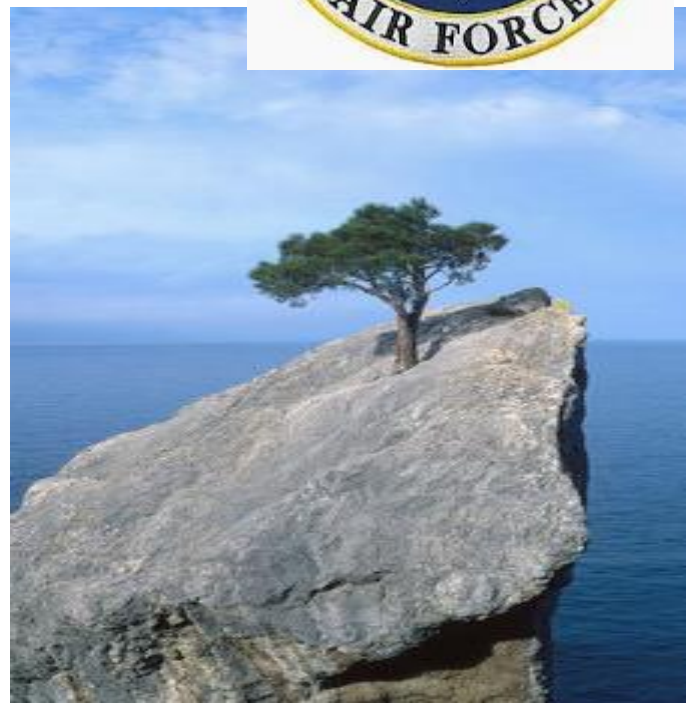


Resilience in the Air Force Includes People

- The Air Force defines resilience as “the ability to withstand, recover, and grow in the face of stressors and changing demands.”

- “That is, it is the ability to withstand (work through in the moment), recover (to gain an adaptive perspective), and grow (to learn from and generalize to other situations) in the face of stressors.”

(Lt Col Jill Silverman, MD, CAP)



The US Air Force 5 Rs Doctrine

ROBUSTNESS: Extent to which a system can absorb an impact or prevent the impact from spreading to other parts of the system.

REDUNDANCY: Extent to which a system has a diversity of methods in which it can continue to provide the required level of service.

RESOURCEFULNESS: Extent to which a system can adapt when impacted during a risk event and the speed with which it adapts.

RESPONSE: Extent to which a system can enable installation activities to return to mission effectiveness.

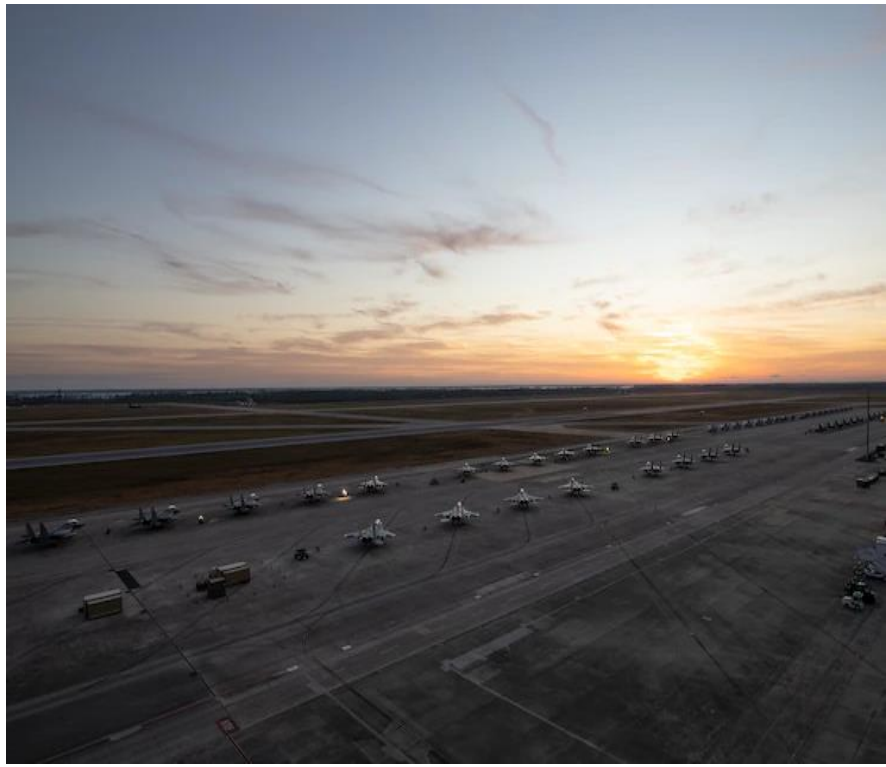
RECOVERY: Extent to which a system can regain initial mission effectiveness as well as normal operations plus the ability to provide support to the surrounding community and region.

Tyndall AFB | Performance Standards | Introduction (tyndallifs.com)

“5 R doctrine requires new thinking for everything Tyndall AFB undertakes — especially investment in its future.”

“5 Rs apply to base operations, mission execution, interaction with the local and regional communities, and protection of people and property.”

“5 Rs encompass facility standards, including:

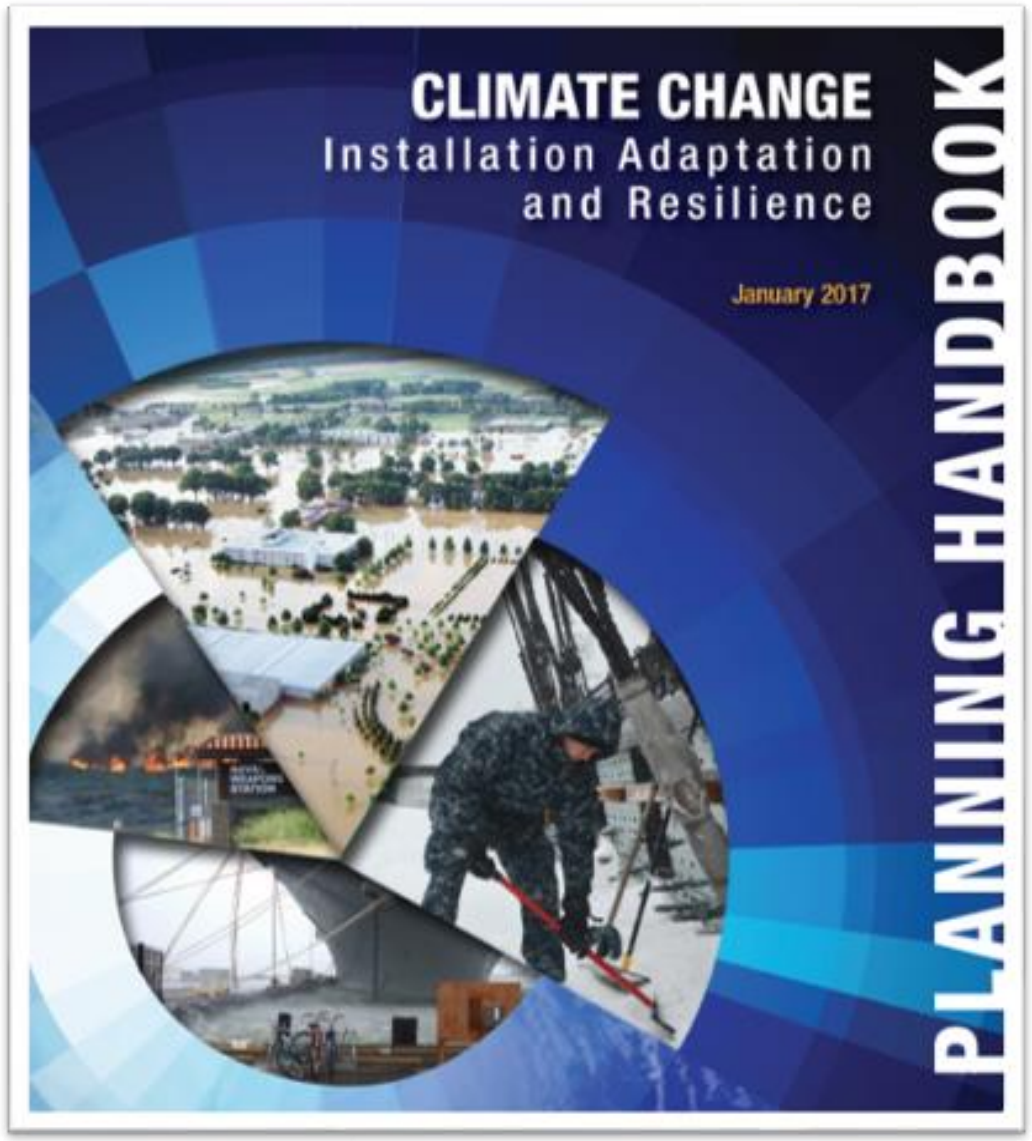


- Energy
- Utility
- Communications, and facility structural systems
- Wind loading requirements
- Base master plan, Area Development and facility site plans
- Designed flood elevation
- Construction methods and materials
- Base respect for the natural environment and the power of nature.”

Tyndall AFB | Performance Standards | Introduction (tyndallifs.com)

Resources: Navy Climate Change Adaptation and Resilience Handbook

NAVFAC Planning Handbook 2017



Case Study: Climate Resilience Engineering Hardening Analysis

- **Remote location, limited redundancy**
- **Analyzed requirements for infrastructure hardening, resilience, repair, and restoration**
- **Focus: Mission Critical and enabling infrastructure**
- **Addressed infrastructure weaknesses and vulnerabilities**
- **Recommended improvements with ROM estimates**

Example Results: Resilience and Hardening Analysis

All designs met Anti-Terrorism Force Protection (AT/FP) criteria

- **Water and Fuels Expedient Repair (WaFER) Team Training and equipment**
  - **ROM Cost: $4,500,000**
- **Replace equipment**
  - **ROM Cost – $19,200,000**
- **New equipment and hardening**
  - **ROM Cost – $58,160,000**

Estimated Total Project Cost – $300M

Civilian Agency Organization Resilience: A Global Portfolio Climate Risk, Resilience, and Adaptation Analysis and Prioritization Project

Case Study: US Department of State Climate Security and Resilience Program Development and *Natural Hazard* Support

CU.S. Embassy Niamey
Design Architect: Miller Hull / Contractor: B.L. Harbert International / Architect of Record: Page

US Department of State Portfolio Climate Security and Resilience Natural Hazard Risk Analysis

294	Locations, **189** Countries
25,098	Domestic & Overseas Assets
9,387	Government-owned
15,710	Leased
16,561	Residences
897	Office Buildings
$75.2B	Portfolio Replacement Value
83M SF	Gross Square Feet of Space

People affected by a recent earthquake walked in the rain at a refugee camp in Les Cayes, Haiti, on Monday, as Grace moved through. Credit, Joseph Odelyn, Associated Press

Why Natural Hazards?

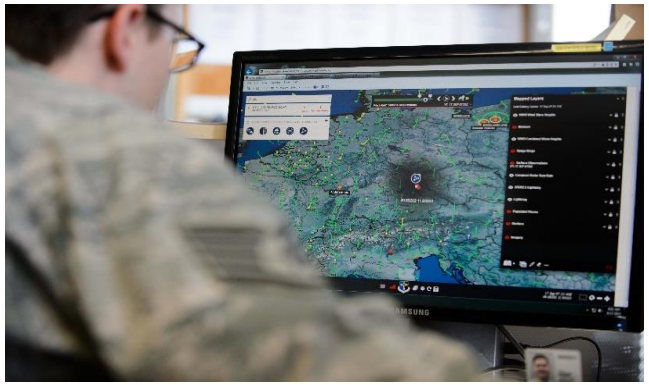
- **In Haiti, in August of 2021 a 7.2-magnitude earthquake struck**
- **Collapsed thousands of homes and made some roads and bridges impassable**
- **3 Days later, Hurricane Grace landed with heavy rains causing mudslides, flooding**
- **Hampered recovery efforts and complicated search-and-rescue**

Climate/Severe Weather and Natural Hazard Exposures

Climate/Severe Weather

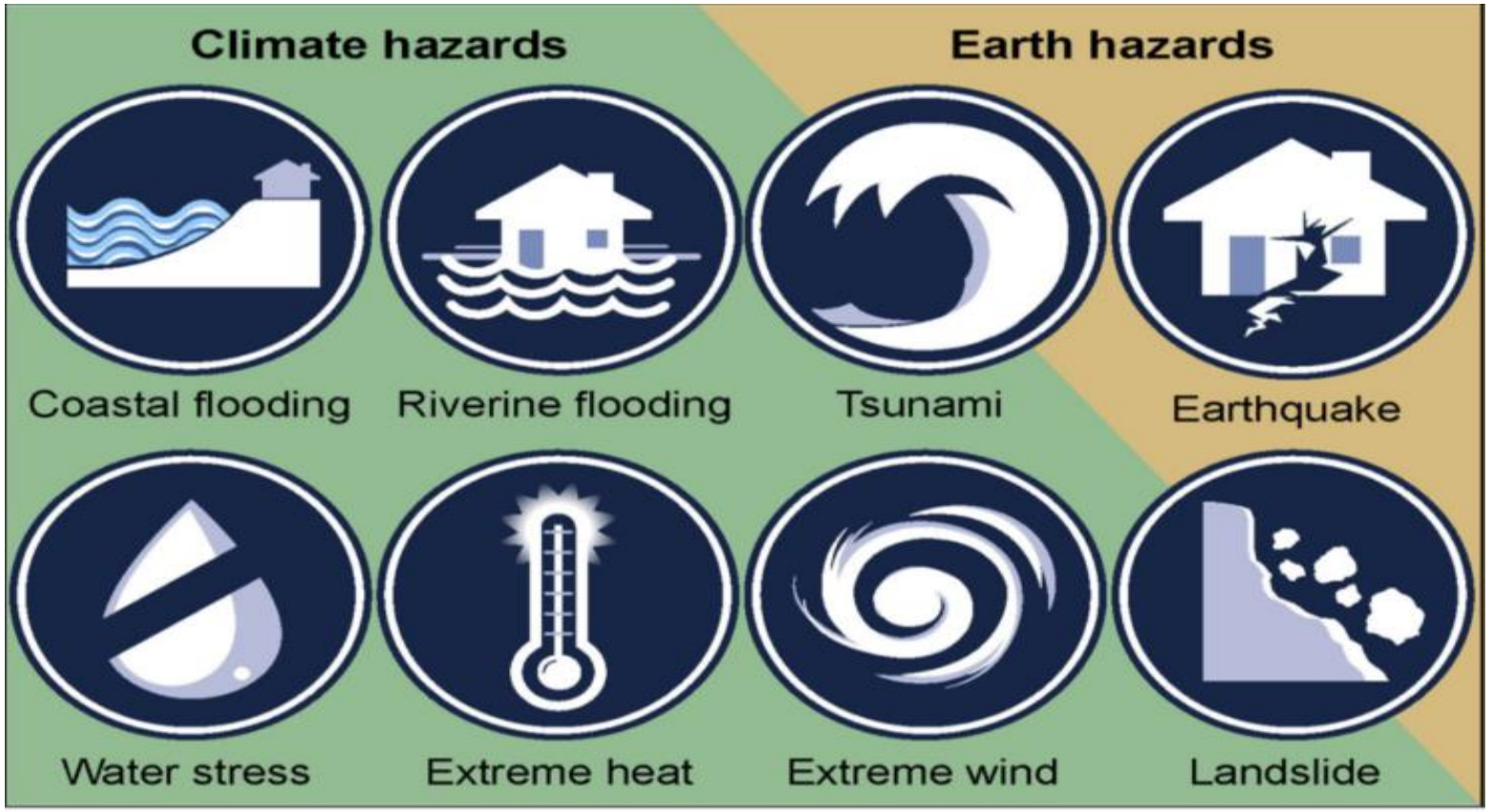
- Wind
  - (Hurricane, Typhoon, Cyclone, Tornado)
- Storm Surge and Tidal Surge
- Precipitation: Rain, Snow, Hail
- Flooding (Coastal, Riverine, Pluvial)
- Drought
- Heat Stress
- Water Stress
- (Saltwater Intrusion into Groundwater)
- Sea Level Rise

Natural Hazards



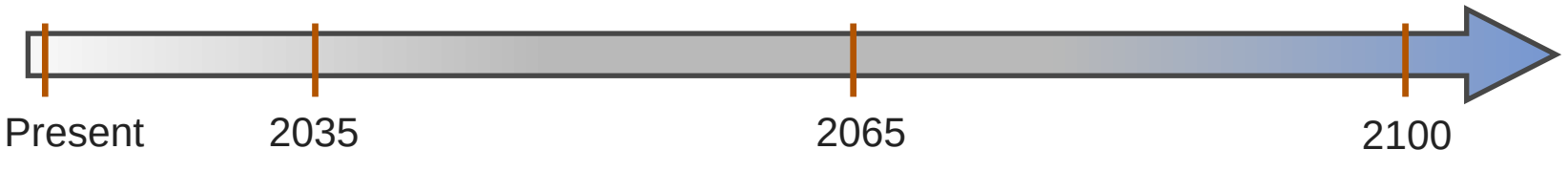
- Earthquake
- Tsunami
- Landslide
- Volcano
- Wildfire / Bushfire / Urban Fires
  - Boulder County Colorado 2021
  - Florida Panhandle 2021
  - Australia 2022
  - Germany 2022
  - Isle of Rhodes 2023
  - Maui, Hawaii 2023

Development of Screening Level Methodology: Hazard Exposure (*Likelihood*), *Severity* of Impact and *Vulnerability*

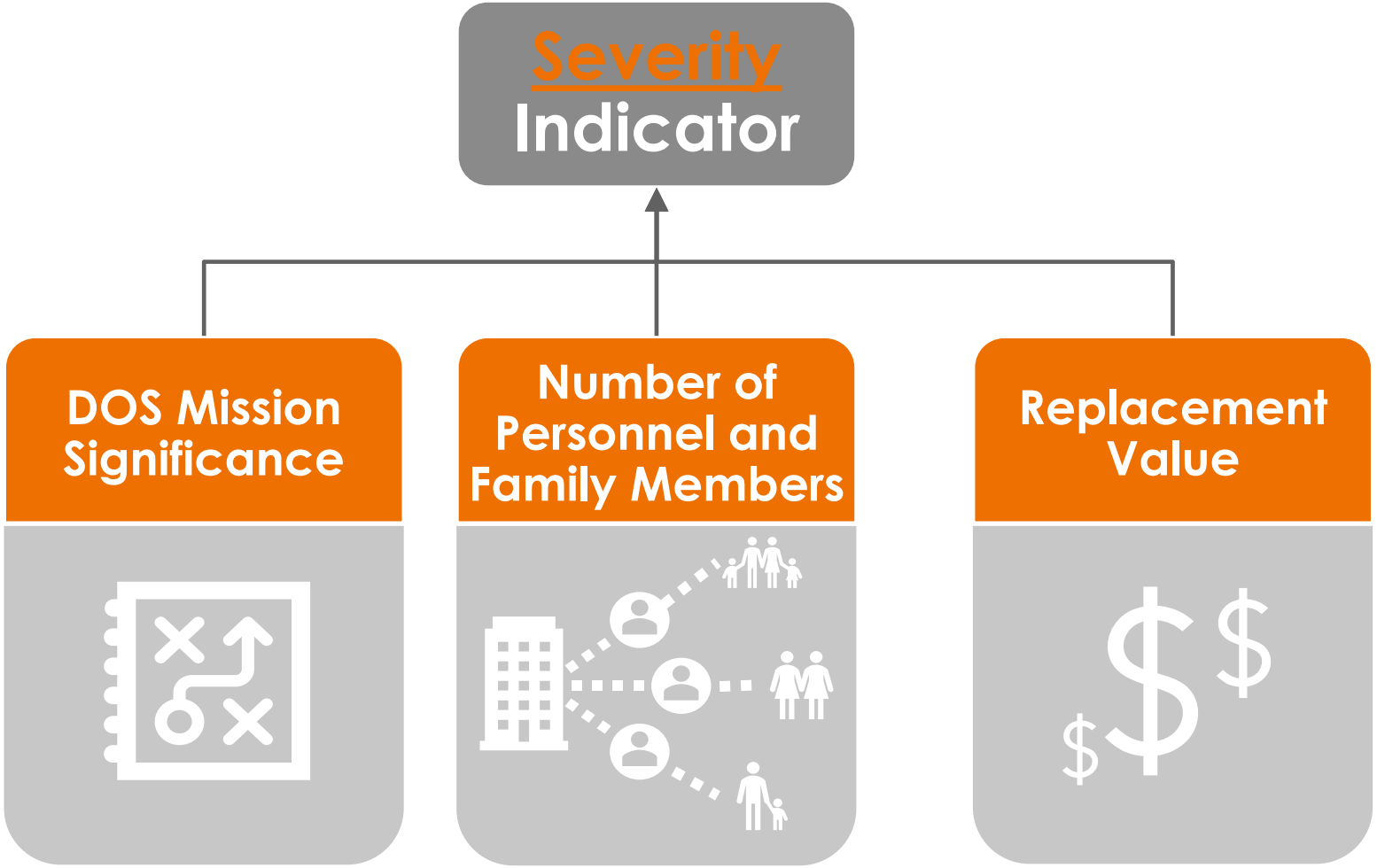


Source: GAO based on Department of State documentation. | GAO-23-105452

Screening considered for multiple epochs

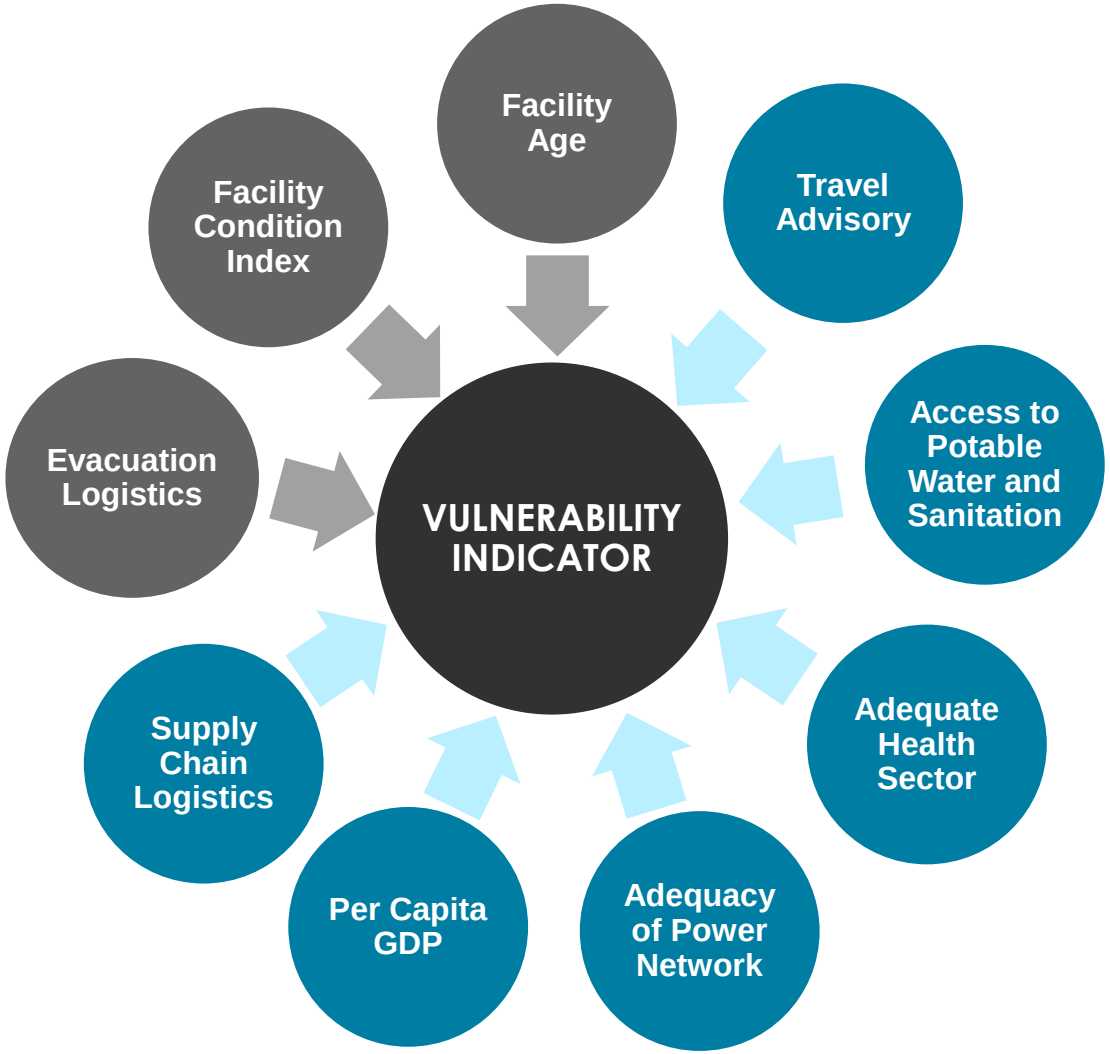


Severity of Consequences Indicators



Vulnerability Indicators

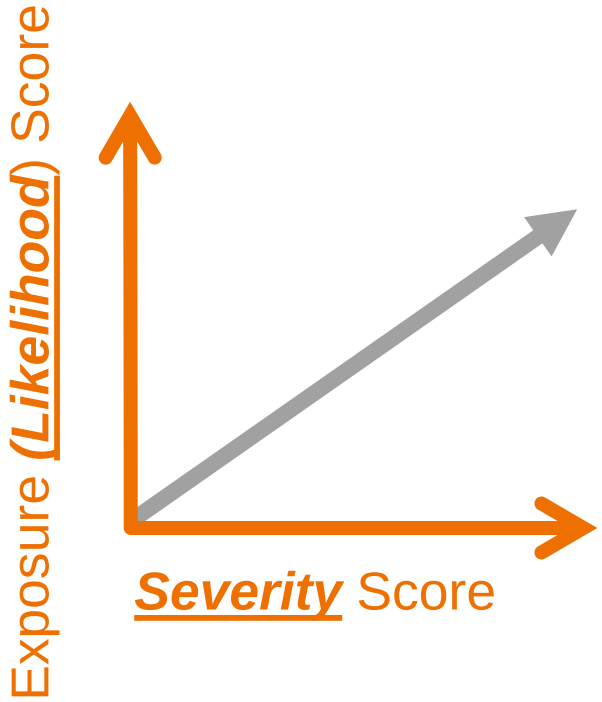
Local



Country Wide

Calculating Risk Score for Each Facility

Preliminary *Risk* Score ✖ **_Vulnerability_ Multiplier** = **Final *Risk* Score**



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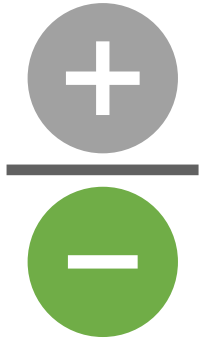

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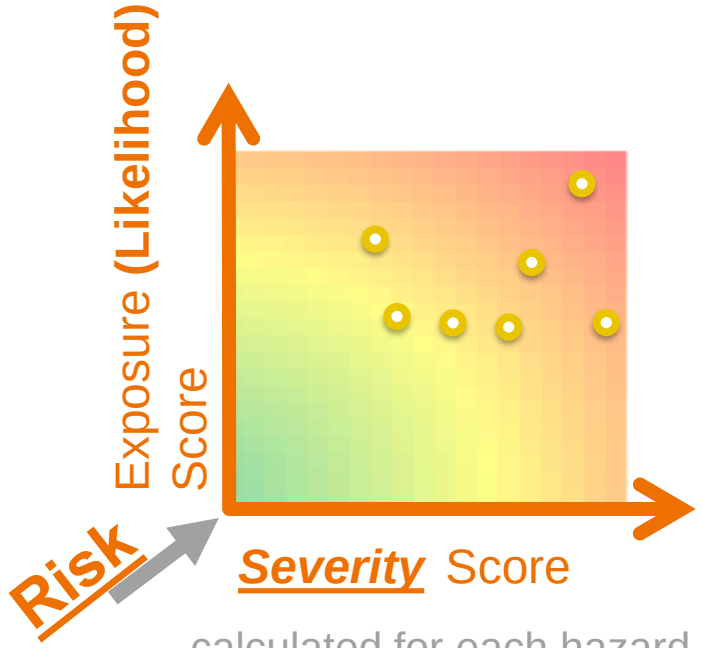
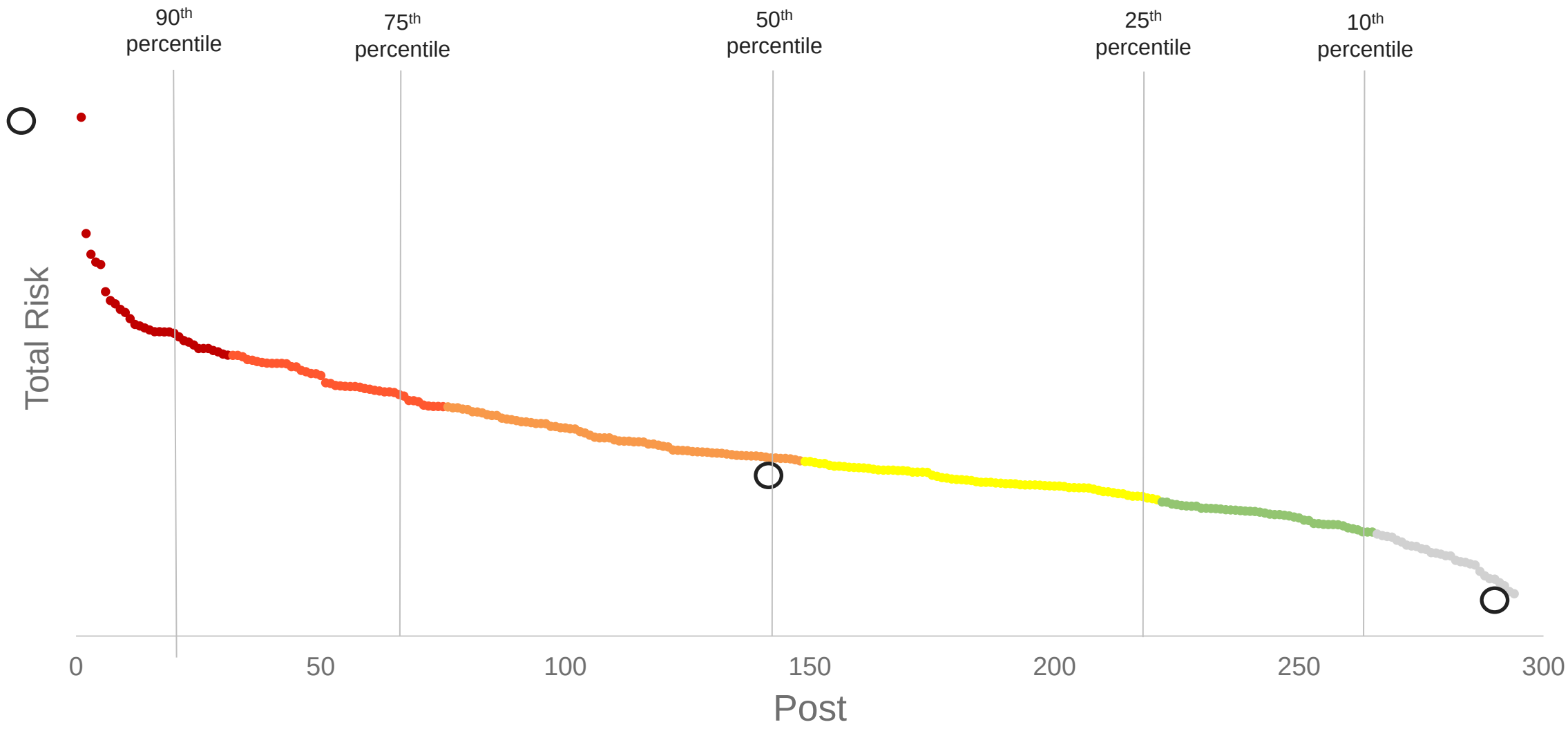


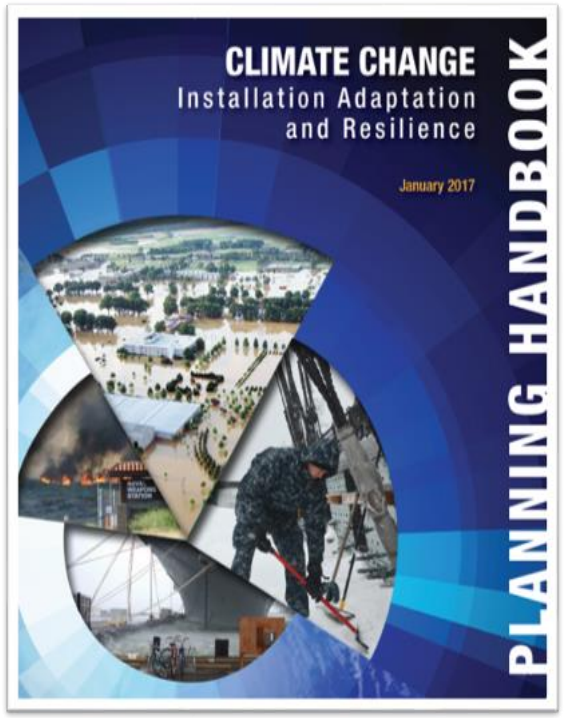
calculated for each hazard

Enterprise Portfolio Risk Rating and Ranking



DOS *On-site* Climate Risk, Resilience and Adaptation Analysis

On-site Pilot Resilience & Adaptation Assessment



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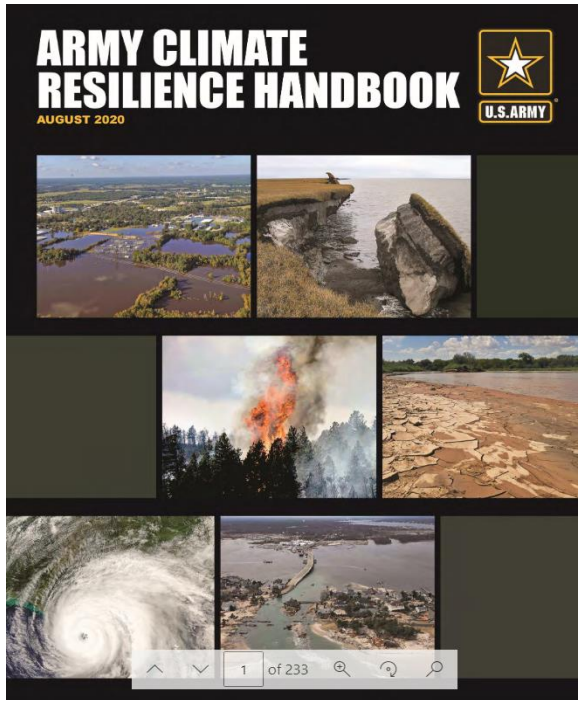
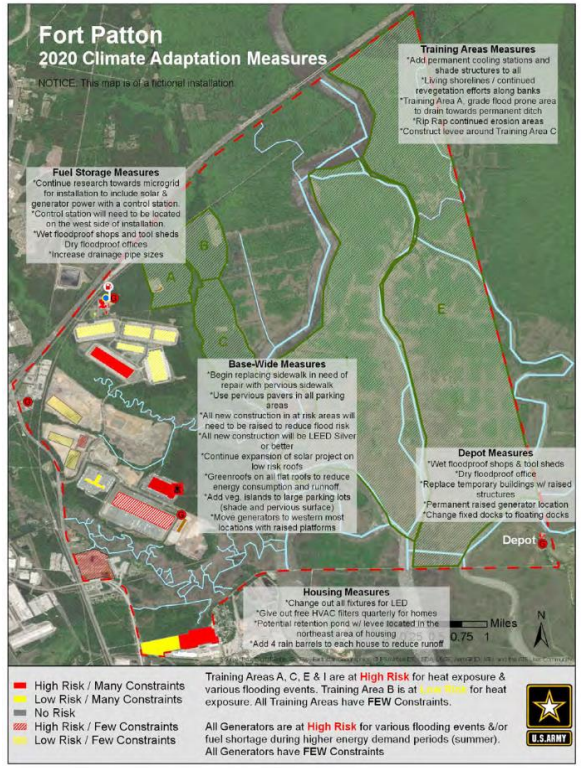




Map is Notional

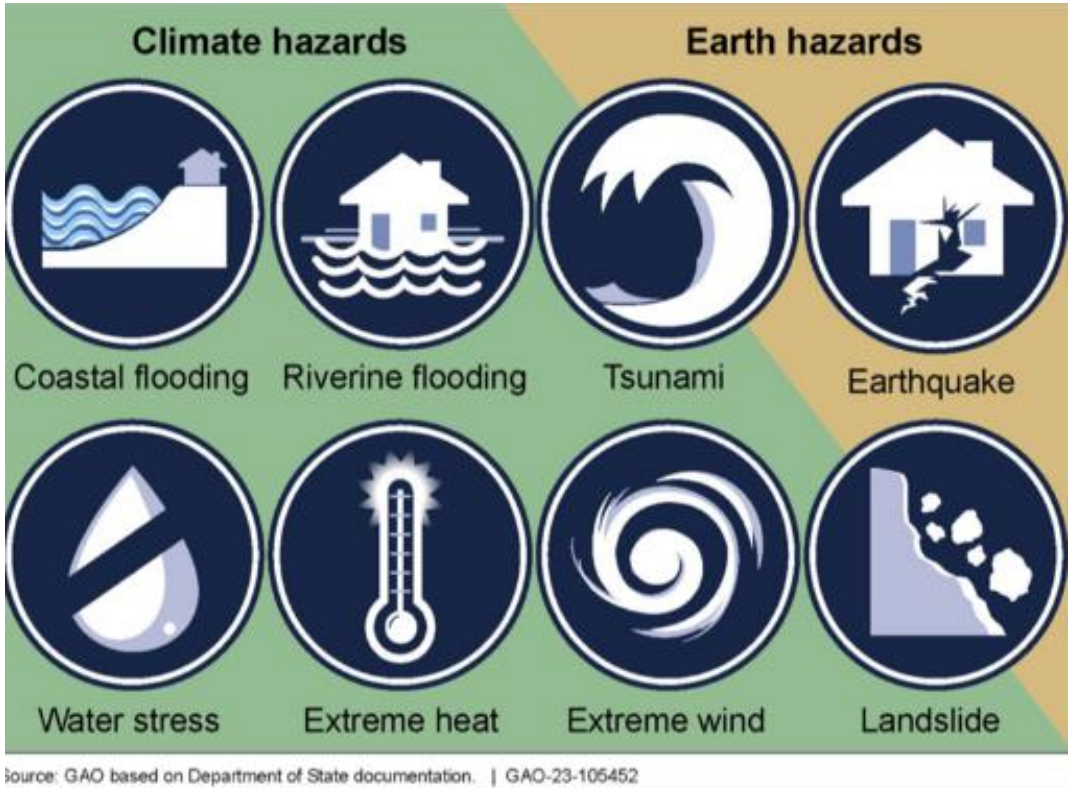
- **NAVFAC Climate Change Planning Handbook Framework**
- **Army Climate Resilience Handbook (ACRH) reference**

Preparations Before the On-site Assessment

- Requested existing location-specific Data / Information
  - Developed scope of the Assessment
  - Developed Pre-site visit Questionnaire
- Remote interviews with facility personnel
  - Facility Manager
  - Regional/Local Security Officer
  - Maintenance
  - Post Community Liaison with Local Authorities
  - Other SMEs
- Reviewed site maps to identify mission-critical assets, structures, utility locations/access points, focus areas
- Reviewed local websites for local Natural Hazard Data
- Drafted 5 Day Planned Activities

During the On-site Assessment with 5 Day Plan

- Introductions and In-brief on project purpose and scope
- Sequence personnel interviews
  - Management
  - Maintenance
  - Security
  - Supply chain
  - Local Authority Coordinators
- Schedule interviews with Local Authorities
  - Energy
  - Water
  - Climate data
  - Planning
  - Emergency Response
- Facility tour / visits to buildings / structures / assets / areas



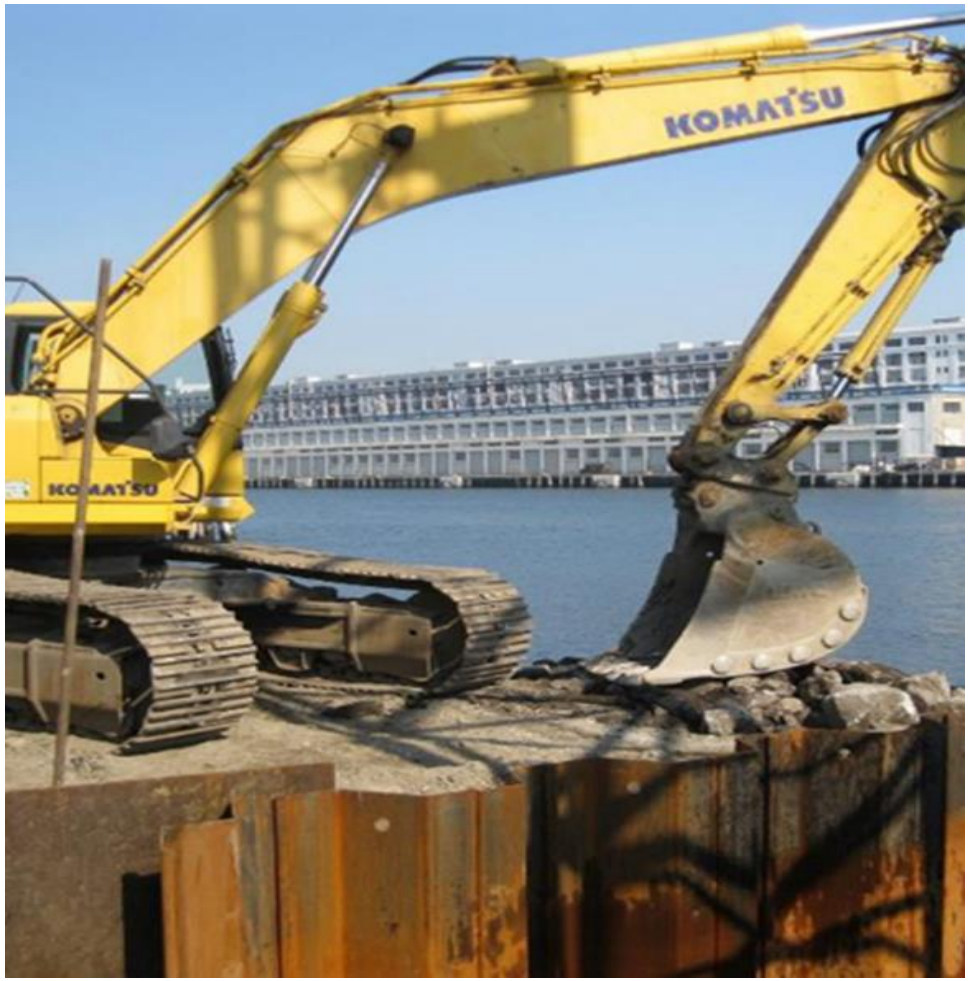
Source: GAO based on Department of State documentation. | GAO-23-105452

After the On-site Assessment

- Consolidated data to define local Exposure, Sensitivity, and Adaptive Capacity
- Identified and recommended potential Adaptation Alternative projects and validate
- Conducted Cost-Benefits Analysis of Adaptation Alternatives
- Identified facility Operational and Management resilience improvement opportunities
- Identified Program Development opportunities

*Gupta, Joyeeta; Termeer, Catrien; Klostermann, Judith; Meijerink, Sander; van den Brink, Margo; Jong, Pieter; Nooteboom, Sibout; Bergsma, Emmy (1 October 2010). "The Adaptive Capacity Wheel"

Example Prospective Adaptive Alternative Projects



- **Conduct drainage analysis to reduce pluvial flooding**
- **Replace damaged temporary storage structures**
- **Improve access to power and water**

Example Operations & Management Opportunities

- **Develop scenario drills using local climate data**
- **Incorporate supply chain problem scenarios in drills**
- **Develop Natural Hazard-specific emergency action checklists**
- **Use nature-based, local drought resistant plants for landscaping to reduce use of fresh water**

Developing a Resilience Program!

Single Facility or Multiple Remote Locations

Resilience Program Organization & Participation

- **Organize: Resilience Leadership Steering Group (RLSG)**
- **Purpose:** Guide, support, and monitor program direction, priorities, progress
- **Membership**: Senior Leadership, department management, supervisors, operations

- **Establish: Resilience Improvement Action Team (RIAT)**
  - **Plan, establish, and execute resilience policy, directives, procedures,** and achieve organization resilience objectives (OROs),
  - Identifies and prioritizes projects
  - Seeks/obtains program and project funding with RLSG support

- **Draft**: Charter defining the **scope, membership, and roles and responsibilities** of the RLSG and RIAT, gain RLSG approval, and finalize

- **Hold**: Kick-off Meeting with the RLSG and the RIAT to plan, establish and **document** expectations, goals, objectives, and expected/planned outcomes

Responsibilities of Resilience Leadership Steering Group

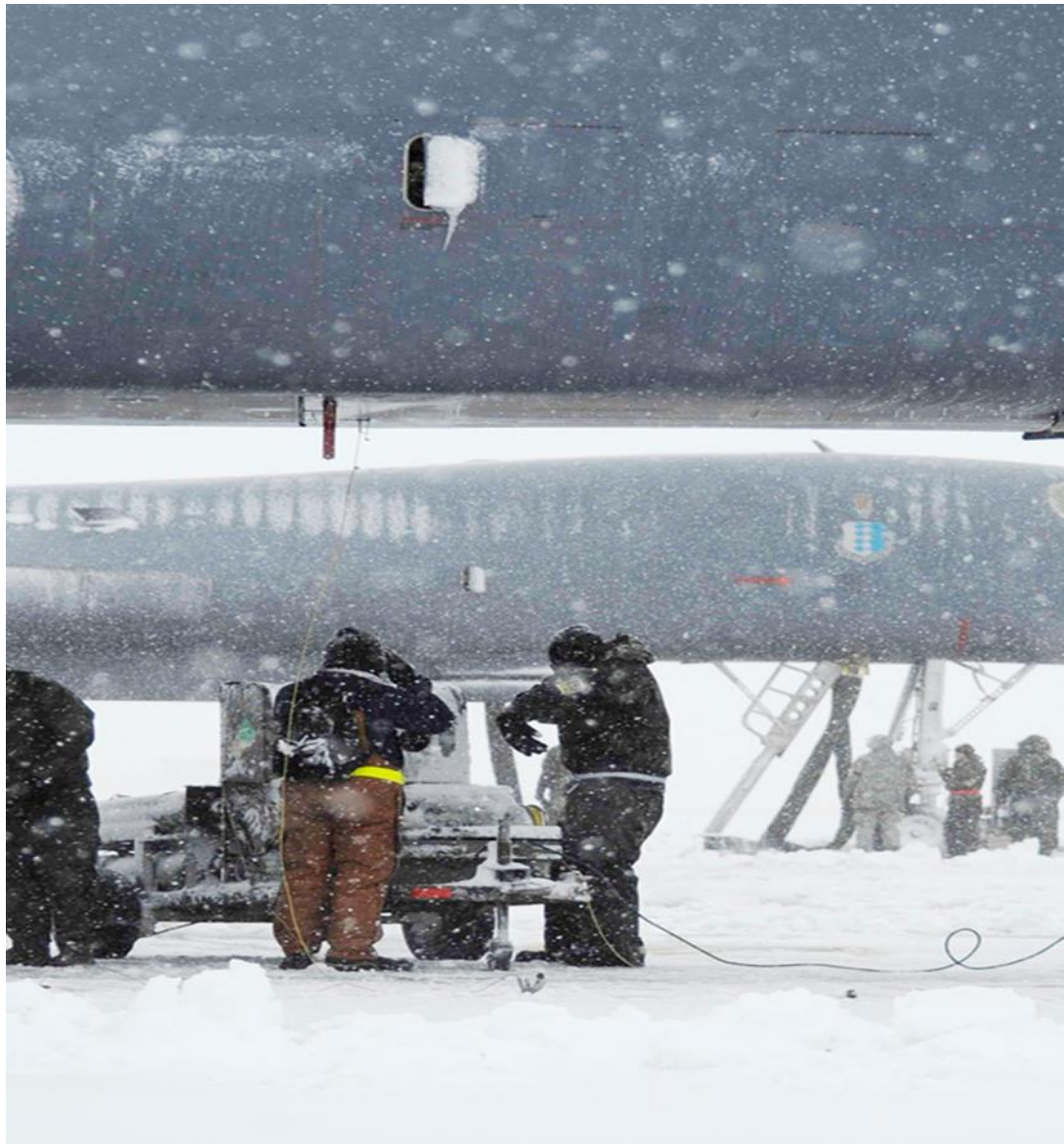
- Oversight, guidance, and monitoring of Resilience Program and Objectives
- Ensure resilience/adaptation actions consistent w/local, state, DOD, Federal policy
- Assure consistent Resilience policy-related communication
- Support finding/obtaining funds for resilience and adaptation projects

Responsibilities/Function: Resilience Improvement Action Team

- **Cross-functional** management, supervisory, engineering, financial, technical, operations, and maintenance personnel
- **Plan**, assign, and execute activities necessary to achieve Resilience Improvement goals, objectives, and outcomes
- **Identify, develop, prioritize, and propose** Resilience Improvement and adaptation projects along with preliminary funding and ROM cost estimates with **cost-benefit analysis where appropriate**
- **Coordinate and communicate** Resilience Improvement Projects across planning, programming, budgeting, and other processes
- **Identify, develop, and propose** management or work process changes to improve Resilience and increase adaptation

Resilience Risk Assessment – Current & "Expected" Climate, Severe Weather & Natural Hazard Effects

- Facility and Infrastructure
- Buildings and Asset Systems
- Energy and Water: Normal & Emergency Situations
- Landscape and Nature-based Solutions
- Stormwater Management System
- Entrance Egress
- Emergency Response
- Supply Chain
- Local, Regional, Country Planning
- Recovery Resource Competition



The Future of Resilience!

Future-Proofing Resilience in People, Organizations, Infrastructure and Assets

Future-Proofing and Resilience

"Future-proofing is the process of anticipating the future and developing methods of minimizing the effects of shocks and stresses of future events (emphasis added). (Wikipedia)

(Recall C.S. Holling – "perturbations" (shocks)?

"Future-proofing is used in industries such as

- Electronics
- Medical industry
- Industrial design, and more recently, in
- Design for climate change." (Wikipedia)

(Recall the DODD definition of resilience?)

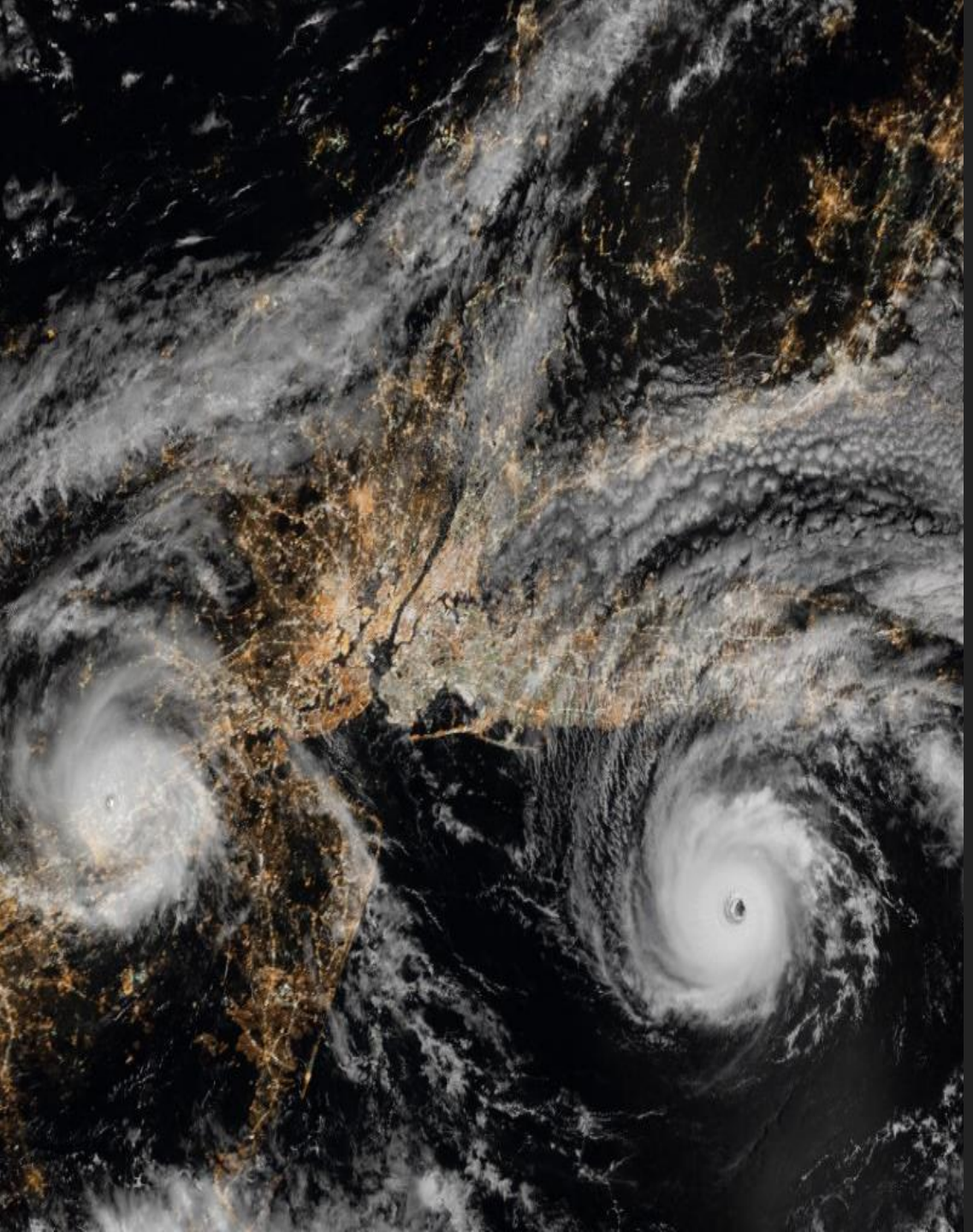
"Resilience - The ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions." (DoDD 4715.21)

Relationship Between Resilience and Future-Proofing

Future-Proofing is engineered from strategic thinking over the long-term to be successful now and into the future.

- Resilience is about systematic planning, prevention, protection, response, recovery and return from disruptions
- Resilience incorporates factors of
  - Robustness
  - Resourcefulness
  - Redundancy
  - Recovery
  - Return

Future-proofing is about increasing resilience through a systematic risk-based approach!



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Climate Risk and Resilience Portfolio Screening, Prioritization, On-Site Assessment, and Program Development

Case Studies in Climate Resilience Analysis

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