Climate and Disaster Risk Assessment: Fundamentals, Current Trends and AI Innovations

Thursday, May 14th | 2:15pm

Climate and Disaster Risk Assessment: Fundamentals, Current Trends and AI Innovations

2026 NLC-RISC Trustees Conference

05.14.2026

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Learning Objectives

Fundamentals

- The three components of *Risk*: *Hazard, Vulnerability and Exposure*
- How building codes and public policies weigh *Hazards* differently
- How *Vulnerabilities* are estimated
- Actionable *Risk* ratings

Current Trends

- Future hazard projections are now available
- Moving towards multi-hazard, national approach
- Demand for risk quantification
- Strong Interest from institutional owners

AI Innovation

- How the use of AI can greatly reduce effort and cost of assessments
- Hazards, vulnerabilities and risk of every building will be available in the future

Fundamentals

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Components of Risk

Risk = Hazard x Vulnerability x Exposure

- Conventional risk definition for disasters
- For risk screening of large groups of assets
- 75 years of history
- Not applicable to other risk types such as fiscal, operational, and liability
- Exposure refers to importance of the asset or the consequence of failure

Hazards

At a given location, a **hazard** has a **magnitude** and a **probability.**
A single hazard can have multiple impacts that affects assets differently.

Sea Level Rise

Sea Level Elevation Rise

Flooding

Surface & Riverine Flooding

Coastal Flooding & Storm Surge

Wind

Loading on Structures

Water Penetration of Buildings

Extreme Temperatures

Heat Duration

Average Daily Highs

Average Daily Lows

Hazards

In disaster planning, it is important to consider both climate and non-climate hazards.

Geologic Change

Permafrost Loss

Fire

Fire Zone

Ember Zone

Air Quality

Earthquake

Fault Rupture

Ground Shaking

Land Deformation

Tsunami

Volcano

Eruption & Pyroclastic Flow

Lava & Lahars Flow

Ash Fall & Smoke Disruption

Hazards: Building Code and Policies Set Levels

Building Code (Building Performance)	
Flooding	100-year
Hurricanes/Typhoon	700-year
Earthquake	700-year
Building Code (Life Safety Shelters)	
Extreme wind (tornado and hurricane)	1,000-year
Tsunami	1,000-year
Resiliency Policy	
Sea Level Rise	50-year horizon
Heat/Cold	50-year horizon
Wildfire/ Air Quality	50-year horizon
Drought	50-year horizon
Threats *(Scenario Base, unknown probability)*	
Power Failure	24 hours

Vulnerability

The ability to withstand hazards. Can be measured by life/safety, loss of value, or loss of function.

Wind

Wind Load on Structure

Total loss

Rainstorm

Surface and Riverine Flooding

Damage, repairable

Rainstorm

Rain Induced Mudslide

Temporary closure

Fire

Fire Zone

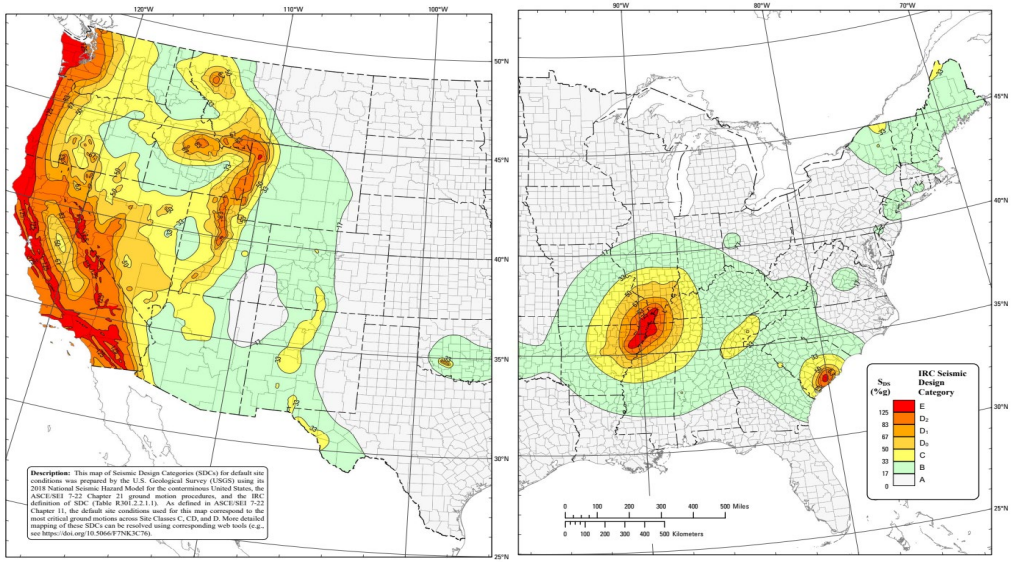
Total loss

Vulnerability: Example Functional Loss Scale

	dark grey: hazard not applicable or insignificant
	green: no impact to functionality
	grey green: only contingent functionality
	yellow: loss of functionality, restorable with minor repair (months)
	amber: loss of functionality, require significant repair to restore (years)
	red: complete loss of functionality, life safety threat

Vulnerability: Example Earthquake Rating

Design Year	UFC 1-200-01 version	IBC version	ANSI/ASCE version	Retrofit version		IRC Seismic Design Category A	B	C	D	E	Key Code Changes
pre-1950			pre ANSI 58.1			75	50	25	0	0	First Risk Categories appeared in 1933
1950 to 1975			ANSI 58.1			75	50	25	0	0	Earthquake Hazards Reduction Act formed NEHRP
1975 to 1999		UBC 1972				99	50	50	25	25	
1999 to 2002		UBC 1997		FEMA 310 (ASCE 31)		99	75	50	50	50	Structural Redundancy incorporated / USGS Seismic map incorporated
2002 to 2013	Jul-02	2000	ASCE 7-98, 02, 05	FEMA 356 (ASCE 41-06)		99	75	50	50	75	ASCE 41-06 states IBC 2000 Benchmark Bldg
2013 to 2019	Jul-13	2012, 2015	ASCE 7-10			99	99	75	75	75	
after 2019	Oct-19	2018	ASCE 7-16	FEMA 356 (ASCE 41-17)		99	99	75	75	75	Site specific ground motion requirements
	Not yet	2024	ASCE 7-22	FEMA 356 (ASCE 41-23)		99	99	75	75	75	

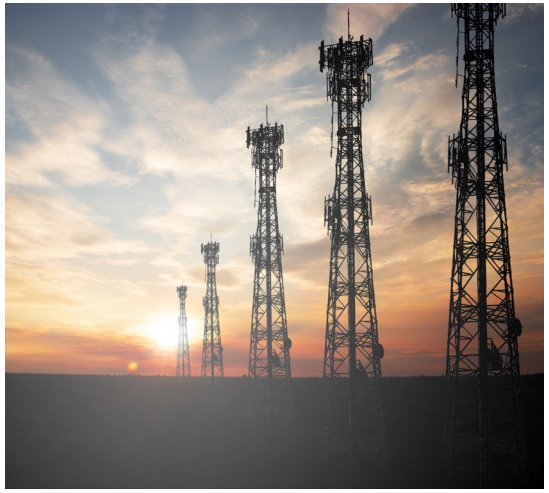


"Standards Approach" based on building code changes, past damage history, and engineering judgment

Exposure

Exposure is the importance of an asset.

Self-Storage Warehouse

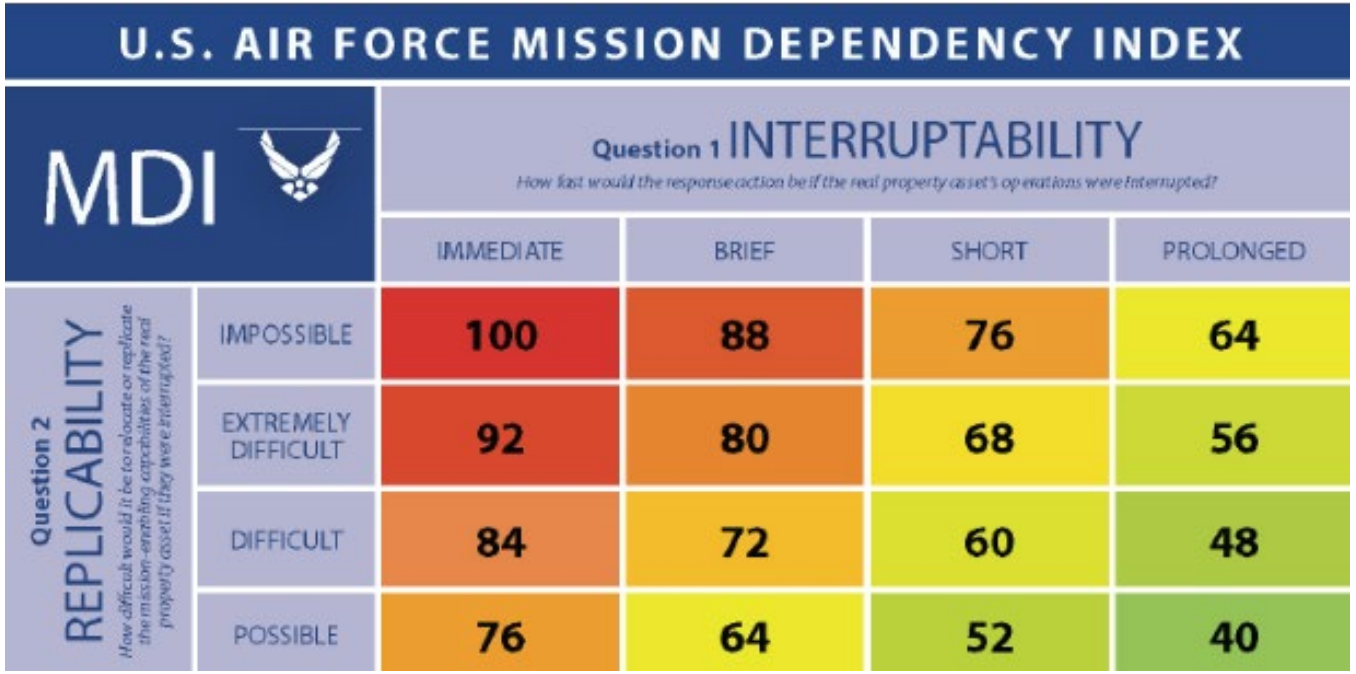


Communication Tower

Hospital

Military Hangar

Exposure: Example Importance Scale



U.S. AIR FORCE MISSION DEPENDENCY INDEX

MDI

Question 1 INTERRUPTABILITY

How fast would the response action be if the real property asset's operations were interrupted?

Question 2 REPLICABILITY

How difficult would it be to relocate or replicate the mission-enabling capabilities of the real property asset if they were interrupted?

	IMMEDIATE	BRIEF	SHORT	PROLONGED
IMPOSSIBLE	100	88	76	64
EXTREMELY DIFFICULT	92	80	68	56
DIFFICULT	84	72	60	48
POSSIBLE	76	64	52	40

- The Mission Dependency Index (MDI) is the DoD/DHS's standard metric for assessing asset criticality
- How Interruptable?
- How Replicable?

Risk: Combining the Three Components

RISK		Exposure						
		MDI 92-100	MDI 84-88	MDI 76-80	MDI 68-76	MDI 60-64	MDI 52-56	MDI 40-
Vulnerability to Hazard	Failure	EH	EH	EH	H	H	H	H
	Long-Term Loss of Function	EH	EH	H	H	M	M	M
	Short-Term Loss of Function	EH	H	H	M	M	M	L
	Critical Function During Event Only	H	H	M	M	M	L	L
	No Loss of Function	L	L	L	L	L	L	L

EH= Extremely High; H= High; M= Medium; L=Low

- Example developed in collaboration with Army HQ
- Accounts for vulnerability to specific hazards (loss of mission functionality)
- Accounts for the importance (MDI) of an asset
- Produces risk ratings that are consistent and meaningful

Risk: Example Display of Results

MIRC Risk Assessment Summary

ABC Installation

50 year planning Horizon

Year of Assessment: 2025

	Buildings														
	1	2	3	4	5	6	7	8	9	10	11	12		13	14
Asset Type	B	B	B	S	S	B	S	S	S	S	S	B		B	B
date built	1943	future	2021	future	future	future								2011	2011
date renovated	2021													1965	1966
Exposure (MDI)	85	60	85	39	39	60	85	85	85	85	85	60		70	70

Hazards			Hazard Magnitude *in 50 year*	Probability or Senario	Vulnerability														
	Sea Level Fluctuation				99	99	99	99	99	99	99	99	99	99	99	99		99	99
	Rain																		
		Coastal + Storm Surge+ Riverine+ SL Flooding	El + 18?	1.0%	50	0	0	0	99	99	0	0	99	0	99	0		99	99
		Surface/Inland Flooding	varies	1.0%	20	99	99	99	99	99	99	99	99	99	99	99		99	99
		Rain Induced Land Deformation	Insignificant	1.0%	100	100	100	100	100	100	100	100	100	100	100	100		100	100
	Wind																		
		Tornado	Insignificant	very low	100	100	100	100	100	100	100	100	100	100	100	100		100	100
		Storm wind load on structures	65 mph 3 sec gust	0.2%	99	99	99	99	99	99	99	99	99	99	99	99		99	99
		Storm Water Penetration of Buildings	65 mph 3 sec gust	0.2%	100	50	100	100	100	50	100	100	100	100	100	100		99	100
	Heat/Cold																		
		5 day Max Temperature	105 F	2085	99	99	99	99	99	99	99	99	99	99	99	99		99	99
		River Water Warming (Surface Temp)	94F	2070	75	100	100	100	100	100	100	100	100	100	100	100		100	100
		Power Outage	24 hr duration	scenario threat	75	75	75	75	75	75	99	99	99	75	99	75		75	75
		Average Daily Lows, Coldest Month	Insignificant	very low	100	100	100	100	100	100	100	100	100	100	100	100		100	100
	Fire																		
		Fire Zone	Insignificant	0.10%	100	100	100	100	100	100	100	100	100	100	100	100		100	100
		Ember Zone	Insignificant	0.10%	100	100	100	100	100	100	100	100	100	100	100	100		100	100
		Air Quality	0 days over AQI 150	2055	99	99	99	99	99	99	99	99	99	99	99	99		100	100
	Environmental Change																		
		Permafrost Loss	Not applicable	Not applicable	100	100	100	100	100	100	100	100	100	100	100	100		100	100
		Drought	Insignificant	very low	100	100	100	100	100	100	100	100	100	100	100	100		100	100
	Earthquake																		
		fault rupture	low	0.20%	100	100	100	100	100	100	100	100	100	100	100	100		100	100
		ground shaking	low hazard	0.002	100	100	100	100	100	100	100	100	100	100	100	100		100	100
		land deformation (liquefaction, slides)	low	0.20%	100	100	100	100	100	100	100	100	100	100	100	100		100	100
		tsunami	Not applicable	0.10%	100	100	100	100	100	100	100	100	100	100	100	100		100	100
	Volcano																		
		Eruption/Pyroclastic Flow Zone	Not applicable	Not applicable	100	100	100	100	100	100	100	100	100	100	100	100		100	100
		Lava and Lahars Flow Zone	Not applicable	Not applicable	100	100	100	100	100	100	100	100	100	100	100	100		100	100
		Ash Fall/Smoke Disruption	Not applicable	Not applicable	100	100	100	100	100	100	100	100	100	100	100	100		100	100

Vulnerability Legend

description	score value
dark grey: hazard not applicable or insignificant	100
green: no impact to functionality	99
grey green: only contingent functionality	75
yellow: loss of functionality, restorable with minor repair	50
amber: loss of functionality, require significant repair to restore	25
pink: insufficient data to rate	20
red: complete loss of functionality, life safety threat	0

Worst Vulnerability Score (Calculated)	20	0	0	0	75	50	0	0	99	0	99	0		75	75
RISK	EH	H	EH	H	L	M	EH	EH	L	EH	L	H		M	M

Quiz: Which Expression of Risk is More Useful?

A. Your cholesterol level is high, and your risk of a heart attack is elevated.

B. Your chance of dying from cardiovascular disease in the next 10 years is 15%.

Illustration of Risk Quantification in Plain English:

Fire Station #5 is projected to be flooded by 3 feet of water during a 1% storm. This event would likely destroy the building, and the City would not be able to respond to emergencies. Given the critical importance of the facility, the risk is rated as Extremely High because this consequence is unacceptable.

Current Trends

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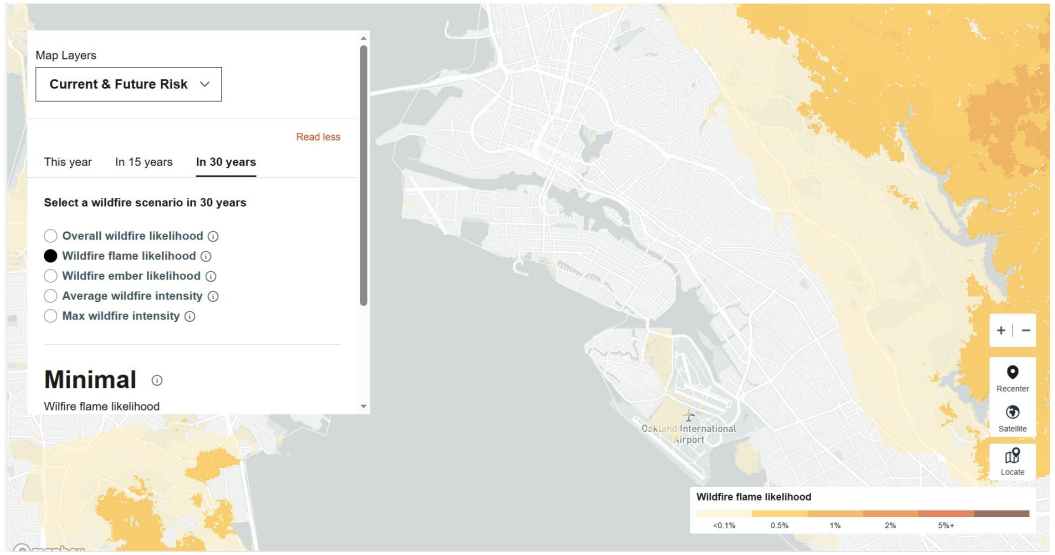
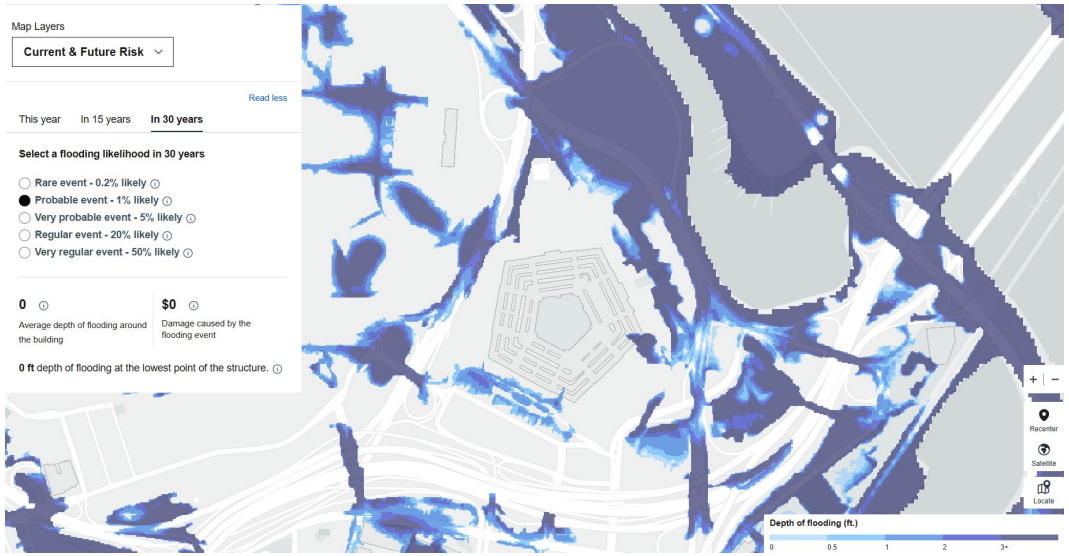
Hazard Projections Enables Risk Assessments

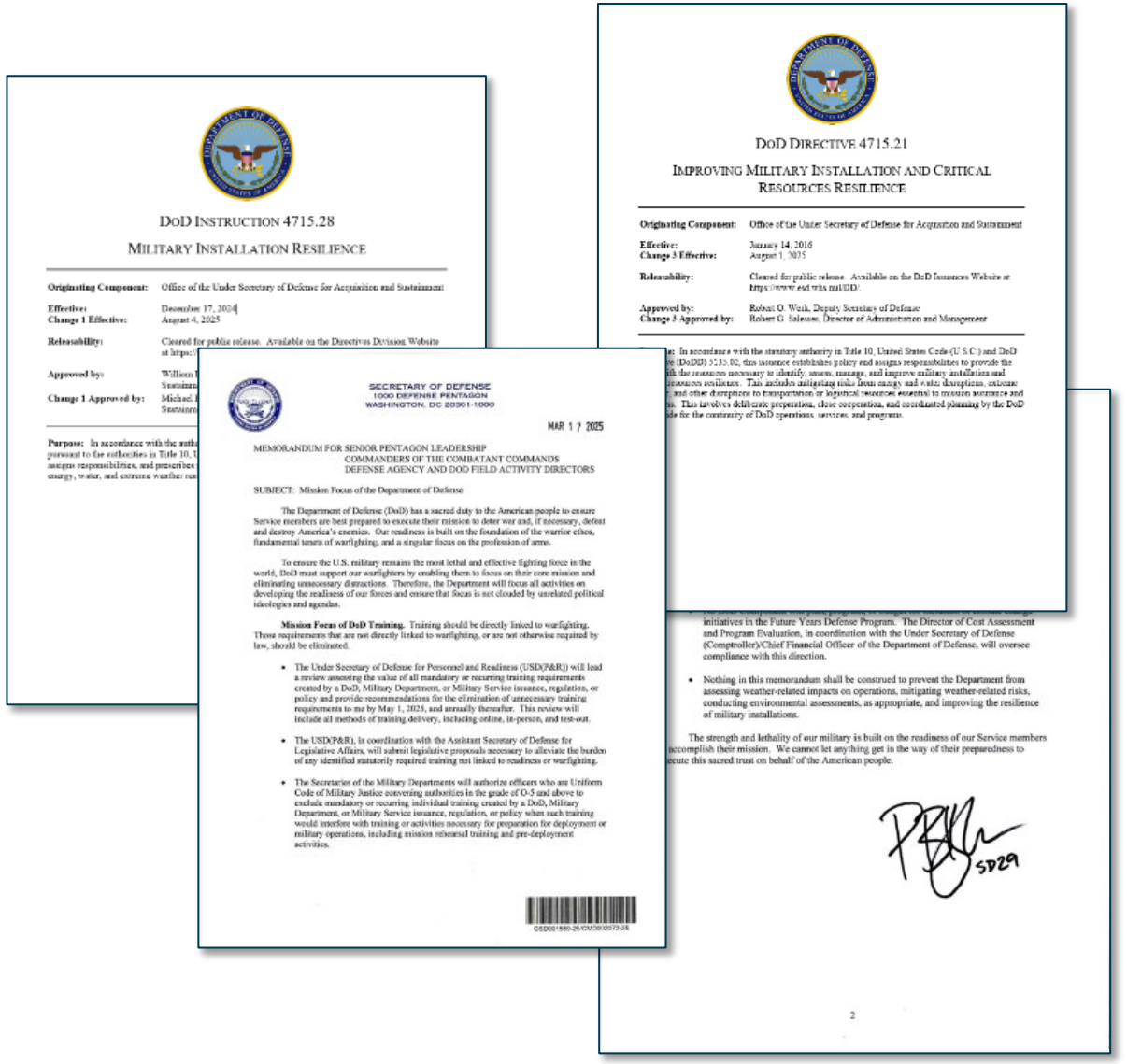
- Since 2024, 30-year future climate hazard projections are available for every location in the continental US.
- These projections include flood, wind, heat, fire and smoke hazards.
- Example display from *First Street Foundation* website.





Multi-Hazard, National Focus: DoD Example

- *US Code, 10 USC §2864(c)* requires a Military Installation Resiliency Component (MIRC) to support the master planning for all major federal installations.
- Requires risk assessment of all major climate and non-climate hazards.
- Currently being executed for all DoD bases worldwide.
- DoD has 550,000+ assets, 2B sf worldwide.



DoD INSTRUCTION 4715.28

MILITARY INSTALLATION RESILIENCE

DoD DIRECTIVE 4715.21

IMPROVING MILITARY INSTALLATION AND CRITICAL RESOURCES RESILIENCE

SECRETARY OF DEFENSE
1000 DEFENSE PENTAGON
WASHINGTON, DC 20301-1000

MAR 1 7 2025

MEMORANDUM FOR SENIOR PENTAGON LEADERSHIP
COMMANDERS OF THE COMBATANT COMMANDS
DEFENSE AGENCY AND DOD FIELD ACTIVITY DIRECTORS

SUBJECT: Mission Focus of the Department of Defense

Risk Quantification: Pentagon MIRC Example

- Risk Framework accounts for Hazard, Vulnerability, and Importance
- Multi-hazard evaluation (20+), extreme conditions and non climate disasters
- Include buildings, utilities, and transportation systems
- Include adjacent communities
- **Risks are quantified which enables planning actions**

The most critical installation in the DoD

Strong Interest from Institutional Owners

Planning is the most cost-effective way to reduce risk

90+ rapid assessments completed last 2 years by GFT:

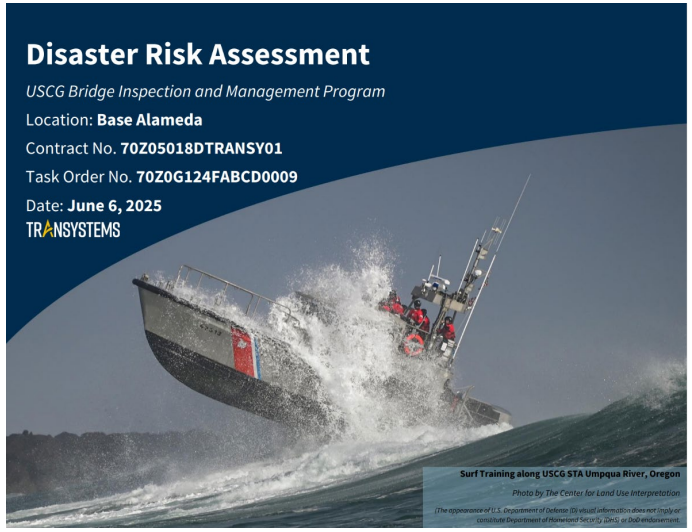
- *New confidential Rail Intermodal facility ($5B)*
- *FedEx Memphis Sort Facility ($1B)*
- *New Lancaster County Detention Facility*
- *US Secret Service Confidential Campus 100 assets*
- *US Coast Guard pilot, three installations, 100 assets*
- *US Coast Guard Enterprise Bridge Management Program, 66 assets*

Confidential Rail Intermodal Facility

Climate Resiliency Assessment

Lancaster County Correctional Facility
Location: **Lancaster, Pennsylvania**
TranSystems Project No. P707210175
Draft Date: March 13, 2025

TRANSYSTEMS



AI Innovations

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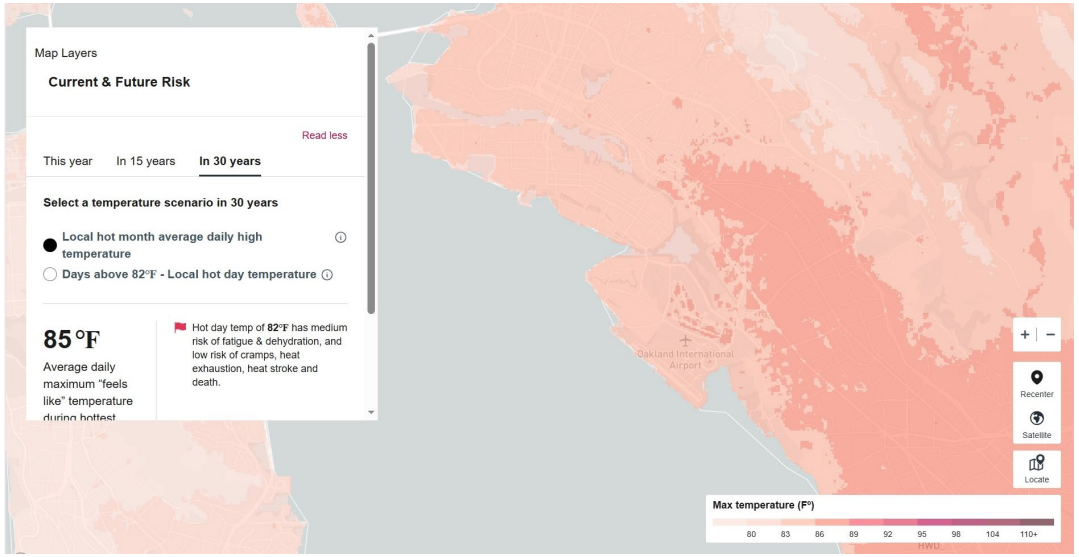
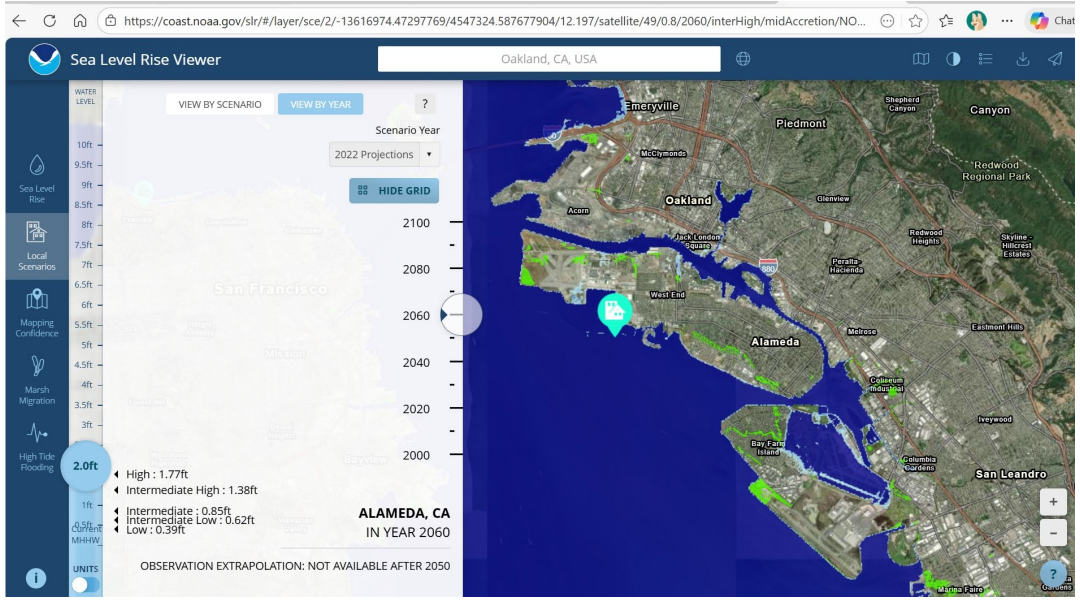
Scaling Rapid Assessment with AI

- Rapid assessments still require substantial effort due to the large volume of buildings.
- We trained an AI agent (Chat GPT v5.2) to interpret hazard maps.
- Vulnerability and risk rating methodologies were coded into software algorithms.
- The AI Assessment tool was tested on a project at Aviano Air Base. The ratings for 89 buildings were completed instantly!





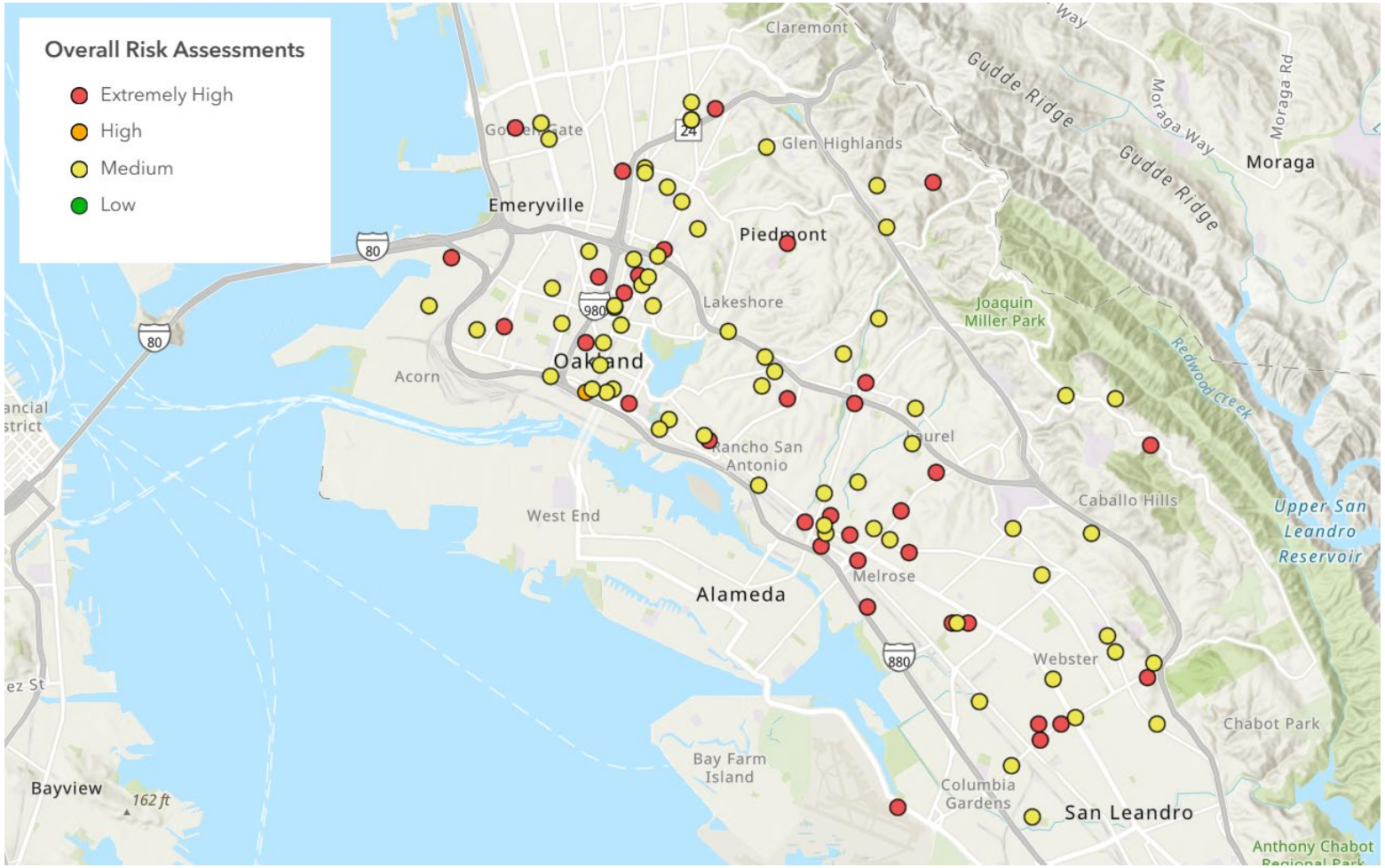
Enhanced Visualization with GIS

- We moved our AI tool to a GIS platform.
- Enables map-based and aerial visualization of results.
- The number of assets assessed is unlimited.
- The tool is compatible with most client GIS platforms.

Current proof of concept: FLETC Enterprise, 4 campuses, 6.3msf, 788 assets

AI Radically Transforms Risk Assessment

- Automation greatly reduces costs, to well below $0.01 per square foot for large asset pools.
- As the asset pool increases, the unit cost decreases.
- **Climate risk data for every building in the United States will soon be available.**



Conclusion

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Summary

Fundamentals

- The three components of *Risk*: *Hazard, Vulnerability and Exposure*
- How building codes and public policies weigh different *Hazards*
- How *Vulnerabilities* are estimated
- Actionable *Risk* ratings

Current Trends

- Future hazard projections are now available
- Moving towards multi-hazard, national approach
- Demand for risk quantification
- Strong Interest from institutional owners

AI Innovation

- How the use of AI can greatly reduce effort and cost of assessments
- Hazards, vulnerabilities and risk of every building will be available in the future

Invitation to Collaborate

- GFT will provide AI/GIS Rapid Risk Assessments to any NLC municipality at essentially **no cost** *(at the lowest contractable value)*.
- In return, we are seeking feedback to understand how the results are used for planning action so we can refine our process.
- Participating municipalities will provide basic building data; GFT will return a building-level database including *hazards, vulnerability, exposure*, and overall *risk*.
- Our goal is to engage in 50+ collaborative efforts over the next 12 months.

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