CAMBRIDGE SYSTEMATICS

# RESILIENCE – EDUCATIONAL SERIES - WORKSHOP

*presented to*

COMPASS Educational Series Participants

*presented by*

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Principal, Practice Lead – Resilience and Sustainability

Cambridge Systematics

May 30, 2024

# Cambridge Systematics

Policy + Strategy

Planning + Operations

Modeling + Analytics

Software + Tools

## Over 50 Years of Insights through Innovation

- Founded in 1972
- 200+ staff in 12 nationwide offices
- Independent, employee owned

Resilience and Sustainability

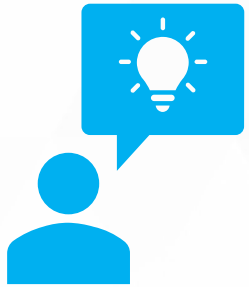
# WORKSHOP OVERVIEW

# Session Overview

- Recap from Public Meeting
- Risk and Resilience – Basics
- Making the Business Case and Communicating It
- Exercise
  - Overview and Rules
  - Table Presentations
  - Voting
- Recap and Closing

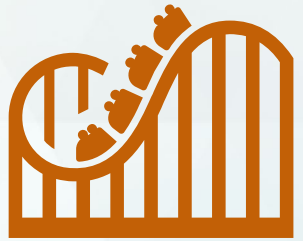
# Workshop Objectives

Applying Risk and Resilience Basics



Making the Business Case for Resilience

Communicating the Case



Have Fun!



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# PUBLIC MEETING TAKEAWAYS AND RECAP

DEFINE

# 1. What is a word or phrase that defines what resilience means to you?

10 responses




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IMPORTANCE

## 2. Why is "planning for resilience" important to the residents of treasure valley?

14 responses

Good planning

Predictability

We have floods and fires

Saves money on long run

We are growing

To ensure that we have safe and accessible options in case of emergencies.

Continued commerce

I'm an emergency you have to use the roads to respond

Equity

$$$

The growth in the area is faster than how the community can respond.

Financial responsibility

It keeps goods and services flowing.

Life continues. Work arounds needed.

1 8

# 3. Which stressors come to your mind when you think about the need for transportation resilience in the treasure valley?

22 responses

LOCAL KNOWLEDGE

# 4. List some known areas/facilities that are impacted by these stressors from your lived/recent experiences.

16 responses

| | | | |
|---|---|---|---|
| Sidewalks | Foothills = fires | I-84 | Greenbelt flooding |
| Greenbelt | Greenbelt east of VMP | Bridges crossing the river. Gary Lane | Snow on neighborhood streets, lack of storm drains equals flooding |
| Homes on the edge of town | Water mains bursting | Road to mccall | Flooding in neighborhoods |
| Potholes caused by ice | Can't drive to work (neighborhood snow) | Greenbelt | Couldn't get out of the driveway to go anywhere |

1 8

COMMUNITY FUNCTIONS

# 1. What core/basic needs would be impacted due to the disruptions we discussed? (Examples: access to groceries, medical appointments)

11 responses

Emergency responders

Getting to work

Can't drive to work (neighborhood snow)

Military functions

Access to whatever is on the other side of the disruption.

Senior homes (those who need medical care or simply socialization)

Evacuations

Fire agency

Amazon deliveties

Access to schools, access to tourist spots

Medical care

# RISK AND RESILIENCE BASICS

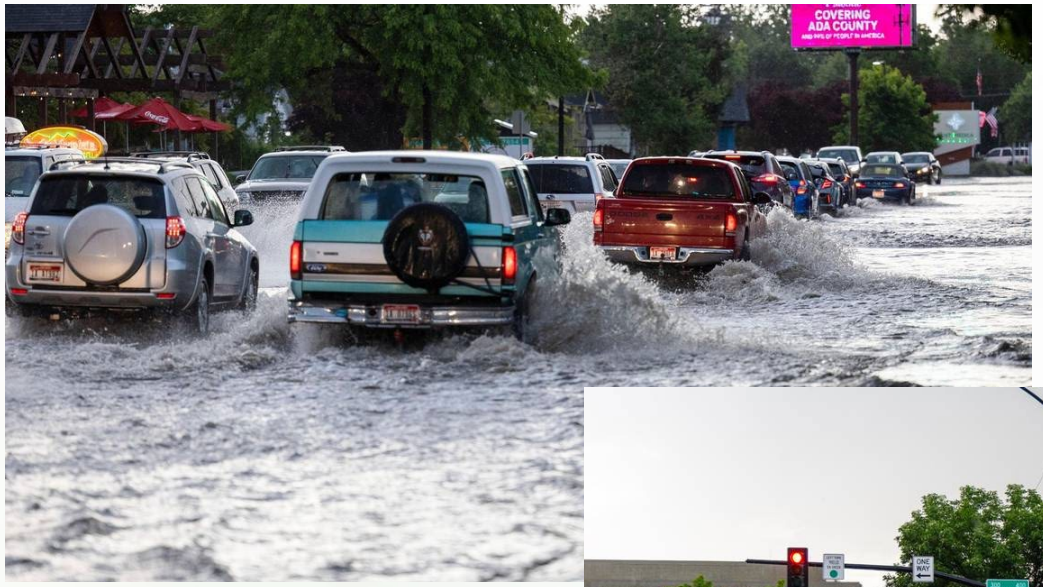
# Impacts Across the US

Interstate 45 inundated during Hurricane Harvey, August 2017.

Rain, warm temperatures and snowmelt-induced flooding across the Midwest Flooding, 2019 (Nebraska)

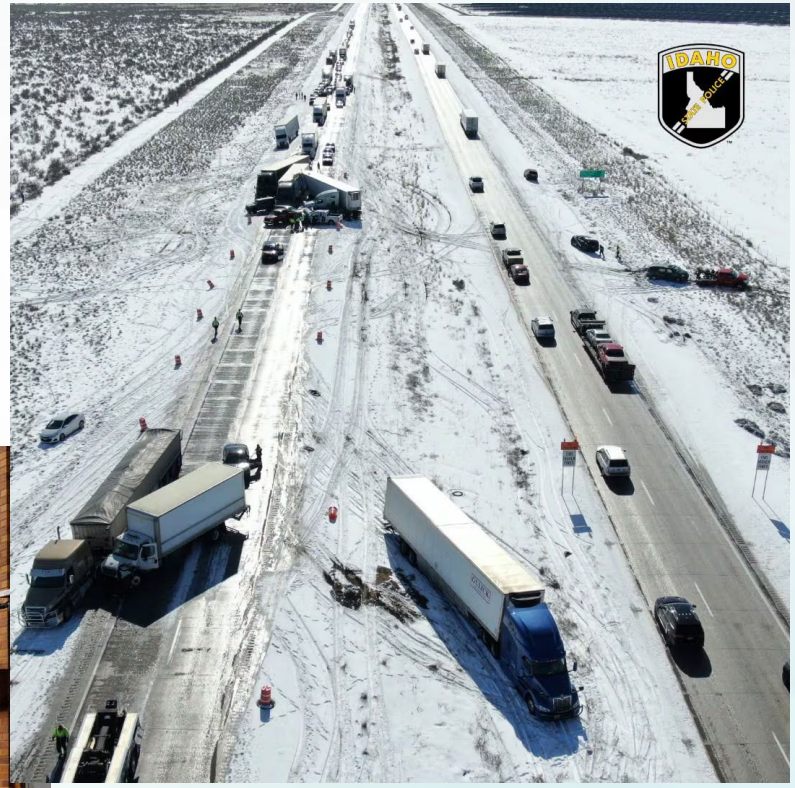
Interstate 80 in Vacaville, Calif., Aug. 19, 2020. Source: AP Photo, Courthouse News.

# Regional Transportation Impacts and Disruptions





Downtown Boise Flooding – Flash Thunderstorm – June 2023 – Source: Idaho Statesman

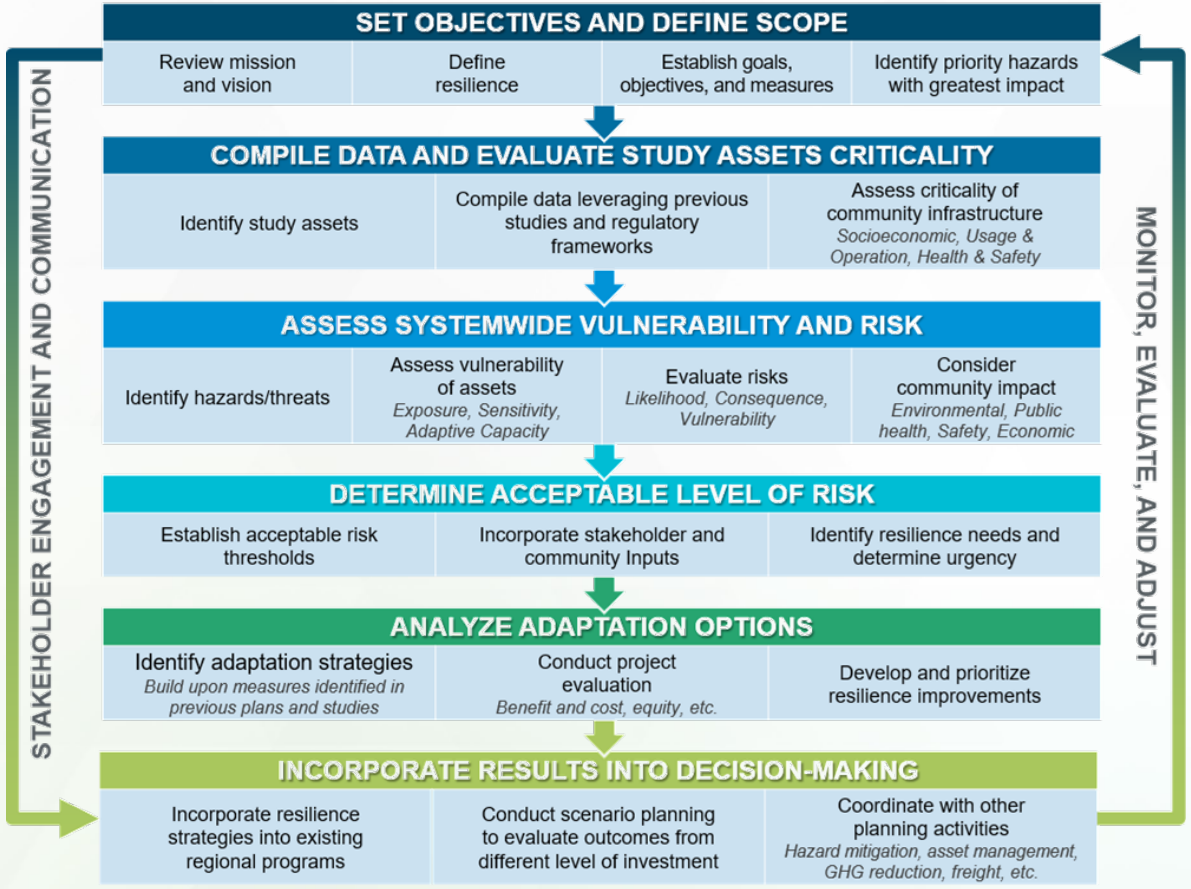


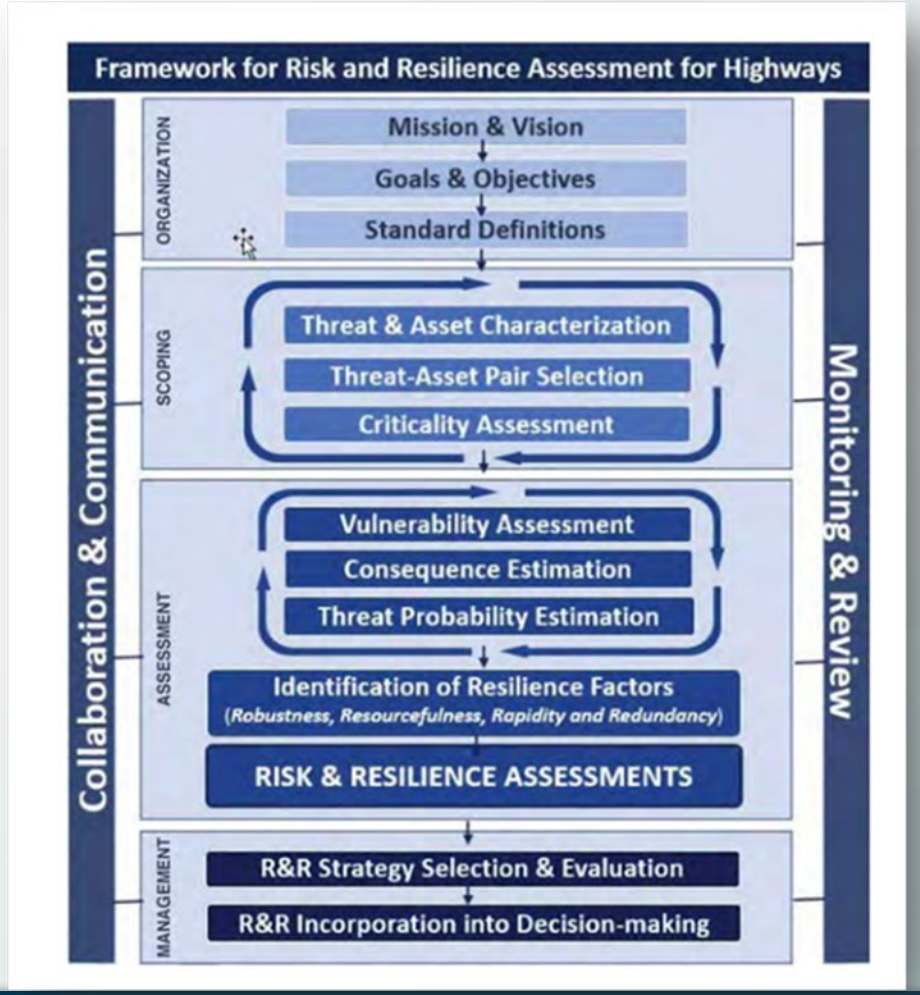

Interstate 84 Disruptions in March 2024 between Boise and Mountain Home

# Understanding and Defining Resilience

- ***Resilience or resiliency is the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions (FHWA Order 5520)***
- ***Risk: The positive or negative effects of uncertainty or variability upon agency objectives. (23 CFR 515.5)***

# Frameworks for Assessment



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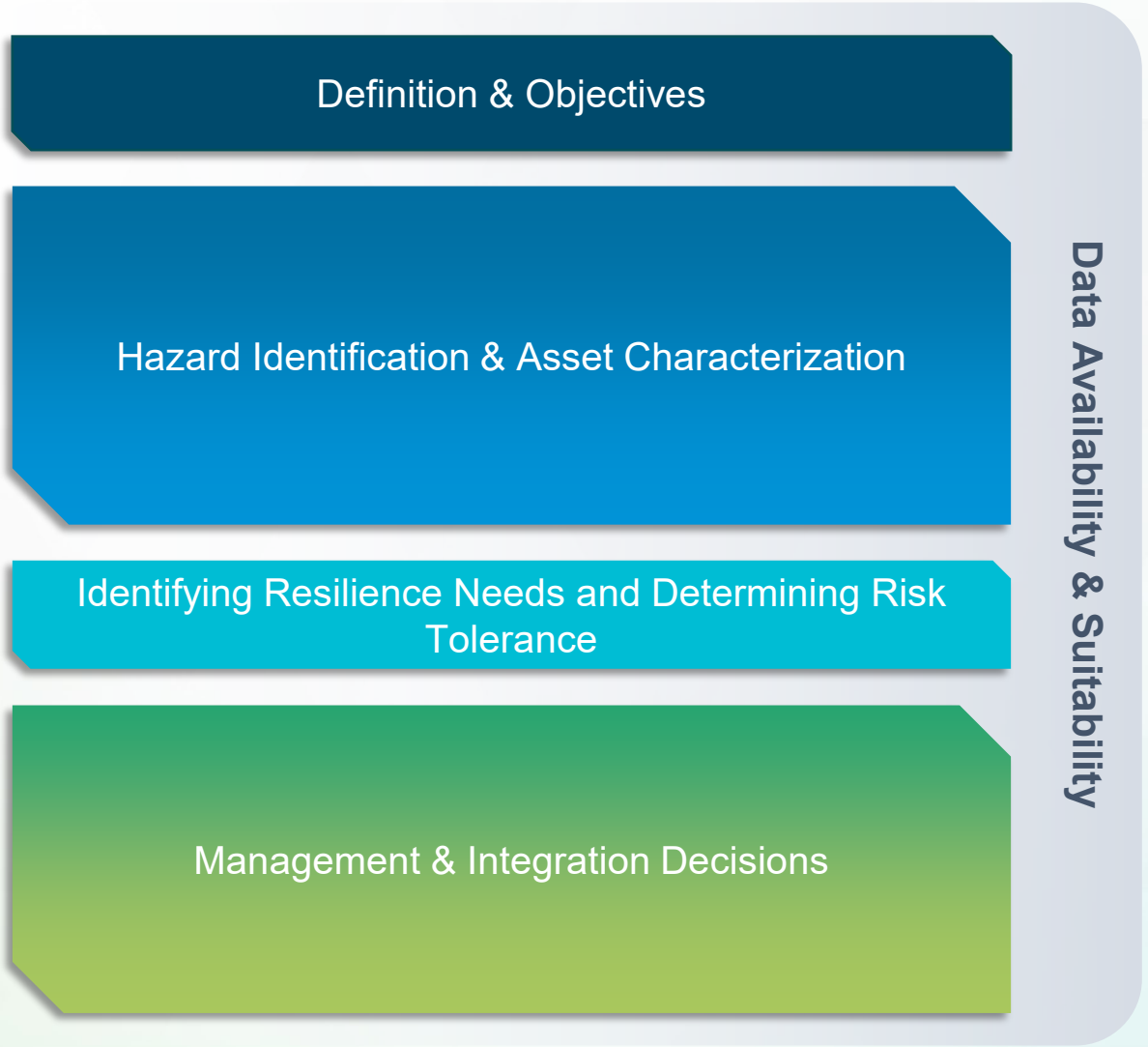
# Assessing Vulnerabilities, Risk, and Resilience



# ASSET CHARACTERIZATION - CRITICALITY

# Asset Characterization – Criticality - Example

## Usage and Operational Importance

- Evacuation Routes / Lifelines (2)
- Functional Class (2)
- AADT (2)
- Freight Network (2)
- Northeast Corridor (1)
- Broadband Network (1)

## Socioeconomic Importance

- Equity Areas (4)
- Population Density (3)
- Employment Density (3)

## Health and Safety Importance

- Access to Dam (1)
- Access to Fire or Police Stations (1)
- Access to Hospitals (1)
- Access to Schools (1)
- Access to Emergency Shelters (1)
- Access to Power plants (1)
- Access to Transit Centers (1)
- Access to Airport (1)
- Access to Seaports (1)
- Access to Maintenance Facilities(1)
- Access to Military Installations(1)

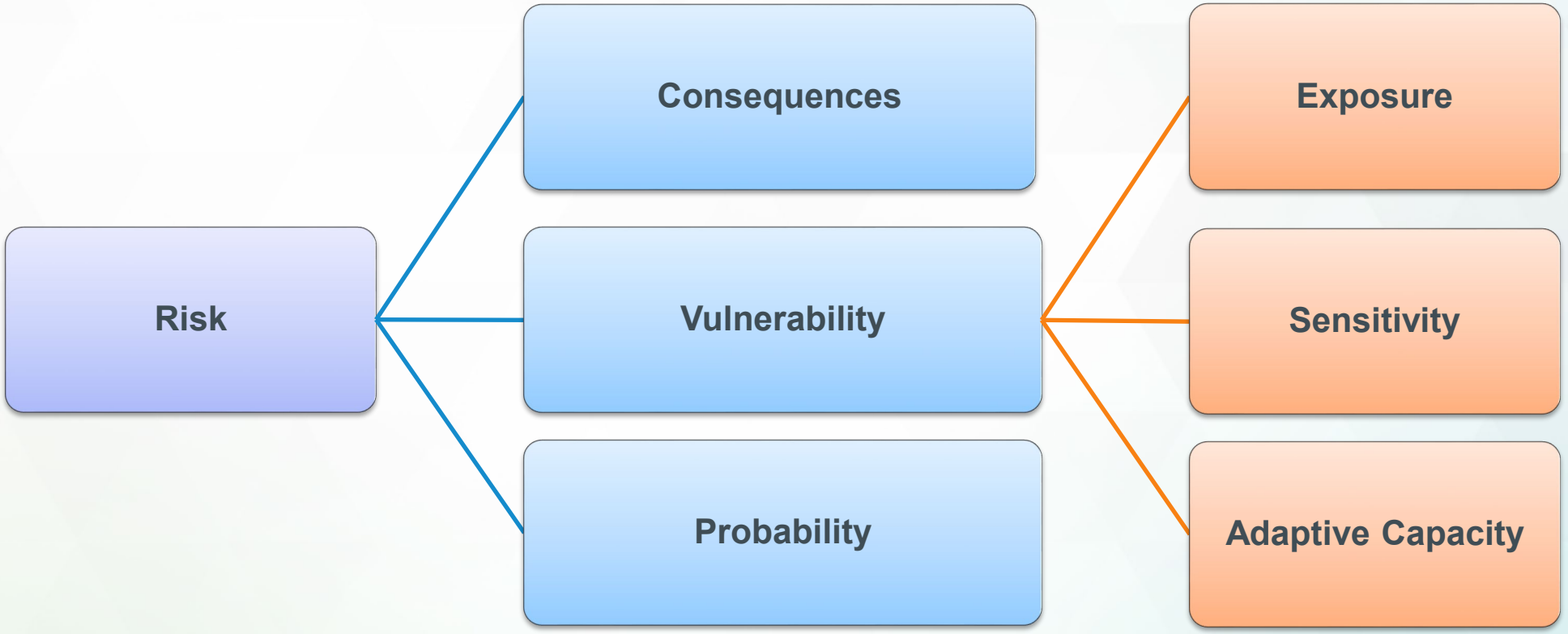
# Criticality Scoring Approach – Example

| Factor | Max Score | Scoring Method | Score | Description |
|---|---|---|---|---|
| **Functional Class** | 4 | Local | 1 | Roadway functional classification (UCTC) combining urban and rural roadway classes. |
| | | Major Collector | 2 | |
| | | Minor Arterial | 3 | |
| | | Principal Arterial | 4 | |
| **Access to Essential Facilities** | 3 | 0 facilities in a ½-mile distance | 0 | Number of Essential Facilities within a ½-mile distance from the road (*distance calculated is not network-distance, but crow-fly distance*) |
| | | 1 to 2 facilities in a ½-mile distance | 1 | |
| | | 3 to 5 facilities in a ½-mile distance | 2 | |
| | | >5 facilities in a ½-mile distance | 3 | |
| **Evacuation/Detour Route** | 1 | 1 if Yes, 0 otherwise | 0-1 | Whether the roadway is an evacuation route |
| **Transit Corridor** | 1 | 1 if Yes, 0 otherwise | 0-1 | Whether the roadway is a transit corridor |
| **Population Density** | 3 | <=100; | 1 | Population density normalized by network density to avoid any disproportionate impact to rural areas/assets |
| | | 101 – 200; | 2 | |
| | | > 201; | 3 | |
| **Equity Areas** | 3 | 0 - 10% | 1 | Based on the proportion of population with 3+ risk factors (Census Community Resilience Estimates (CRE) Data) |
| | | 11% - 20% | 2 | |
| | | 21 % - 35% | 3 | |
| ***Maximum Total Score*** | **15** | | | |

Source: Critical Transportation Infrastructure Vulnerability Assessment, Ulster County, NY, Cambridge Systematics

# ASSESSING RISK AND RESILIENCE

# Assessing Risk

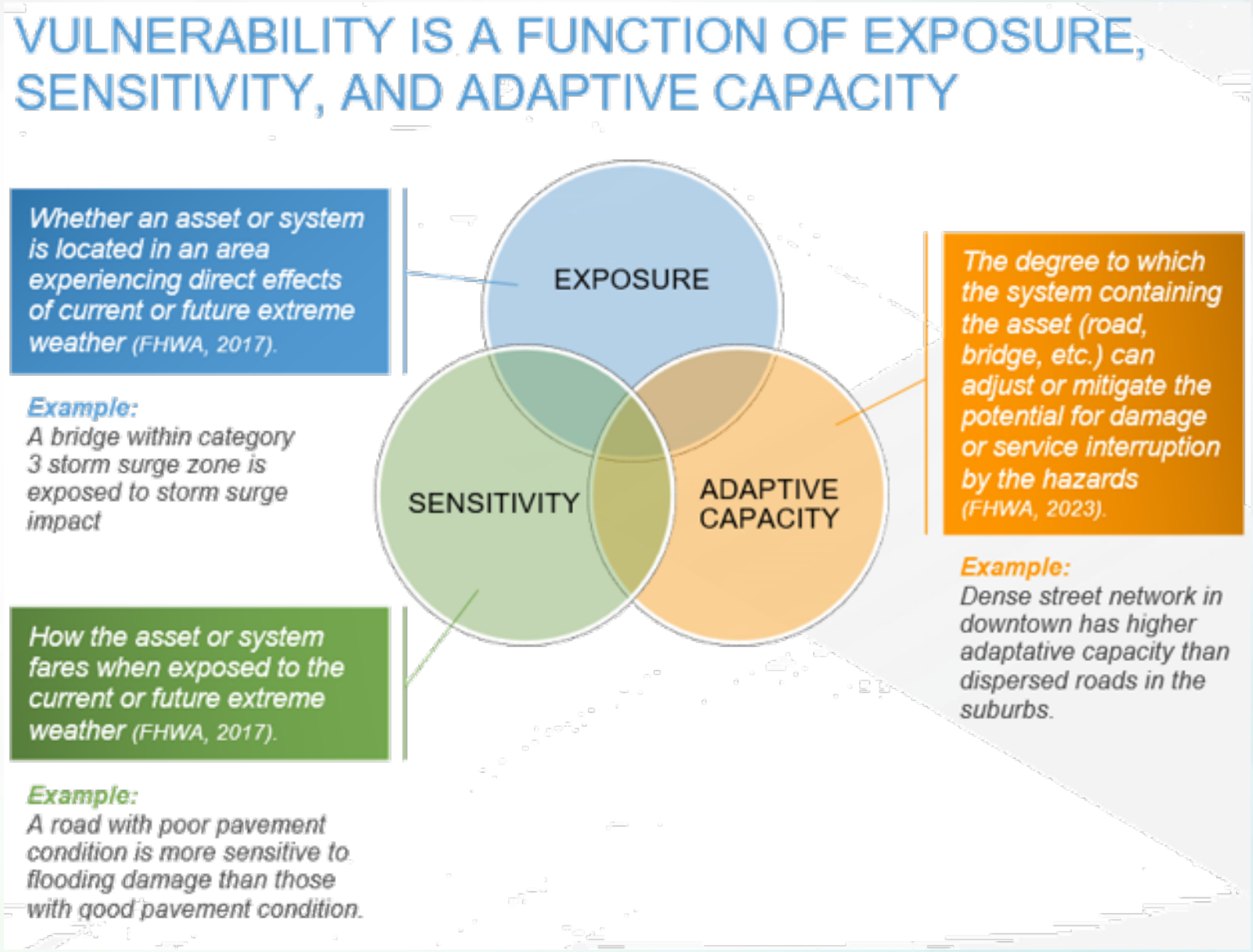



- A risk-based assessment should consider both the **probability or likelihood** that transportation assets will experience potential impacts due to disruptions, and the **consequences** of those impacts.

# Vulnerability

What is vulnerability

- The degree to which a system is **susceptible to, or unable to cope with**, adverse effects of climate change and extreme weather.



# Elements of Vulnerability – Sample Indicators

## Exposure

- Roads: Inundation Depth
- Bridges: Inundation Depth
- Stormwater Pipes: Inundation of pipes and outfalls
- Stormwater Treatment Units: Inundation of STU
- Sidewalks and Shared use Paths: Inundation Depth

## Sensitivity

- Roads: Pavement Condition
- Bridges: BB Rating
- Stormwater Pipes: Last Cleaning Dates
- STU: Inspection Scores
- Sidewalks and Shared use Paths: Condition

## Adaptive Capacity

- Roads: Network Density
- Bridges: Network Density
- Stormwater Pipes: Pipe Diameter + Position (up/downstream)
- STU: Ratio of Catchment Size to STU Volume
- Sidewalks and Shared use Paths: Network Density

# Assessing Risk

## Vulnerability

- Exposure
- Sensitivity
- Adaptive Capacity

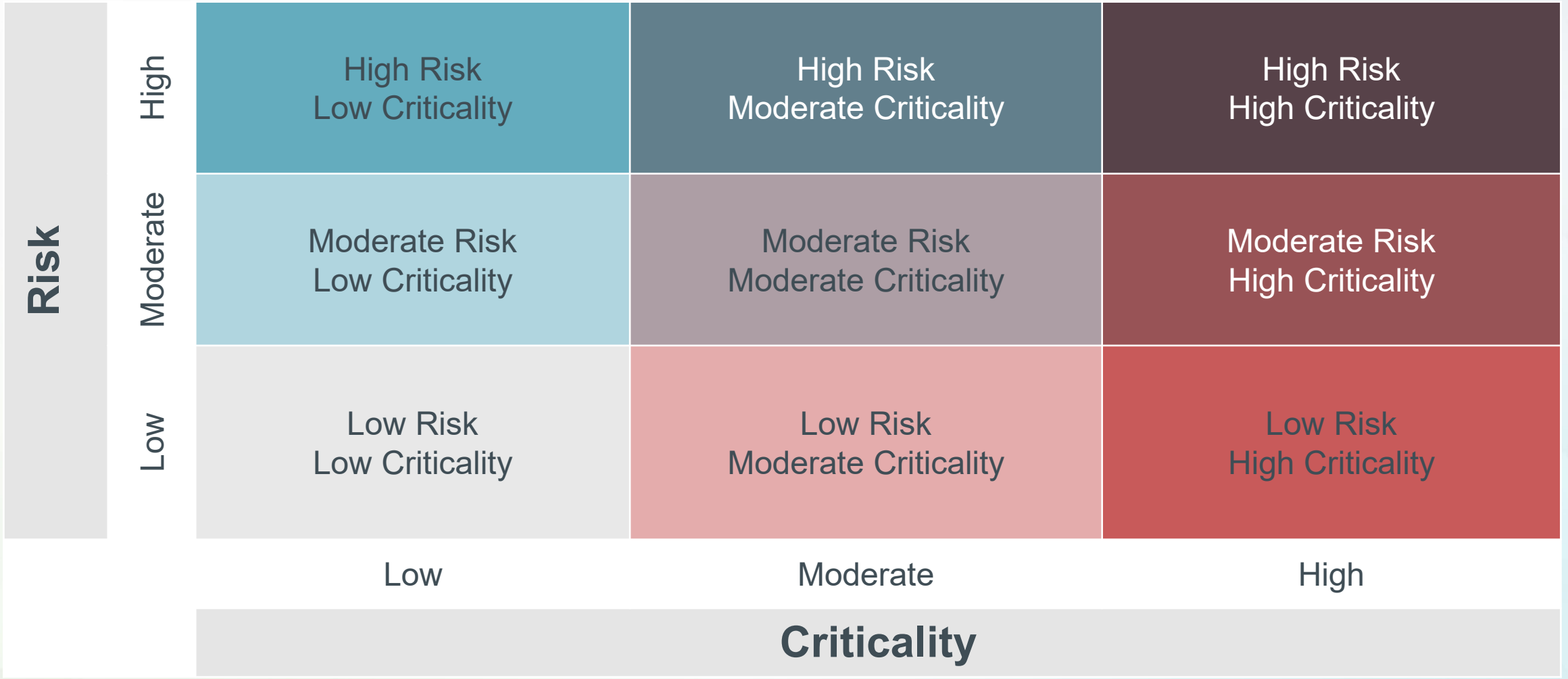
## Likelihood

- Probability of Events

## Consequence

- Owner Cost to Repair or Replace Assets
- User Cost of Time & Vehicle Operation & Reliability due to delay/detour

# Prioritization



# The 4Rs of Resilience

**Robustness**

the ability to withstand disaster forces without significant degradation or loss of performance.

**Redundancy**

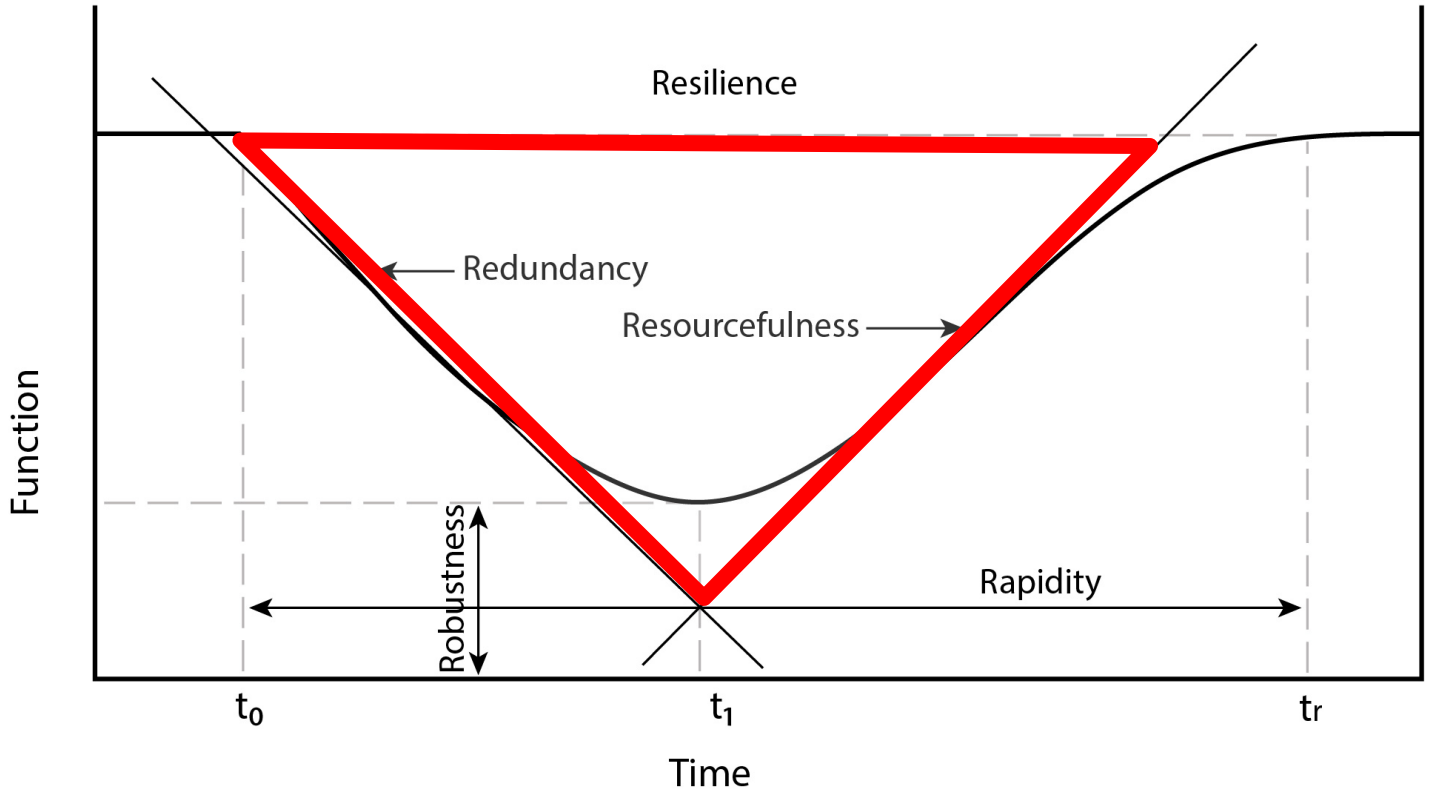
the extent to which the systems can satisfy functional requirements if significant degradation or loss of functionality occurs.

**Resourcefulness**

the ability to diagnose and prioritize problems and to initiate solutions by identifying and mobilizing resources;

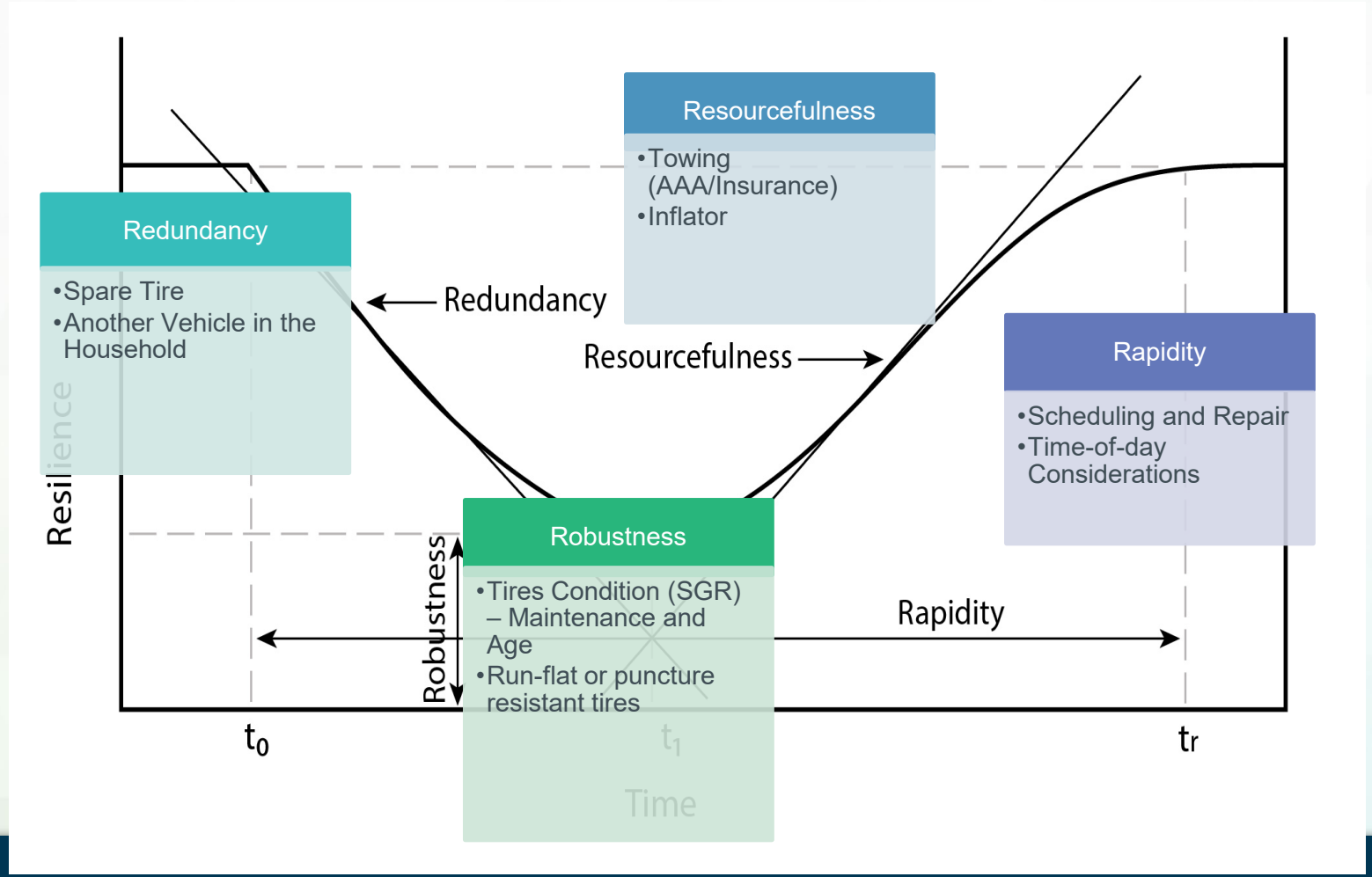
**Rapidity**

the capacity to restore functionality, contain losses, and avoiding disruptions.




Source: Original graphic; based on Simonovic, S. P., and Arunkumar, R. (2016), Comparison of static and dynamic resilience for a multipurpose reservoir operation, Water Resour. Res., 52, 8630–8649, doi:10.1002/2016WR019551.

# Flat Tire Analogy



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# Hazards – Treasure Valley – Current and Future

**Table 2-3.** Hazards of Concern Assessed by Local Jurisdiction

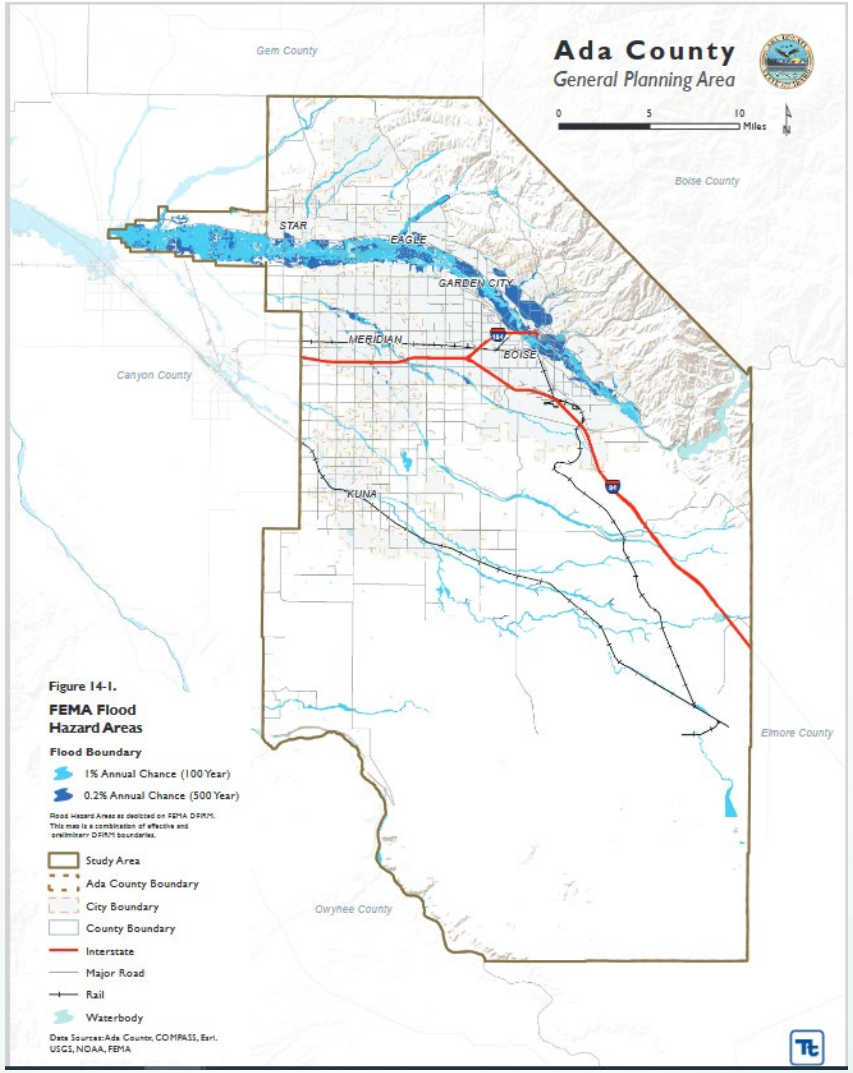
| Jurisdiction | Avalanche | Drought | Earthquake / Seismic | Flood (includes dam failure) | Landslide | Severe Storms (includes wind, tornado) | Volcano | Wildfire |
|---|---|---|---|---|---|---|---|---|
| Ada County | – | √ | √ | √ | √ | H | √ | √ |
| Adams County | – | – | √ | √ | √ | H | – | H |
| Bannock County | √ | – | √ | √ | √ | H | – | H |
| Bear Lake County | √ | – | √ | √ | √ | H | – | √ |
| Benewah County | – | – | √ | H | √ | H | – | H |
| Bingham County | √ | H | √ | H | √ | H | – | H |
| Blaine County | √ | H | √ | H | √ | √ | – | H |
| Boise County | √ | – | √ | H | H | √ | – | √ |
| Bonner County | √ | – | √ | √ | √ | H | – | H |
| Bonneville County | √ | √ | √ | H | √ | H | – | H |
| Boundary County | √ | √ | H | H | √ | H | – | H |
| Butte County | – | – | H | – | – | – | – | – |
| Camas County | √ | H | H | H | √ | H | – | H |
| Canyon County | – | √ | H | √ | √ | H | – | √ |

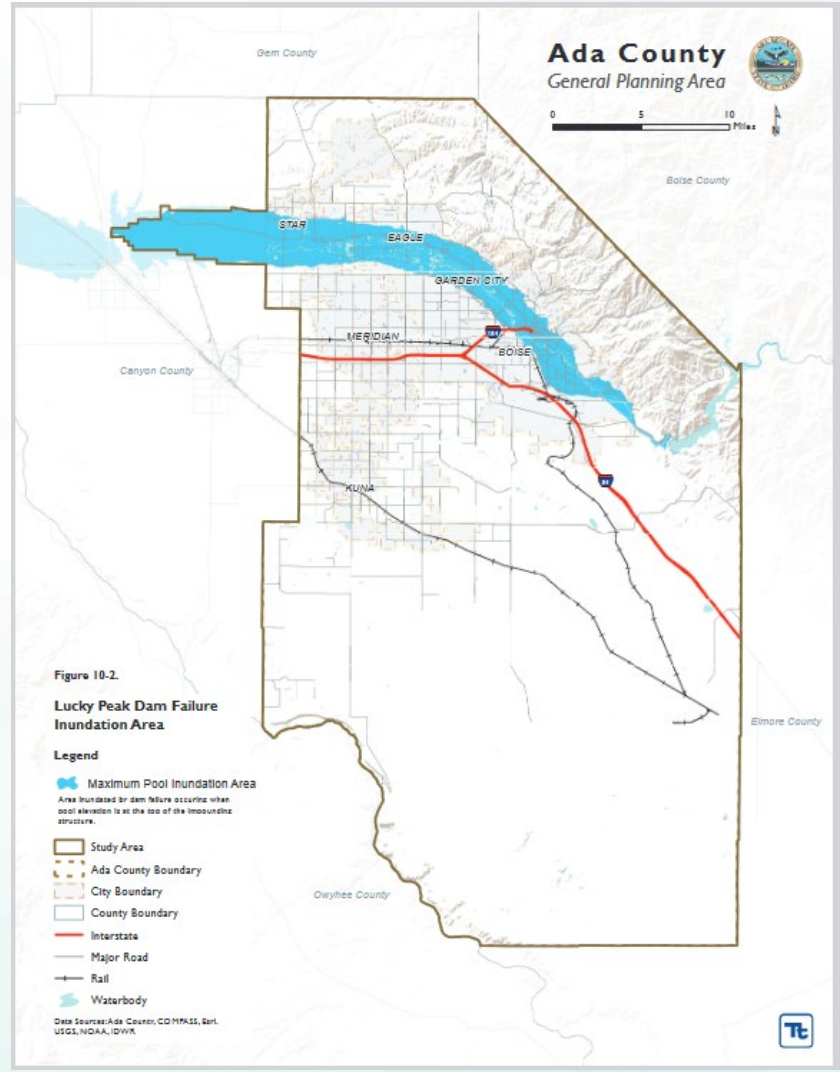
√ = hazard assessed
H = assessed as high hazard
– = no assessed hazard
Source: IOEM 2023

Source: Idaho Statewide Hazard Mitigation Plan

# Hazards – Local (Ada County)

- Hazards
  - Dam/canal failure
  - Drought
  - Extreme weather
  - Flood
  - Landslide
  - Volcano (ash fall)
  - Wildfire.




Source: Ada County Hazard Mitigation Plan



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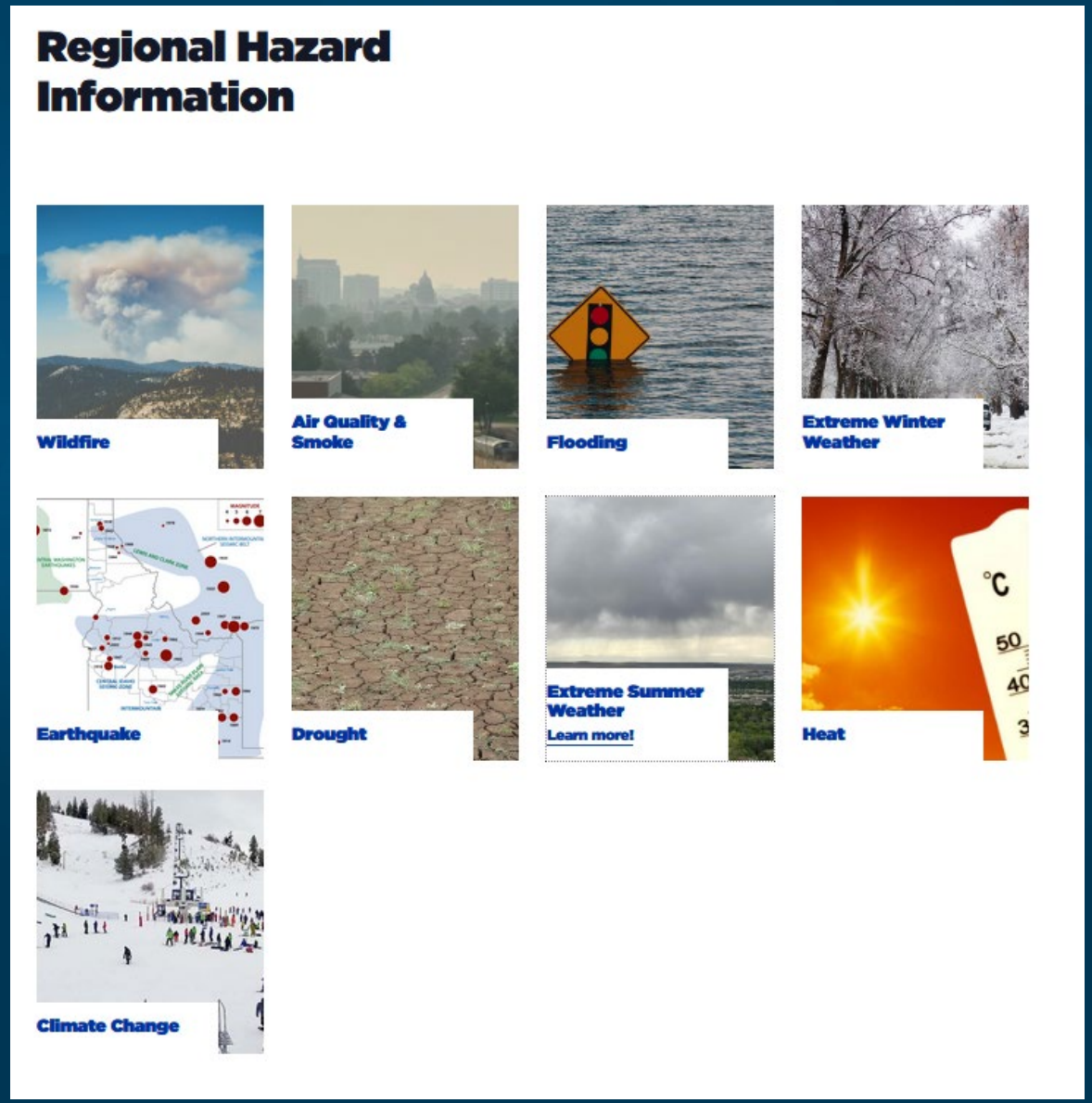
# Hazards – Regional and Local Resources

- Hazard and Climate Resilience Institute (HCRI) – Boise State University
  - » Overview
  - » How to prepare
  - » Local Resources
  - » How is this hazard impacted by a changing climate?




Source: Boise State University

# INTEGRATION INTO PLANNING OR AGENCY BUSINESS PROCESSES

# Incorporation into Regional Planning

Project Screening and Prioritization

Scenario Planning and Performance-based Investing

Project Design and Development

# Regional Project Prioritization – Resilience

| | | | SAFETY SCORING | | | | | | | | | | | SYSTEM PRESERVATION SCORING | | | | | | | | CAPACITY MANAGEMENT SCORING | | | | | | | | | | | | | | ECONOMIC VITALITY SCORING | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Project Name | Estimated Project Cost (2018 Dollars) | Annual Average Daily Traffic | Safety | EPDO | EPDO per 100,000,000 vehicles (Risk) | Cost per EPDO (Cost/Benefit) | Risk Group | Cost/Benefit Group | Project Impact Group | Top 200 Crash Location (Total EPDO) | HSIP Cluster (Total EPDO) | HSIP Bicycle Cluster (Bike-involved EPDO) | HSIP Pedestrian Cluster (Ped-involved EPDO) | System Preservation and Modernization | Cost per Index Point (000s) | Percent Resilience Related | Structurally Deficient Bridges | Weighted IRI | Total Project Roadway-miles | Total Project Lane-miles | Weighted Deficiency Index | Capacity Management and Mobility (Autos) | MPO-identified Express Highway Bottleneck Location | MPO-identified Arterial Bottleneck Location | Capacity Management and Mobility (Buses) | Regional and Local Bus Trips (Daily) | Total Regional Bus Trips (Daily) | Total Local Bus Trips (Daily) | Number of Regional Bus Routes Served | Number of Local Bus Routes Served | Capacity Management and Mobility (Peds/Bikes) | Nonmotorized Total | Pedestrian Improvements | Bicycle Improvements | Improves Transit Access | Economic Vitality | Total points | Mostly Serves Existing Area of Concentrated Development | Partly Serves Existing Area of Concentrated Development | Facilitates New Development | Provides Vehicle Acess to Target Development Area | Provides Transit Acess to Target Development Area | Provides Bicycle Acess to Target Development Area | Provides Pedestrian Acess to Target Development Area |
| Route 60 Improvements (Medford, Arlington) est | $40,000,000 | 20,400 | high | 3360 | 16637 | $11,905 | 1 | 1 | 2 | | 2 | | 5 | high | $12 | 0.3 | | 252 | 8.2 | 16.3 | 3374 | medium | | moderate | high | 508 | | 508 | | 8 | high | 4 | 2 | 1 | 1 | medium | 2 | | | | | 1 | | 1 |
| Improvements to Sweetser Circle (Routes 16/99) (Everett) est | $22,000,000 | 45,000 | high | 641 | 1439 | $34,321 | 1 | 1 | 2 | | | | | high | $18 | 0 | 1 | 274 | 1.7 | 5.4 | 1237 | medium | | moderate | high | 497 | | 497 | | 8 | medium | 1 | 1 | | | high | 7 | 2 | | 1 | 1 | 1 | 1 | 1 |
| Widening on Route 1 (Malden, Revere, Saugus) | $172,500,000 | 115,000 | high | 2063 | 1812 | $83,616 | 1 | 2 | 1 | | | | | medium | $34 | 0.3 | | 191 | 8.7 | 34.8 | 5081 | high | severe | | high | 168 | 168 | | 4 | | medium | 2 | 1 | 1 | | medium | 4 | 2 | | 1 | 1 | | | |
| Southeast Expressway Modification (Southampton) (Boston) | $143,750,000 | 225,000 | high | 4662 | 2093 | $30,834 | 1 | 1 | 1 | | | | 1 | medium | $59 | 0 | | 121 | 4.5 | 31.8 | 2417 | high | severe | | high | 464 | 250 | 214 | 6 | 4 | low | | | | | medium | 2 | 2 | | | | | | |

# MAKING THE CASE

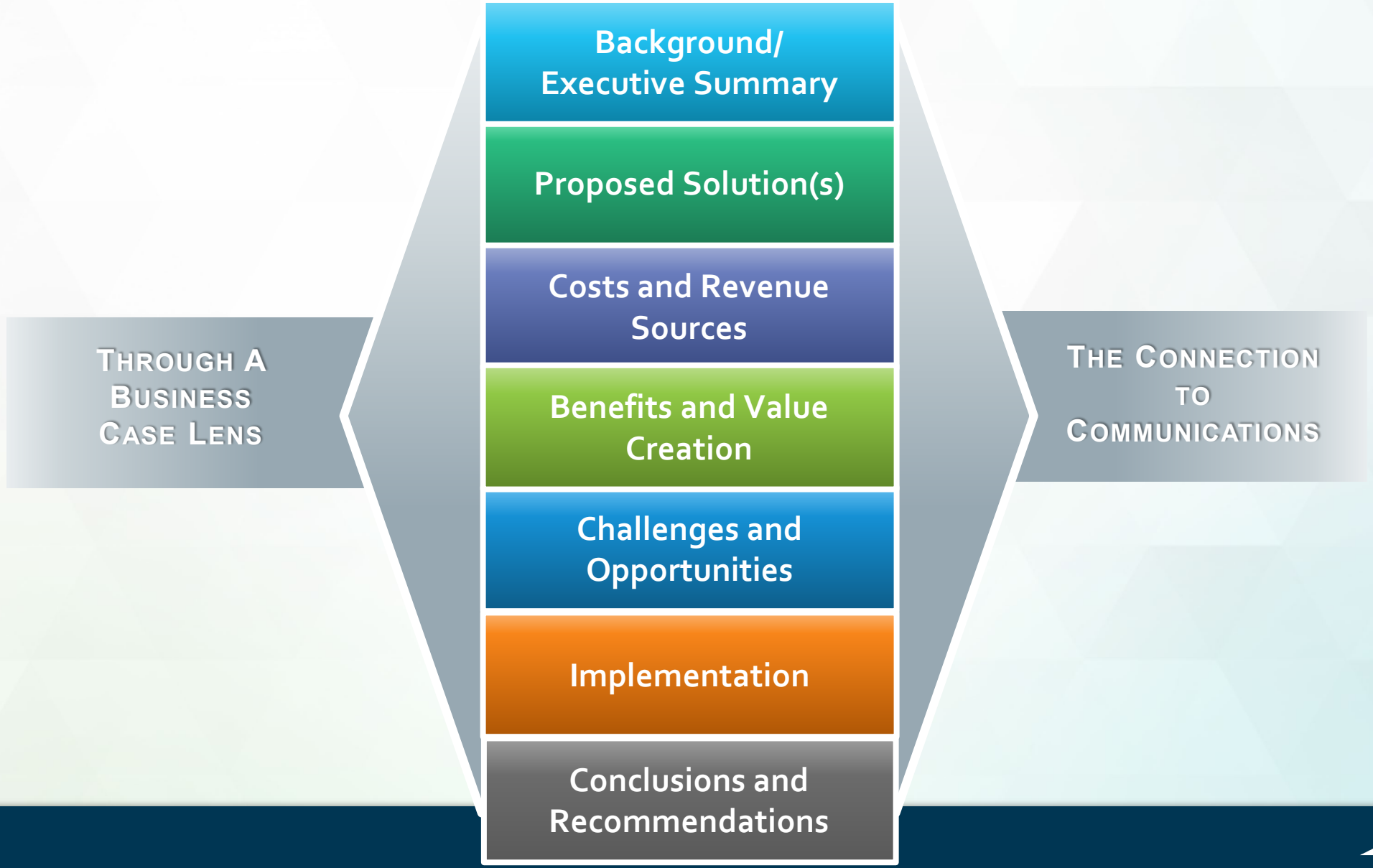
# Business Case

Makes a persuasive argument for an investment that serves a business function and requires resources and buy-in

Emphasizes importance of proposed action by explaining the costs, benefits, and value creation

Communicates risks of inaction, implementation challenges, and uncertainties

# Conceptual Framework





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# Styles and Delivery


Elevator Pitch

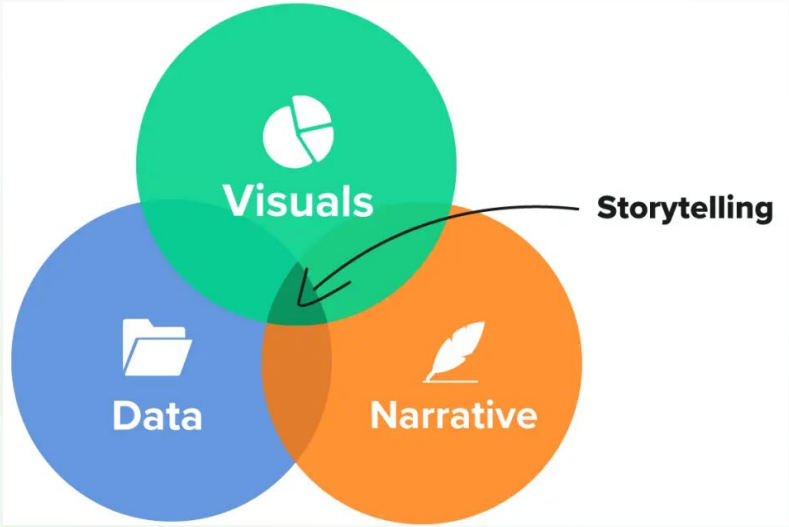
Detailed Business Case

Image Sources: Yale Ventures and Grammarly

# COMMUNICATION – VISUALIZATION SUPPORT

# Visualizations - Some Inspiration for the Workshop

- Visualization is communication of data and information using charts, graphs, diagrams, and other infographics
  - » ***Examples from Case Studies***
  - » ***Examples from Common Evidence Base***



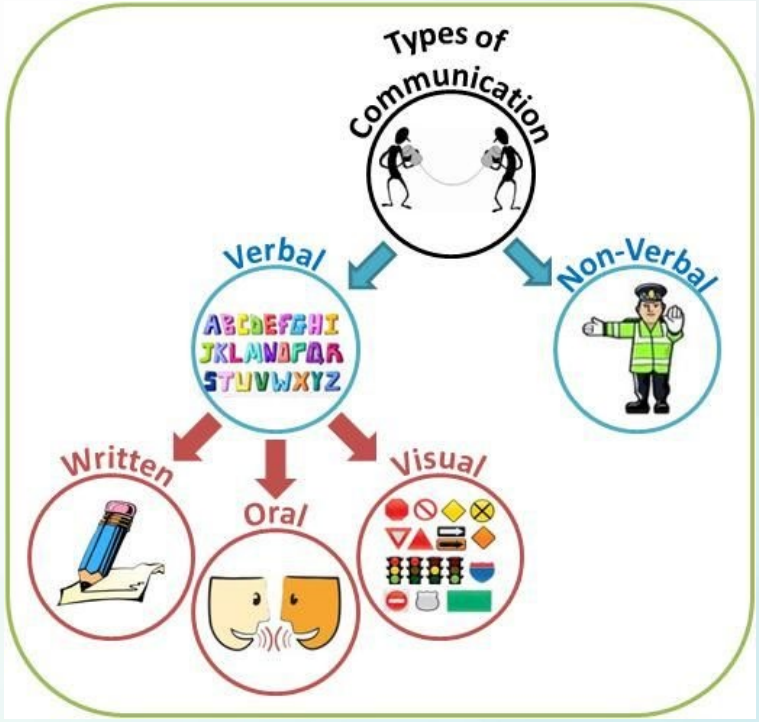
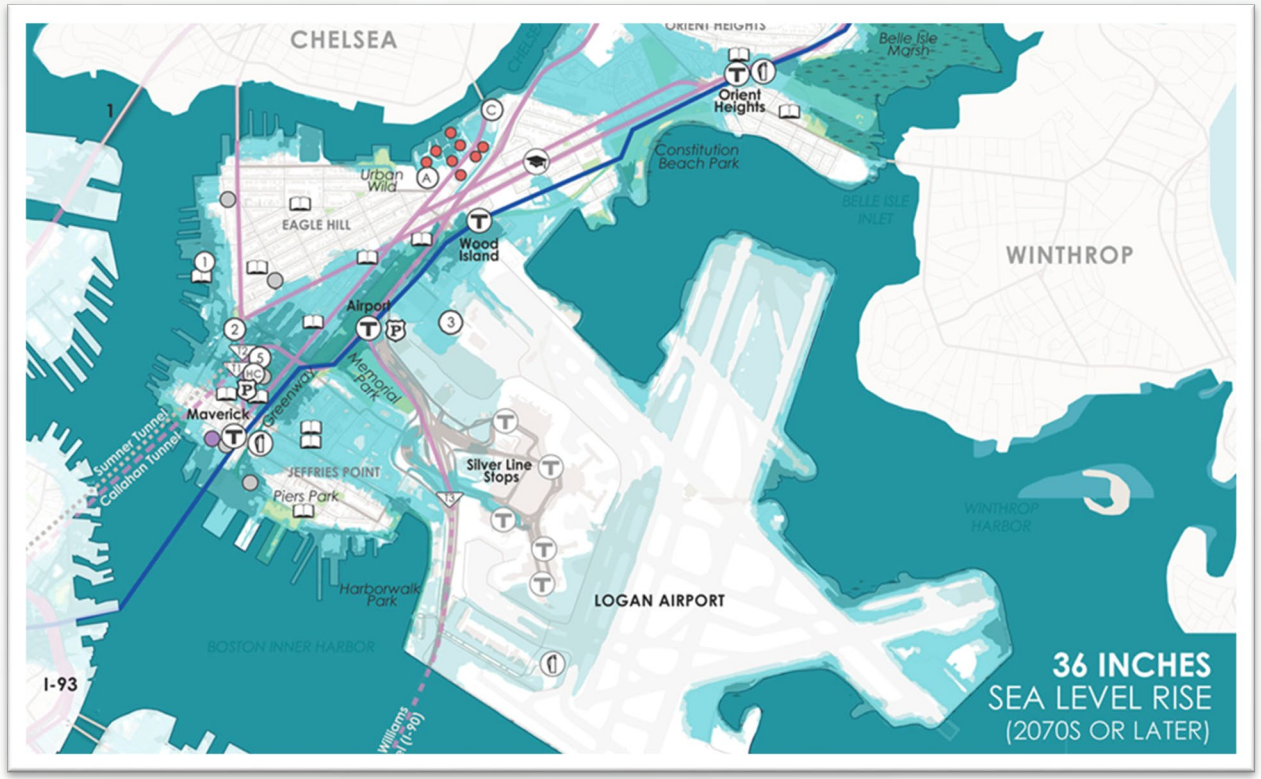
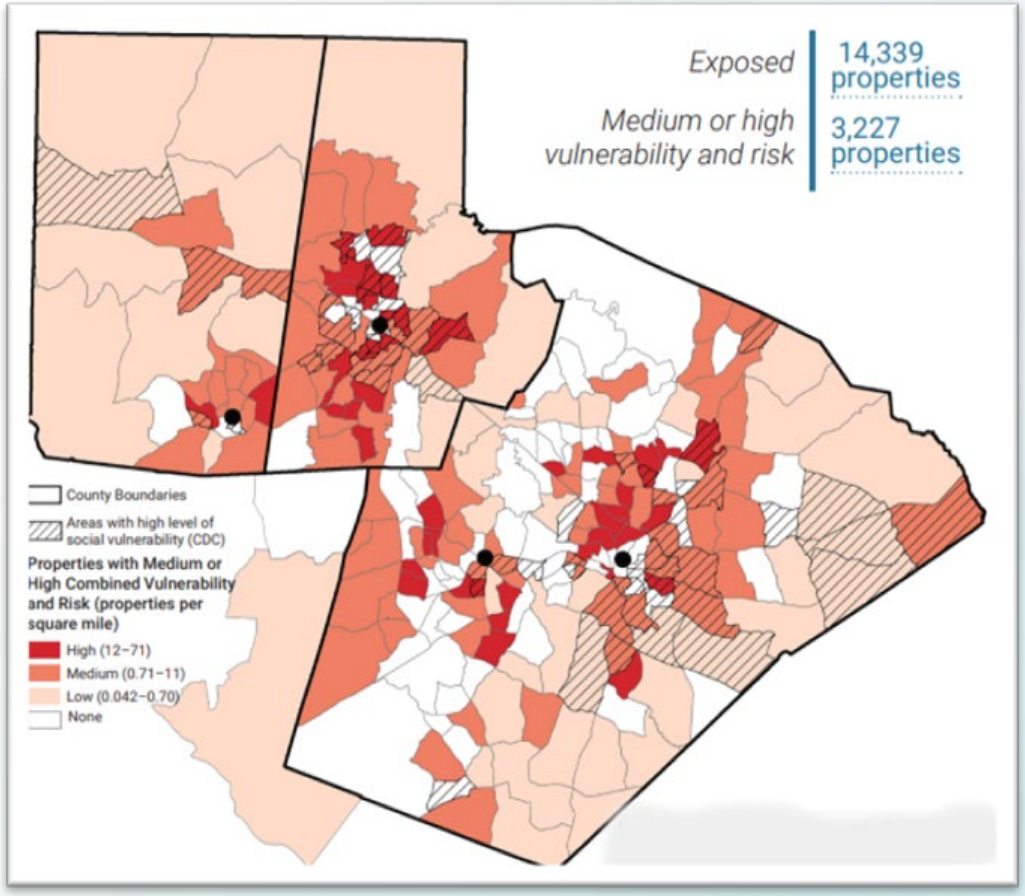




Image Sources: Agency Analytics, CQUniversity

# Example Visualizations – Maps and Photos




Sources: Boston Green Ribbon Commission, Triangle J Council of Government (TJCOG)



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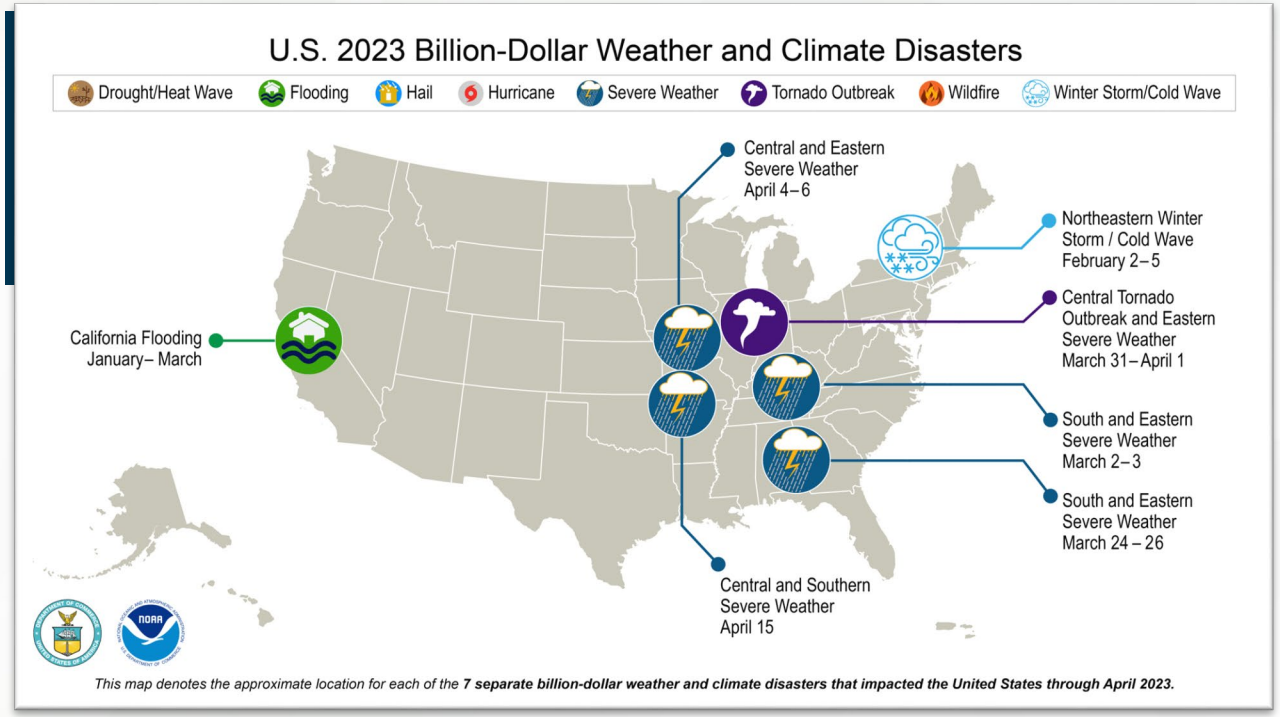
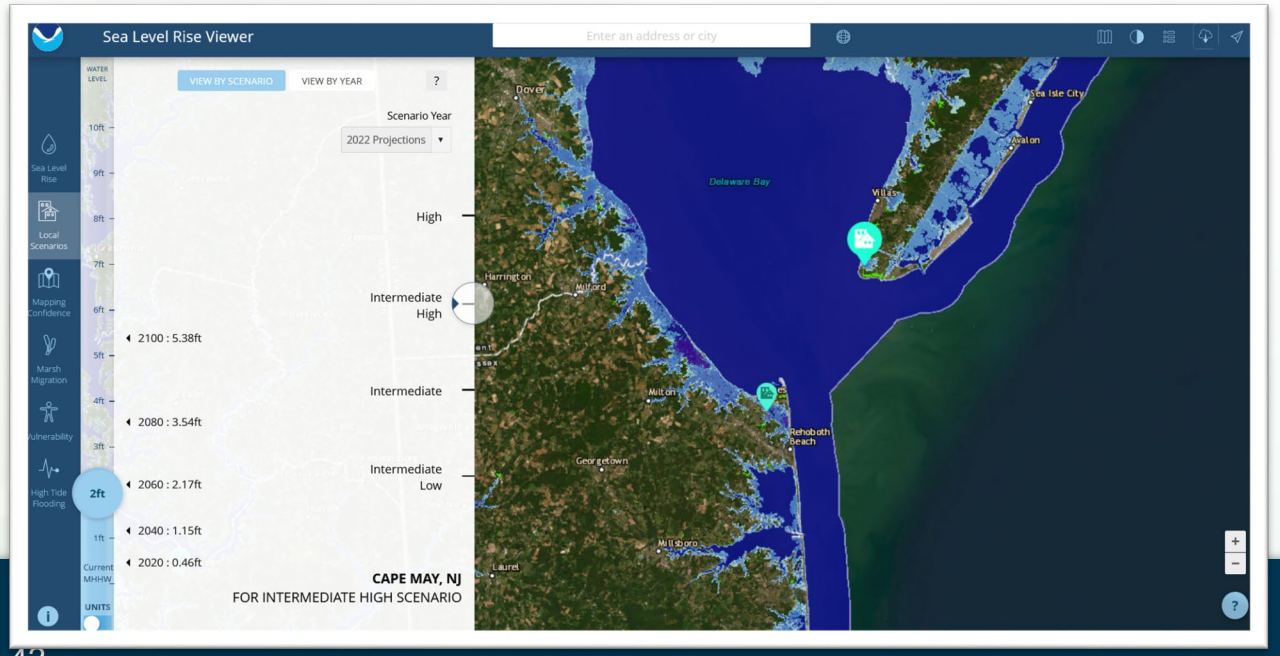
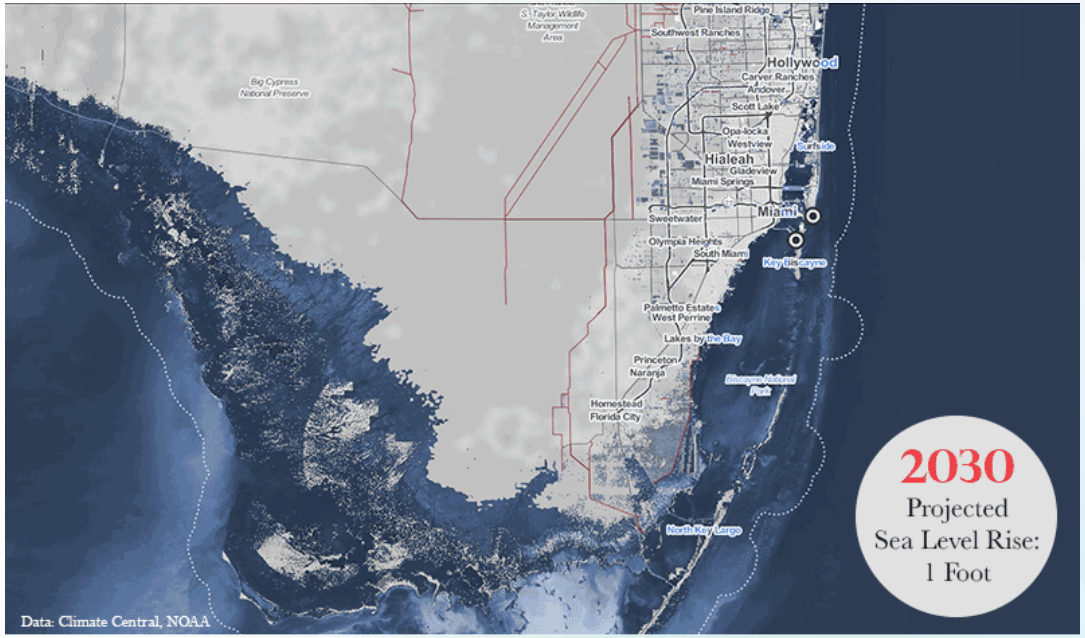
# Example Visualizations – Maps and Photos




Sources: NOAA, Climate Central



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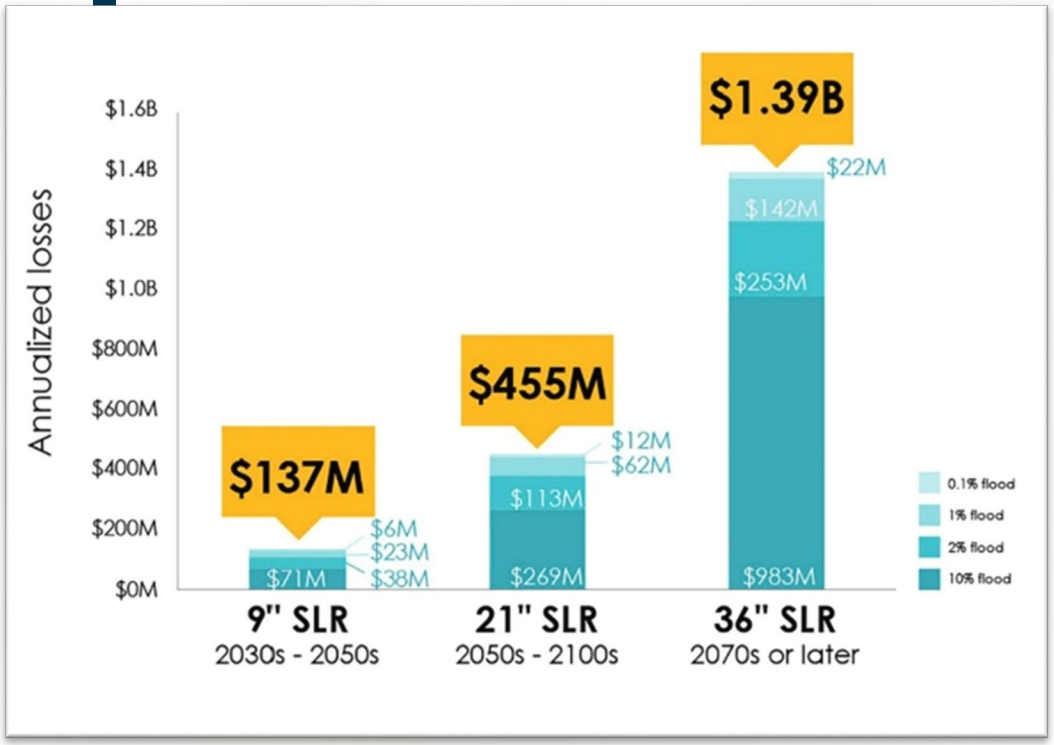
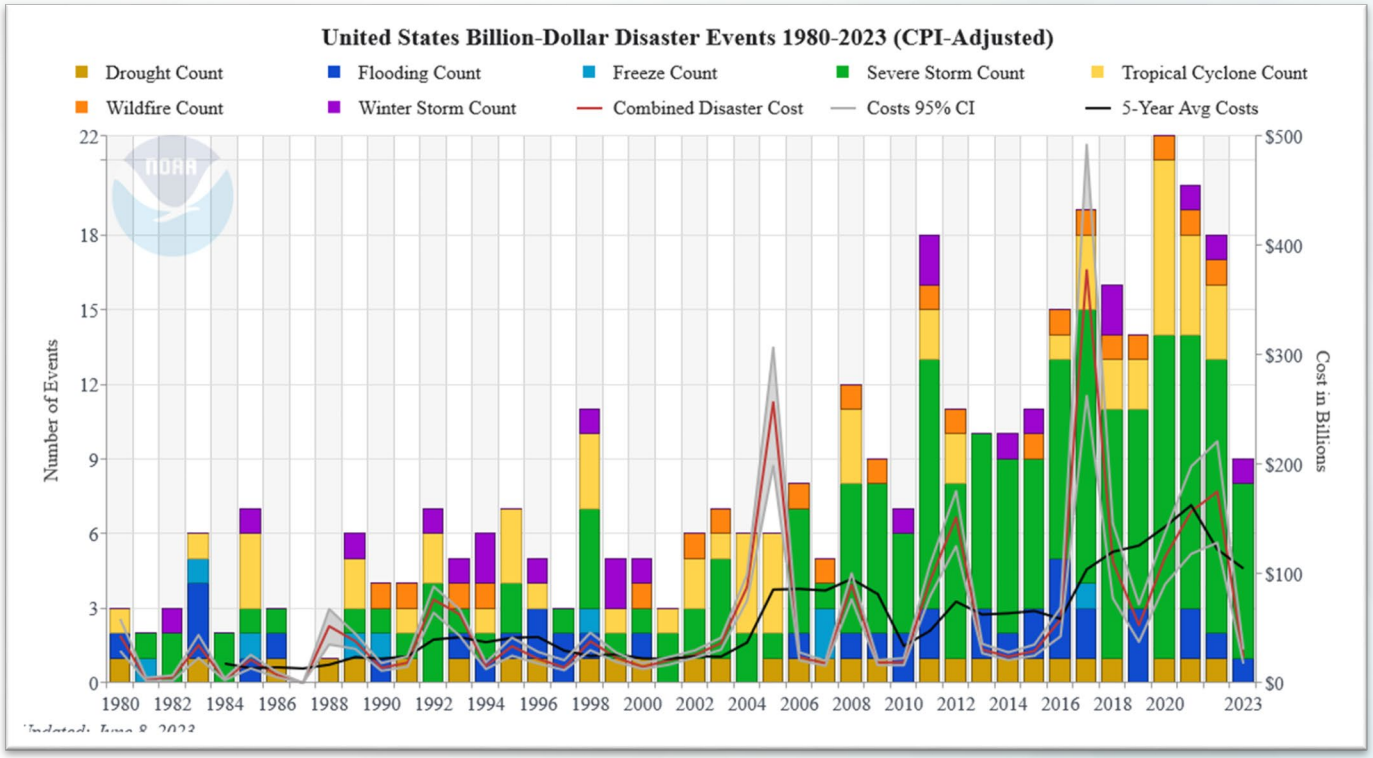
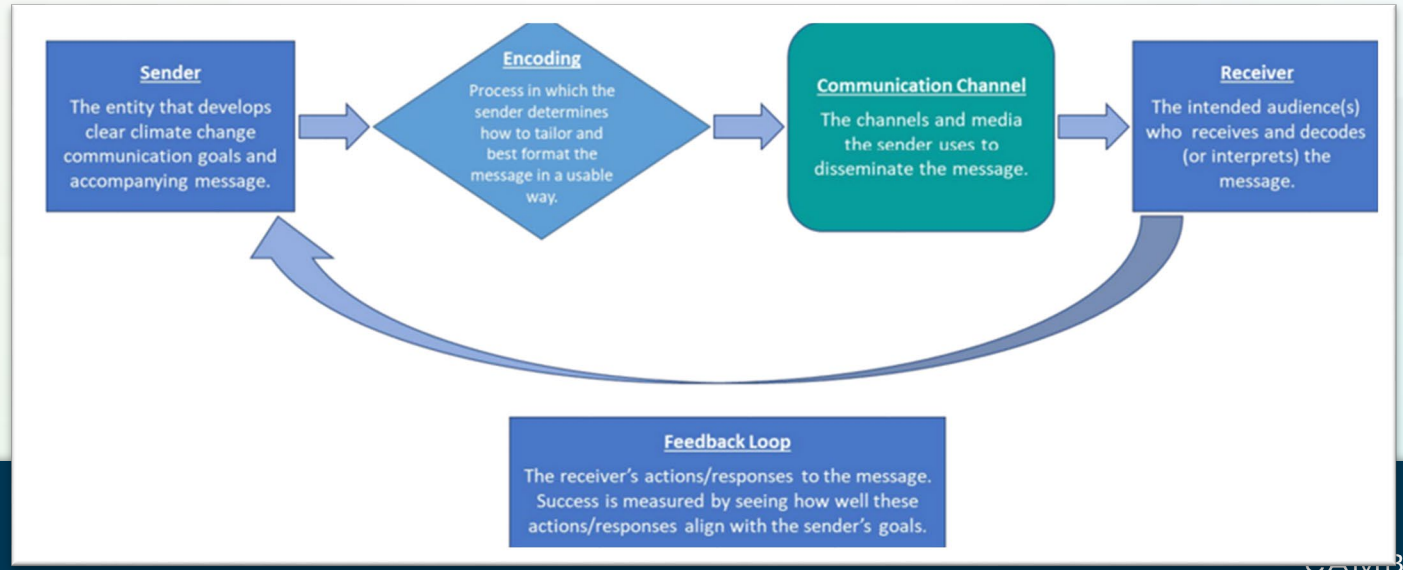
# Example Visualizations – Charts and Graphics



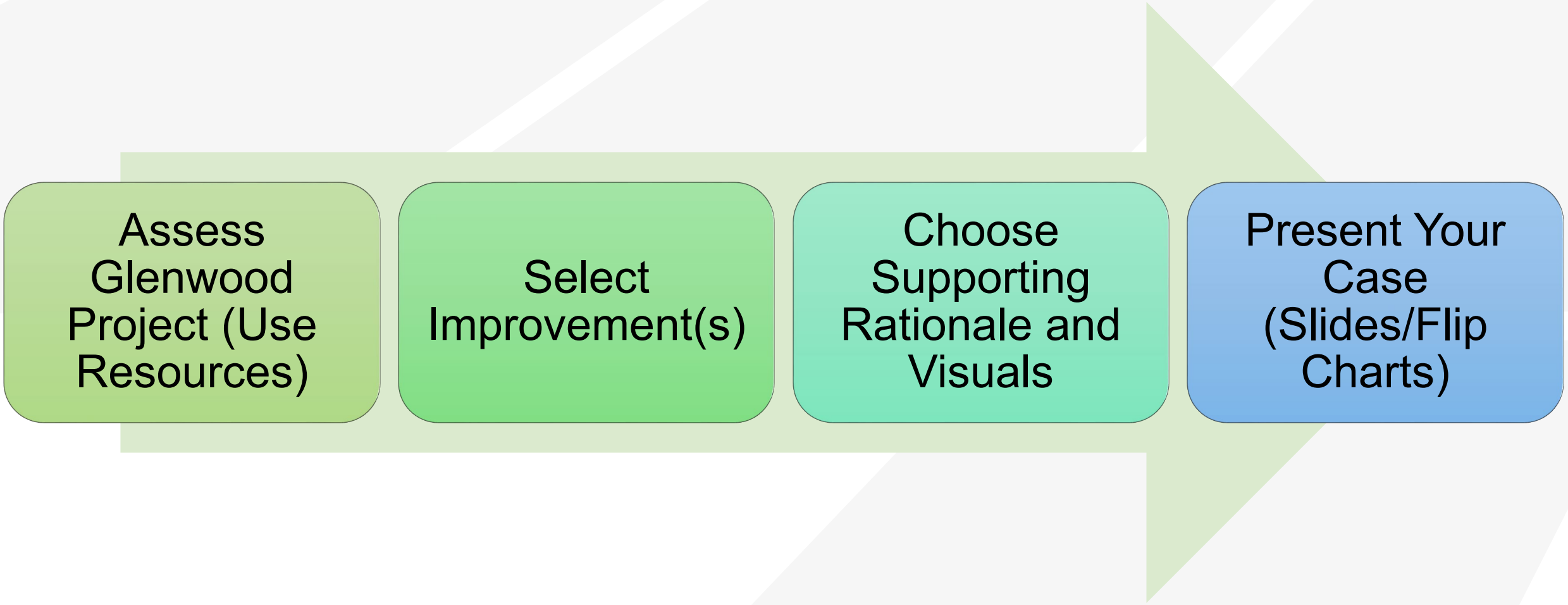



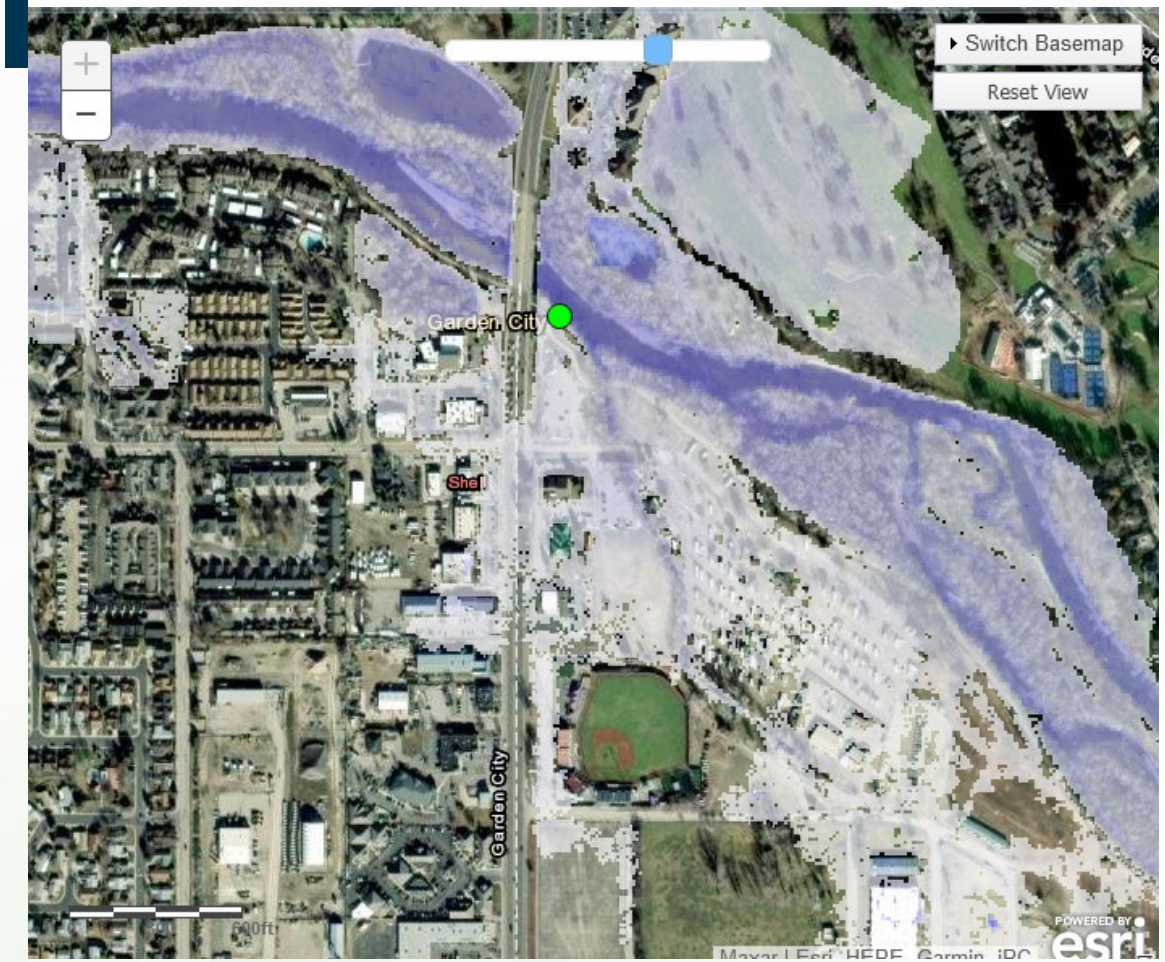

Sources: NOAA, Boston Green Ribbon Commission, Caltrans

# EXERCISE OVERVIEW

# Exercise Overview



# Glenwood Improvement Options




1. Flood Management and Channel Repair/Maintenance **- $1 Million**
2. Bridge Substructure Repair and Scour Countermeasures **- $1.5 Million**
3. Elevate and Rebuild Southern Approach Only **- $2 Million**
4. Elevate and Rebuild both Approaches **- $4 Million**
5. Elevate Bridge and Approaches **- $10 Million**

# Visualization & Business Case Competition!

## Business Case Development

- 3 top impactful points that make for a compelling business case for investing on this project
- What data that might support this business case?
- Identify gaps in information or knowledge
- Identify any available data sources to augment the Glenwood data

## Core Message / Visualizations

- Communicate core messages
- What other elements are important?
- What visualizations will ensure the biggest impact?
- What else would enhance the business case?

## Mentimeter Scoring Rubrik

1. Effectiveness of the Business Case
2. Use of Metrics and Data
3. Message Presentation (Visualization)

- 5 Excellent to 1 Poor

**15 Total Points Available**

# Asset Characterization – Criticality - Example

## Usage and Operational Importance

- Evacuation Routes / Lifelines (2)
- Functional Class (2)
- AADT (2)
- Freight Network (2)
- Northeast Corridor (1)
- Broadband Network (1)

## Socioeconomic Importance

- Equity Areas (4)
- Population Density (3)
- Employment Density (3)

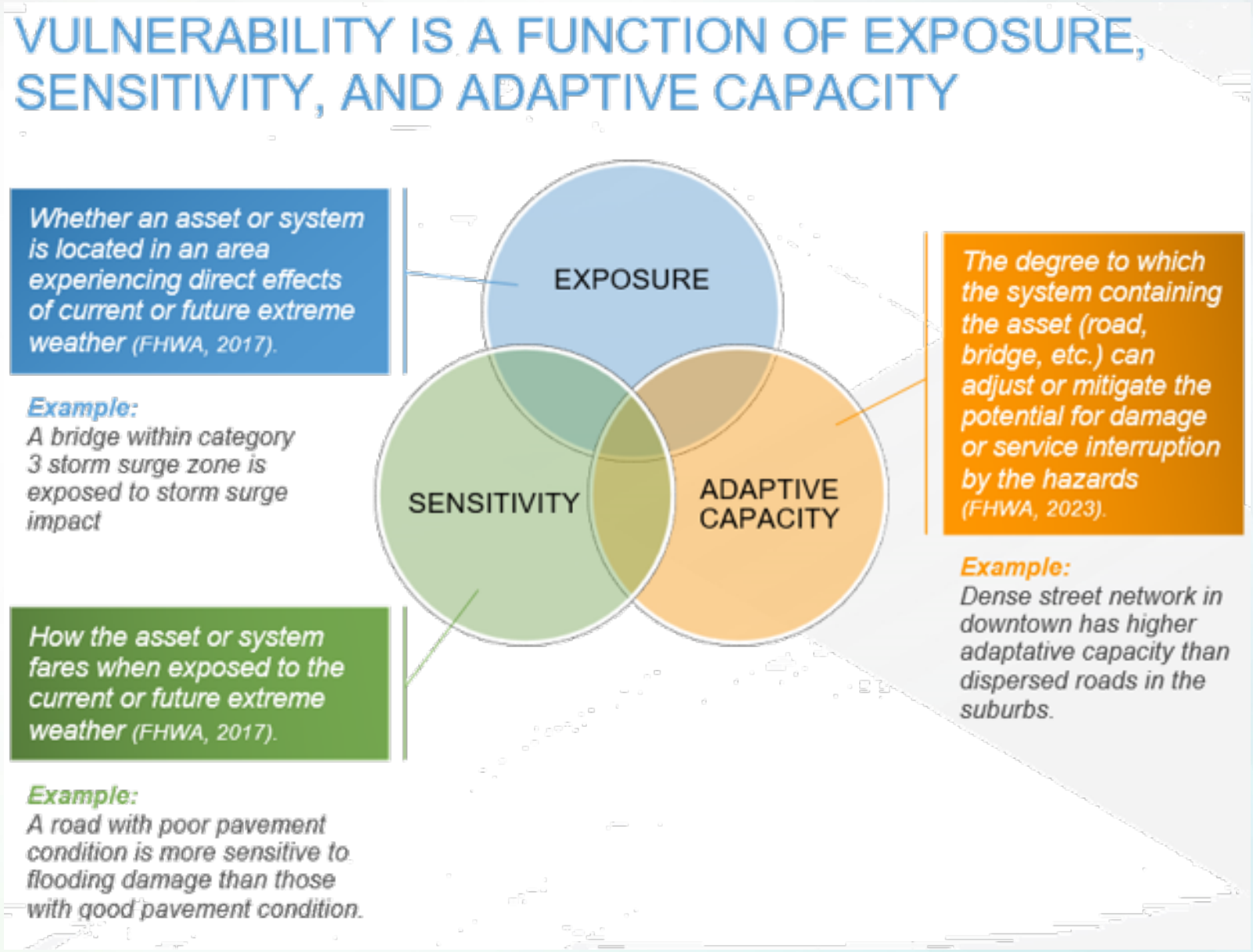
## Health and Safety Importance

- Access to Dam (1)
- Access to Fire or Police Stations (1)
- Access to Hospitals (1)
- Access to Schools (1)
- Access to Emergency Shelters (1)
- Access to Power plants (1)
- Access to Transit Centers (1)
- Access to Airport (1)
- Access to Seaports (1)
- Access to Maintenance Facilities(1)
- Access to Military Installations(1)

# Vulnerability

What is vulnerability

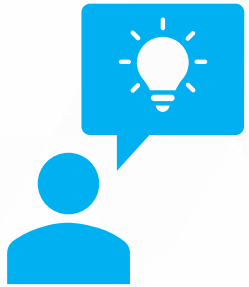
- The degree to which a system is **susceptible to, or unable to cope with**, adverse effects of climate change and extreme weather.



# WORKSHOP OBJECTIVES

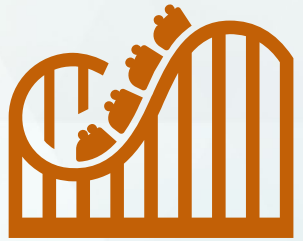
# Workshop Objectives

Applying Risk and Resilience Basics



Making the Business Case for Resilience

Communicating the Case



Have Fun!



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# Thank You!


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- Contact Information