CADMUS

Integrating Climate Risk Management into Operations and Practice

PAUL FAETH | PRINCIPAL

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

VANCOUVER, JULY 30, 2018

Climate Change Sensitivity Information

USDOT - Transportation Climate Change Sensitivity Matrix

Matrix (Excel format) provides the following information for each asset and climate stressor:

1. **Relationship:** qualitative description of the relationship between each climate stressor and each asset subtype;
2. **Thresholds:** any specific information about the threshold at which an asset subtype might be expected to begin experiencing damage;
3. **Indicators:** list of indicators that have been associated with increased sensitivity to that climate variable in the past, or could be associated with that climate variable in the future;
4. **Key Sources:** relevant sources of asset subtype information on design, maintenance, management, etc.; and
5. Additional Notes and Examples: **historical examples** of sensitivity of the asset subtype to that climate stressor and any additional information.

What climate risks are my assets sensitive to?

Sensitivity Matrix: Report Generation

Select the Asset Type(s) and Climate Stressor(s) of interest to generate a report on the sensitivity of the selected asset type(s) to the selected climate stressor(s). You can generate reports for either one asset type at a time or one climate stressor at a time.

Asset Type

- Airports and Heliports
- Bridges
- Oil and Gas Pipelines
- Ports and Waterways
- Rail
- Roads

Climate Stressor

- Increased Temperatures and Extreme Heat
- Precipitation-Driven Inland Flooding
- Sea Level Rise/Extreme High Tides
- Storm Surge
- Wind
- Drought
- Dust Storms
- Wildfires
- Winter Storms
- Changes in Freeze/Thaw
- Permafrost Thaw

Generate report for **one** asset type and **one or more** climate stressor(s):

Sensitivities of one Asset Type to different Climate Stressors

Generate report for **one or more** asset(s) and **one** climate stressor:

Sensitivities of different Asset Types to one Climate Stressor

Return to Table of Contents

Selection boxes not working?
A recent Microsoft security update has caused errors with this functionality for some users. Microsoft is aware of the issue and is working to resolve it. In the meantime, they have issued a workaround affected users can use to correct the issue and use the Report Generation feature. Alternatively, you can proceed to browse the Matrix using the tabs.

Please follow Microsoft's instructions for the workaround here: http://blogs.technet.com/b/the_microsoft_excel_support_team_blog/archive/2014/12/11/forms-controls-stop-working-after-december-2014-updates-.aspx

Return to Selection Page | See References | Export to PDF

Sensitivity of Transportation to Increased Temperatures and Extreme Heat

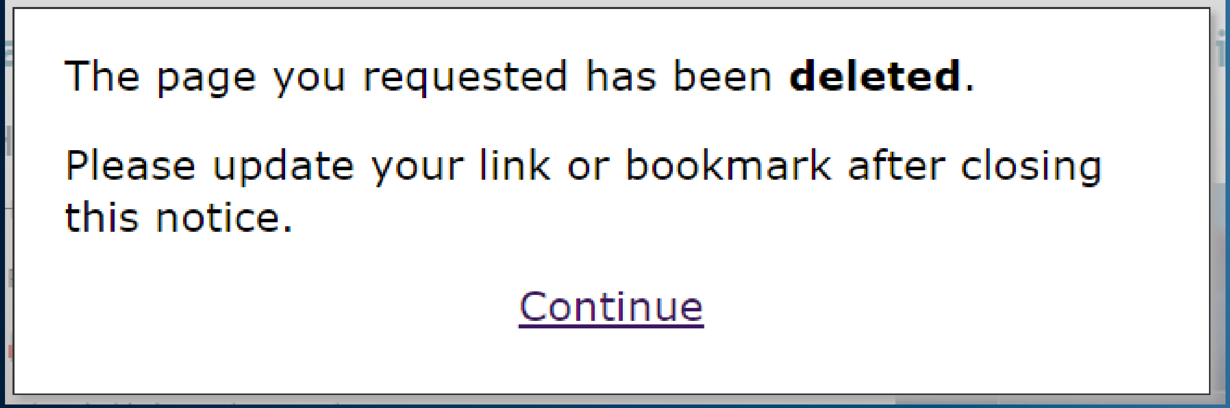
Asset Type: Roads

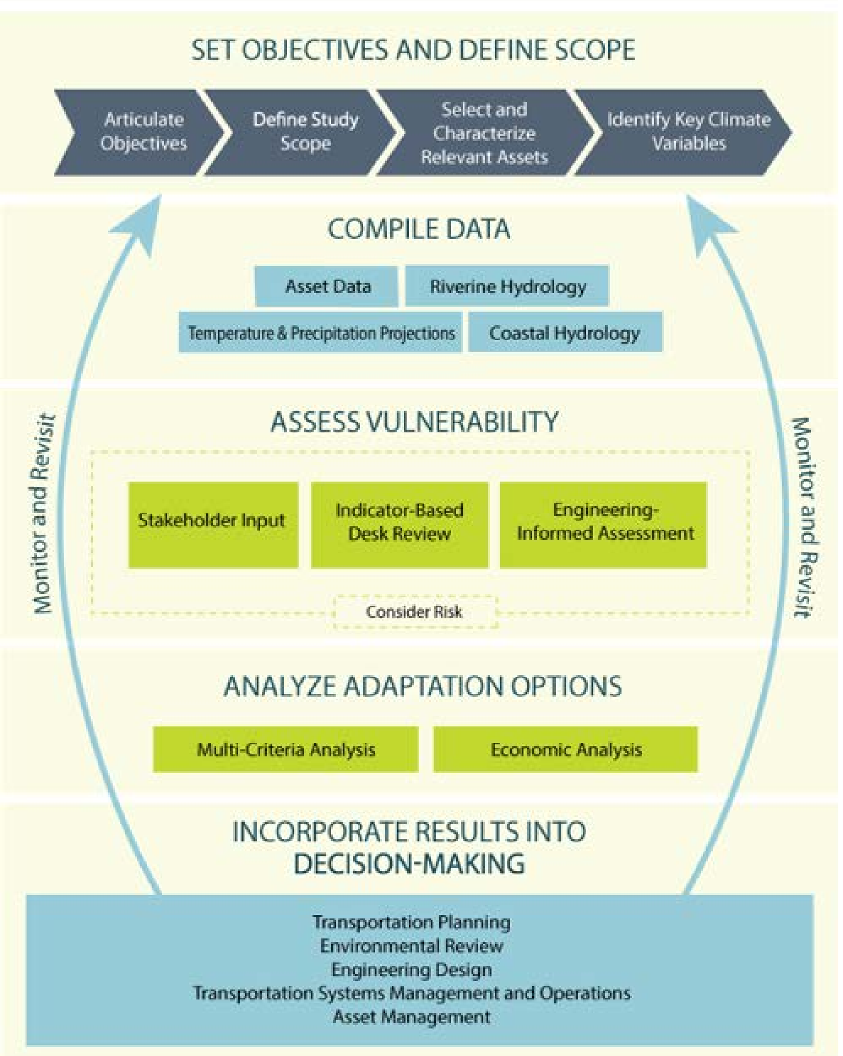
Climate Stressor	Information Type	Physical Infrastructure		
		Paved Roads (Surface and Subsurface)	Unpaved Roads	Stormwater Drainage (Culverts, Side Drains, etc.)
Increased Temperatures and Extreme Heat	Relationship	Sustained high temperatures can cause asphalt concrete pavement to soften resulting in rutting and shoving. Concrete pavement can heave at the joints. When high heat is accompanied by drought conditions, asphalt concrete pavement can crack making it more vulnerable to water when it does rain. Asphalt binder is designed to withstand temperatures up to a certain threshold. Incremental temperature increases up until that point are not likely to cause much damage (Heitzman, 2010).	No documented relationship.	No documented relationship.
	Threshold(s)	Thresholds vary depending on pavement design. Pavement binder may exhibit sensitivity beginning at 108°F, particularly if combined with truck traffic (Watson, 2010). In the Pg 64-22 grade, the number 64 stands for the average 7-day high pavement temperature (consecutive days) 20 mm below the surface. The relationship between that temperature and the ambient temperature is given by the following equation: T20mm = (Tair - 0.00618 lat2 + 0.2289 lat + 42.2) (0.9545) - 17.78 *Where* T is expressed in °C and the latitude is in degrees. Lat2 means latitude squared (Watson, 2010).	Not applicable.	Not applicable.
	Indicator(s)	Although aggregate is not sensitive to temperature, it can influence the sensitivity of the overall hot mix asphalt paving. For example, more angular aggregate may help to prevent rutting, which can result from high temperatures (Heitzman, 2010; Anderson et al., 2009).	Not applicable.	Not applicable.
	Key Source(s)	Heitzman, 2010; Watson, 2010; Anderson et al., 2009	Not applicable.	Not applicable.
	Additional Notes and Examples	Mobile County currently does not experience a lot of damage due to pavement softening. However, during extreme heat spells when the temperature can remain above 100°F, with relatively little cooling at night, the pavement can soften. Areas with high truck traffic (particularly areas where trucks stop) can experience shoving during heat spells (Mitchell, 2010). There was a recent hot spell in Birmingham where the temperature did not drop below 100°F even at night, and as a result a lot of the pavement softened and rutted, particularly in areas of high truck traffic. Damage was particularly bad in areas where trucks stopped, since the force of stopped "shoved" the soft pavement and caused damage (Mitchell, 2010). During a heat wave in July 2000, three lanes on Interstate 80 in the San Francisco Bay Area buckled due to thermal expansion, shutting down the freeway (Peterson et al., 2008).	Not applicable.	Not applicable.

Vulnerability Assessment

US DOT – FHWA

- Asset types covered in this tool are (1) rail, (2) ports and waterways, (3) airports and heliports, (4) oil and gas pipelines, (5) bridges, and (6) roads and highways.
- Climate stressors covered in this tool are (1) increased temperature and extreme heat, (2) precipitation-driven inland flooding, (3) sea level rise/extreme high tides, (4) storm surge, (5) wind, (6) drought, (7) dust storms, (8) wildfires, (9) winter storms, (10) changes in freeze/thaw, and (11) permafrost thaw.





CADMUS

Climate Risk Data

Downscaled Climate and Hydrology Projections

RECLAMATION NCAR USGS
Santa Clara University CIRES CLIMATE CENTRAL
SCRIPPS INSTITUTION OF OCEANOGRAPHY

- **CMIP** – Coupled Model Intercomparison Project
- **CMIP3 and CMIP5**

Purposes:

- assessment of potential climate change impacts on natural and social systems (e.g., watershed hydrology, ecosystems, water and energy demands).
- assessment of local to regional climate projection uncertainty.
- risk-based exploration of planning and policy responses framed by potential climate changes exemplified by these projections.

https://gdo-dcp.ucllnl.org/downscaled_cmip_projections/

U.S. DOT CMIP Climate Data Processing Tool
User's Guide

March 2016

CMIP5 Processing Tool

Directions

1. **Follow all steps in the User's Guide to request and save all data. Note that it is very important that all data have been saved in the correct folders.**

2. **Answer the following five questions about the data you downloaded.**

• Confirm that you have downloaded data from CMIP5. (If you downloaded data from CMIP3, use the CMIP3 version of the tool.)	CMIP5
• Describe the location you selected (only for your reference)	*<<Enter Location>>*
• How many climate models did you select? (i.e., how many boxes did you check in Step 2.6?)	1
• How many grid cells did you download?	1
• Describe the emissions scenario(s) you chose (only for your reference)	*<<Scenario>>*

3. **Set your output preferences**

Time Periods

Baseline time period (must end by 1999) (e.g., 1950-1999):	Start:	
	End	
Future time period 1:	Name:	*<<e.g., mid-century>>*
	Start:	
	End:	
Future time period 2:	Name:	*<<e.g., end of century>>*
	Start:	
	End:	

Output Variables

What types of output variables do you want to generate?

If you are only interested in precipitation-related outputs, for example, uncheck the "Temperature Variables" box. This will save processing time.

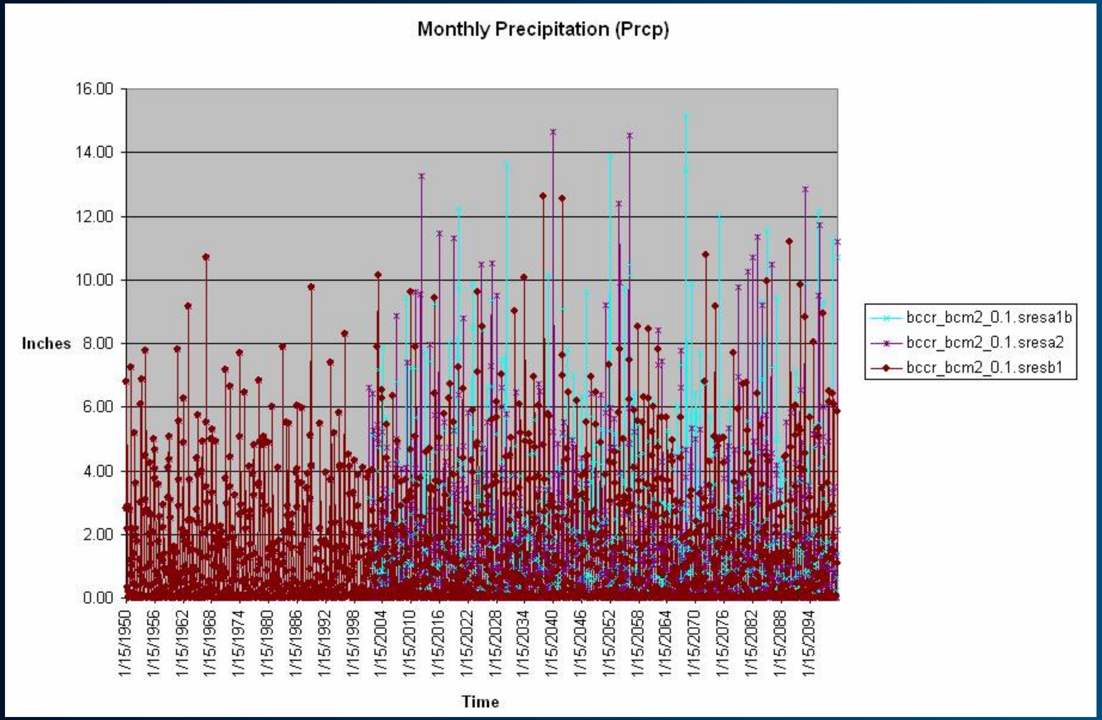
☐ Temperature Variables

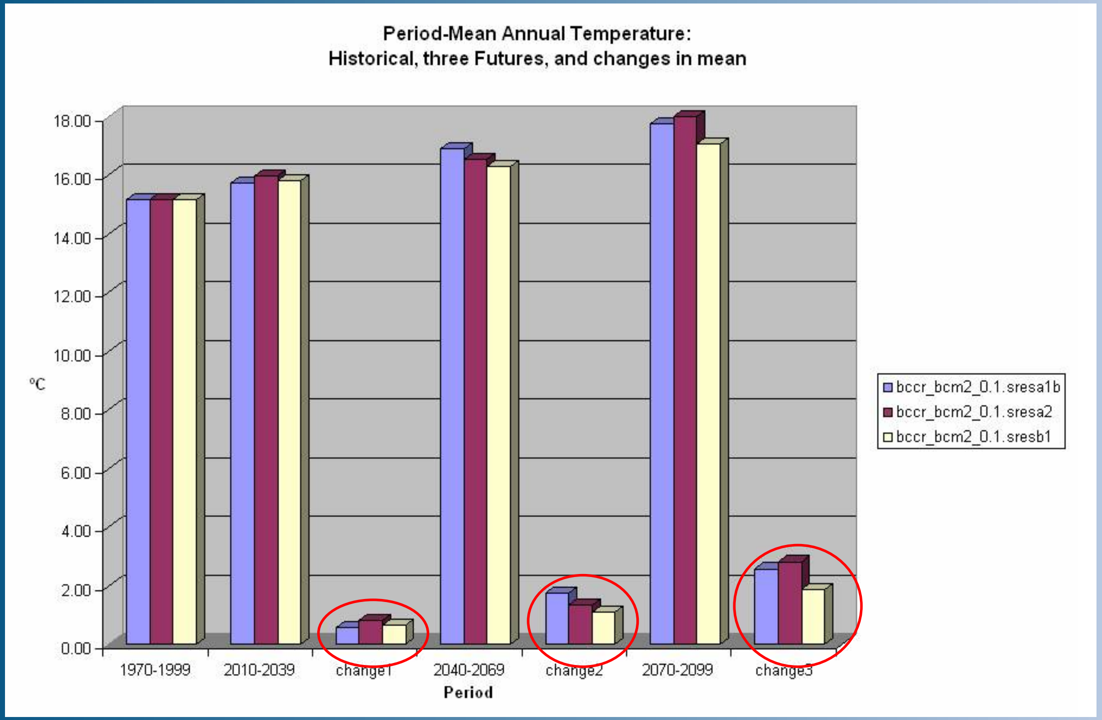
☐ Precipitation Variables

Climate Risk Data

Downscaled Climate and Hydrology Projections

RECLAMATION NCAR USGS
Santa Clara University CIRES CLIMATE CENTRAL
SCRIPPS INSTITUTION OF OCEANOGRAPHY

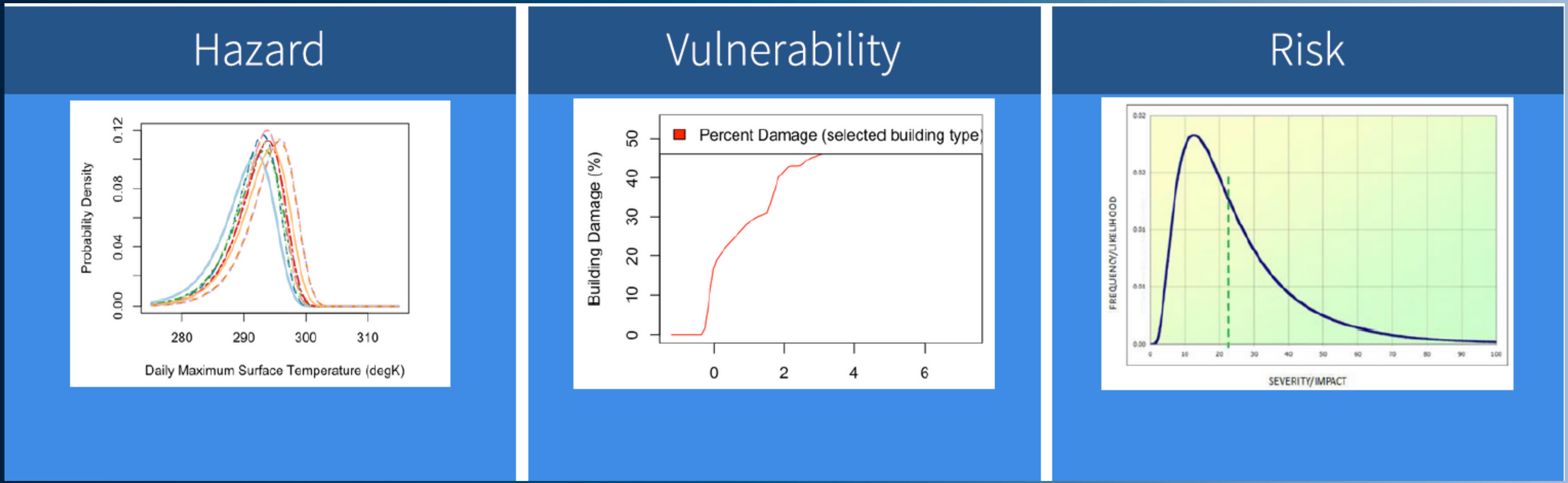




CADMUS

Climate Risk Screening

The Climate Service

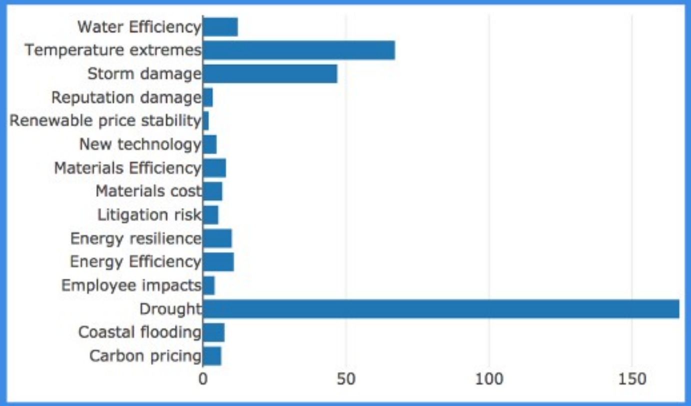


- **Scenario analysis**.
- **Materiality & disclosure.**
- The screening analysis gives a report of top climate-related risks:
- **By location and By time period**.

CADMUS

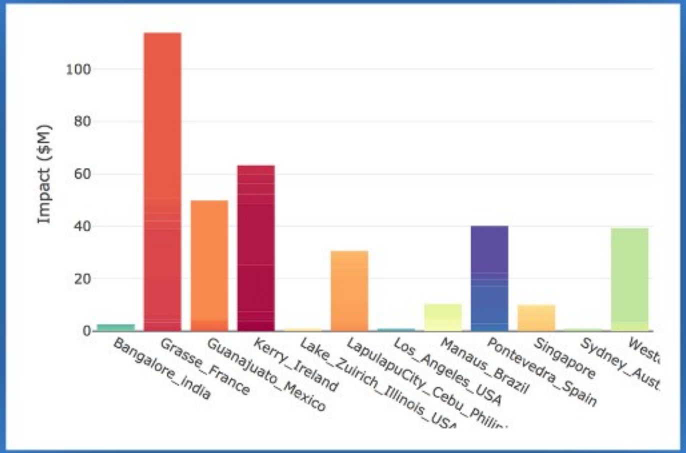
Climate Risk Screening Summary Example

Based on selected locations, climate models, and damage functions from The Climate Service



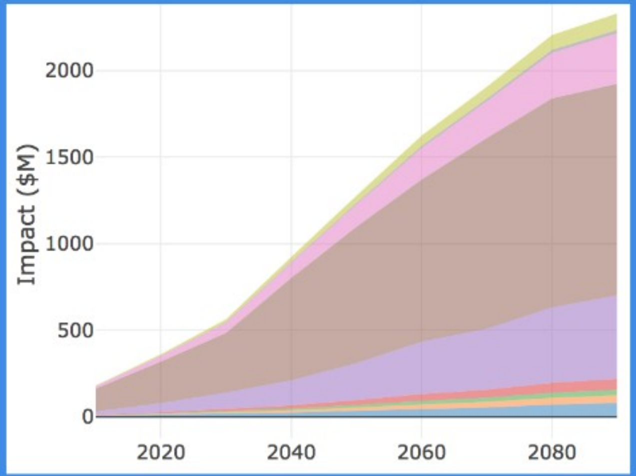
Top Risk Factors

1. Drought
2. Temperature extremes
3. Storms & coastal flooding



Top Risk Locations

1. Grasse, France
2. Kerry, Ireland
3. Guanajuato, Mexico



Risk Timing

1. Climate risk is already significant
2. Risk doubled since 2010
3. Nearly triples again by 2040

Vulnerability & Adaptation Exercises

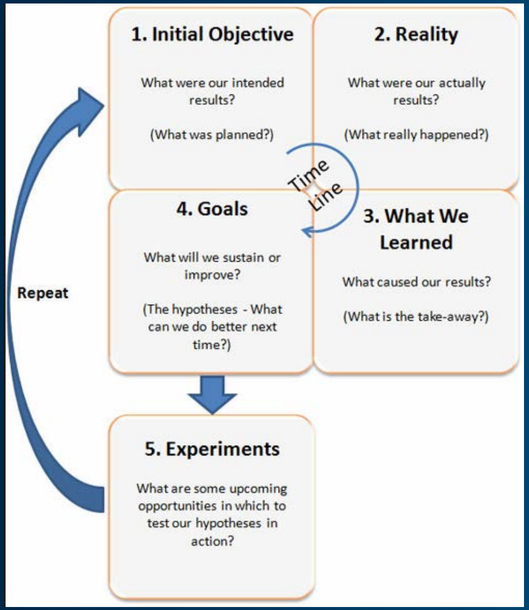
FEMA - *National Exercise Division (NED)*

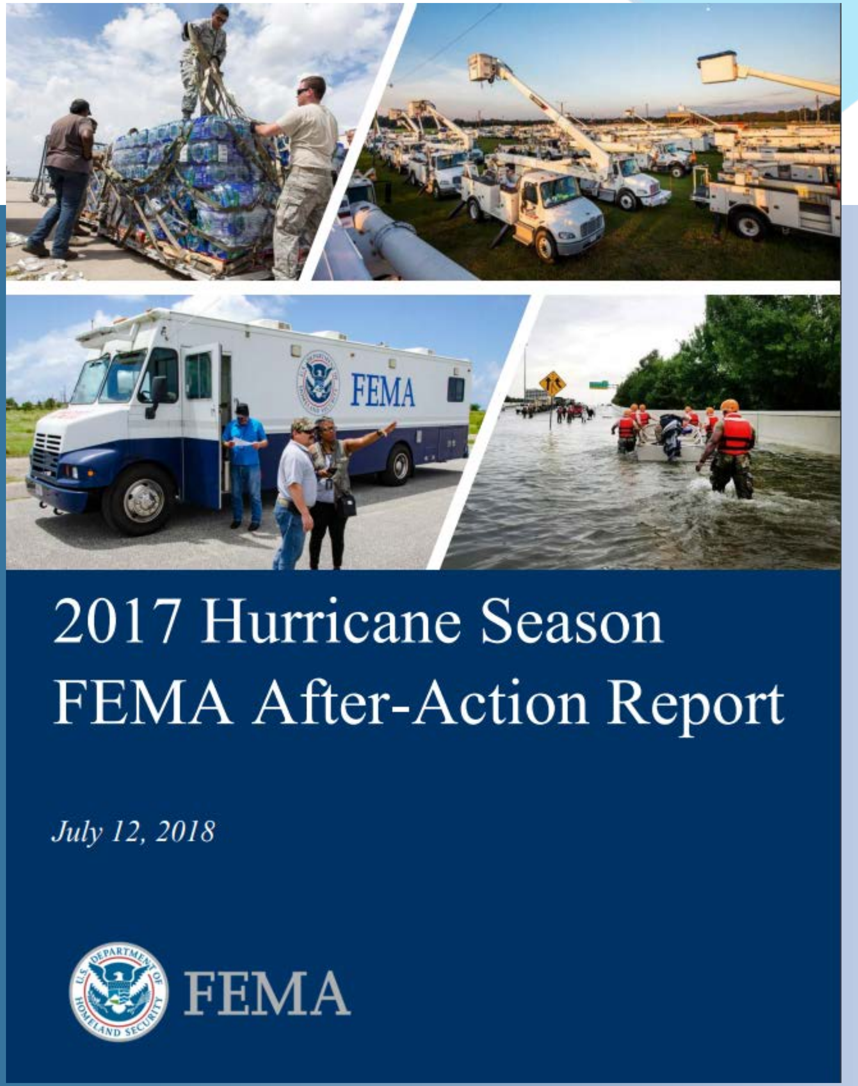
- Trained exercise planners include **regional climate change considerations** and **stakeholders** into emergency management **exercises** and **hazard mitigation** activities
- **Pioneered collaboration** between **climate adaptation experts** and **emergency management stakeholders**
- Training **curriculum** materials and engagement **activities**
  1. Regional **case studies** and **local guest speakers**
  2. **Table top exercises** based on local climate-related hazards
  3. **Resource guide** with training concepts, template exercise materials, and additional resources

CADMUS

After Action Reviews

- An **after action review** (AAR) is a structured **review** or de-brief (debriefing) process for analyzing what happened, why it happened, and how it can be done better by the participants and those responsible for the project or event.





CADMUS