Extreme Weather Vulnerability and Resiliency of Transportation Infrastructure

SPC Activities

PA APA Conference
October 23, 2017
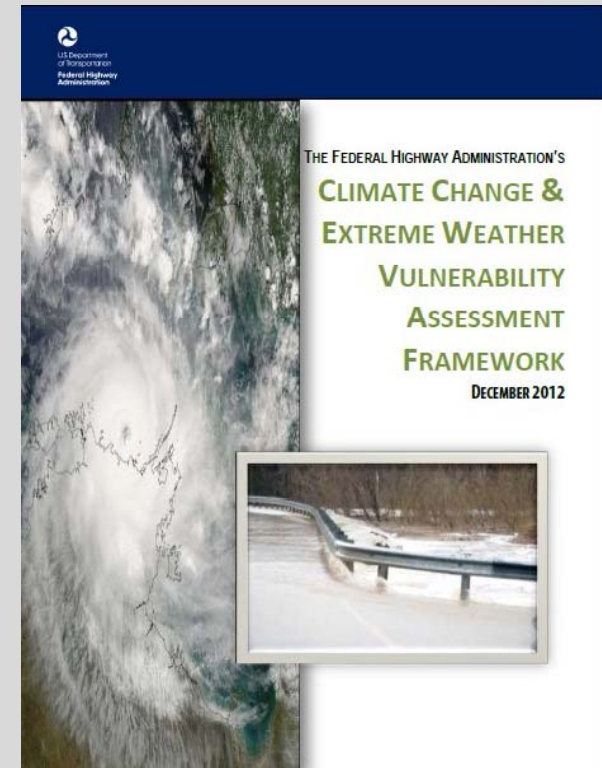Ryan Gordon
Planner, Southwestern PA Commission

# Why Study Extreme Weather Impacts and Resiliency?

Bullskin Twp. Fayette County

THE FEDERAL HIGHWAY ADMINISTRATION'S
CLIMATE CHANGE & EXTREME WEATHER VULNERABILITY ASSESSMENT FRAMEWORK
DECEMBER 2012

Emergency Funds Obligated:
$140 million spent on Federal Aid System since 2006

Resiliency Emphasis at State Level

APRIL 2017

PHASE 1

PENNDOT EXTREME WEATHER VULNERABILITY STUDY

STUDY REPORT

Michael Baker INTERNATIONAL
pennsylvania DEPARTMENT OF TRANSPORTATION

PennDOT Statewide Extreme Weather Study

– SPC Participation on steering committee

- Contributed to on the scope development and contents
- Includes a toolbox of methods and strategies for improving resilience
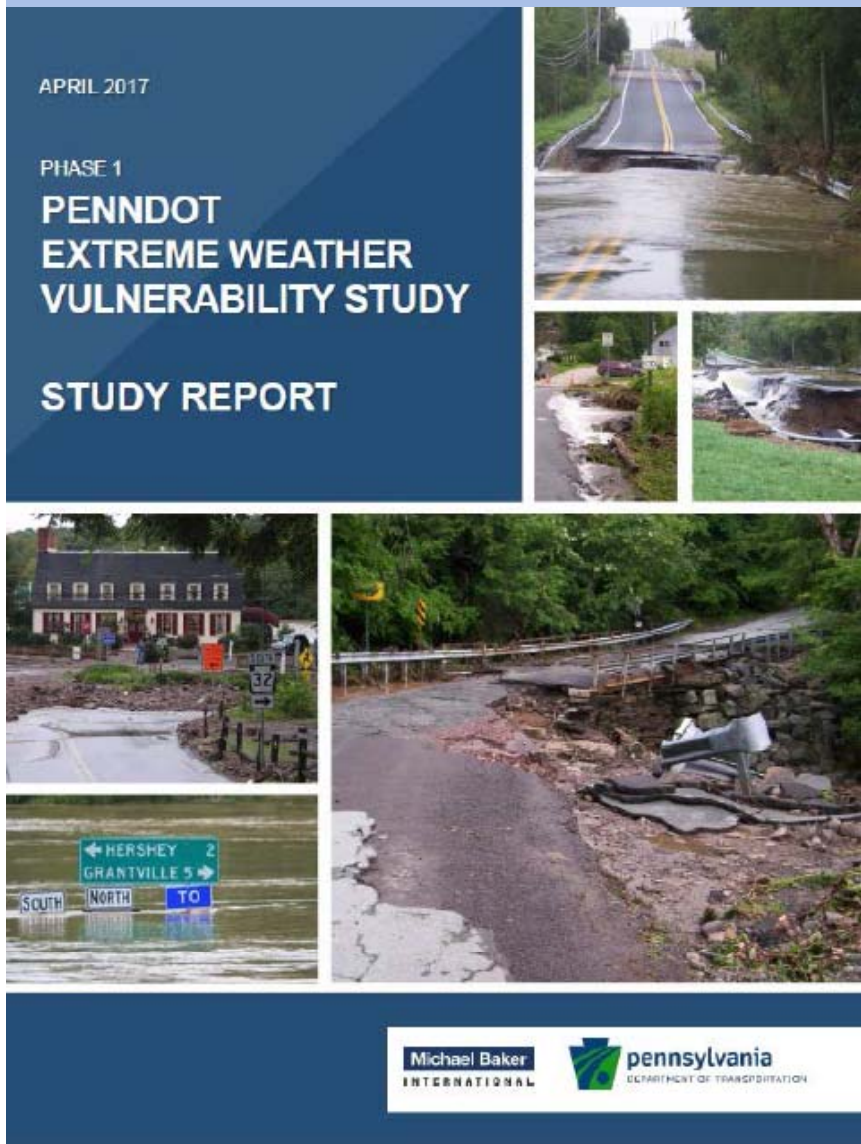
Extreme Precipitation is becoming more Frequent

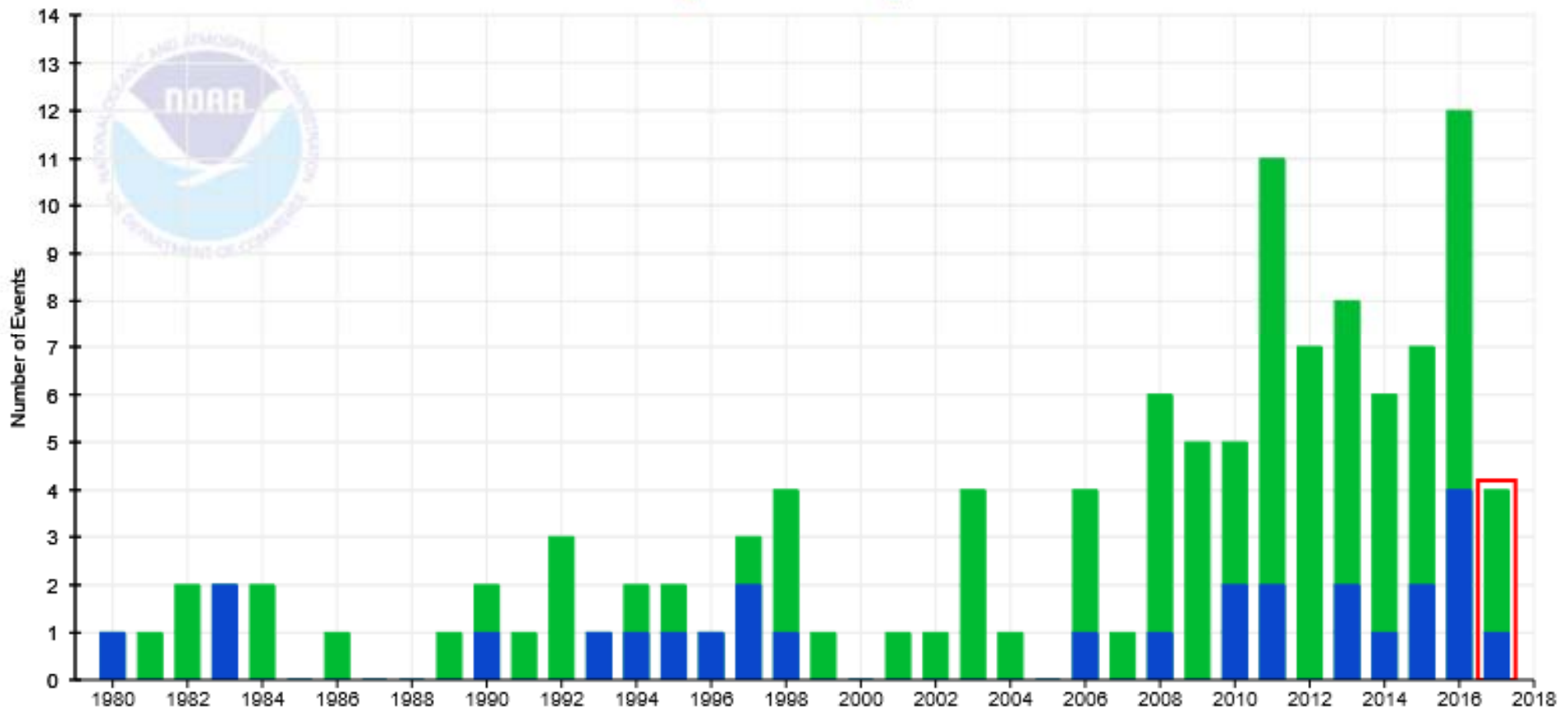Significant increases in extreme precipitation in PA and the Northeast
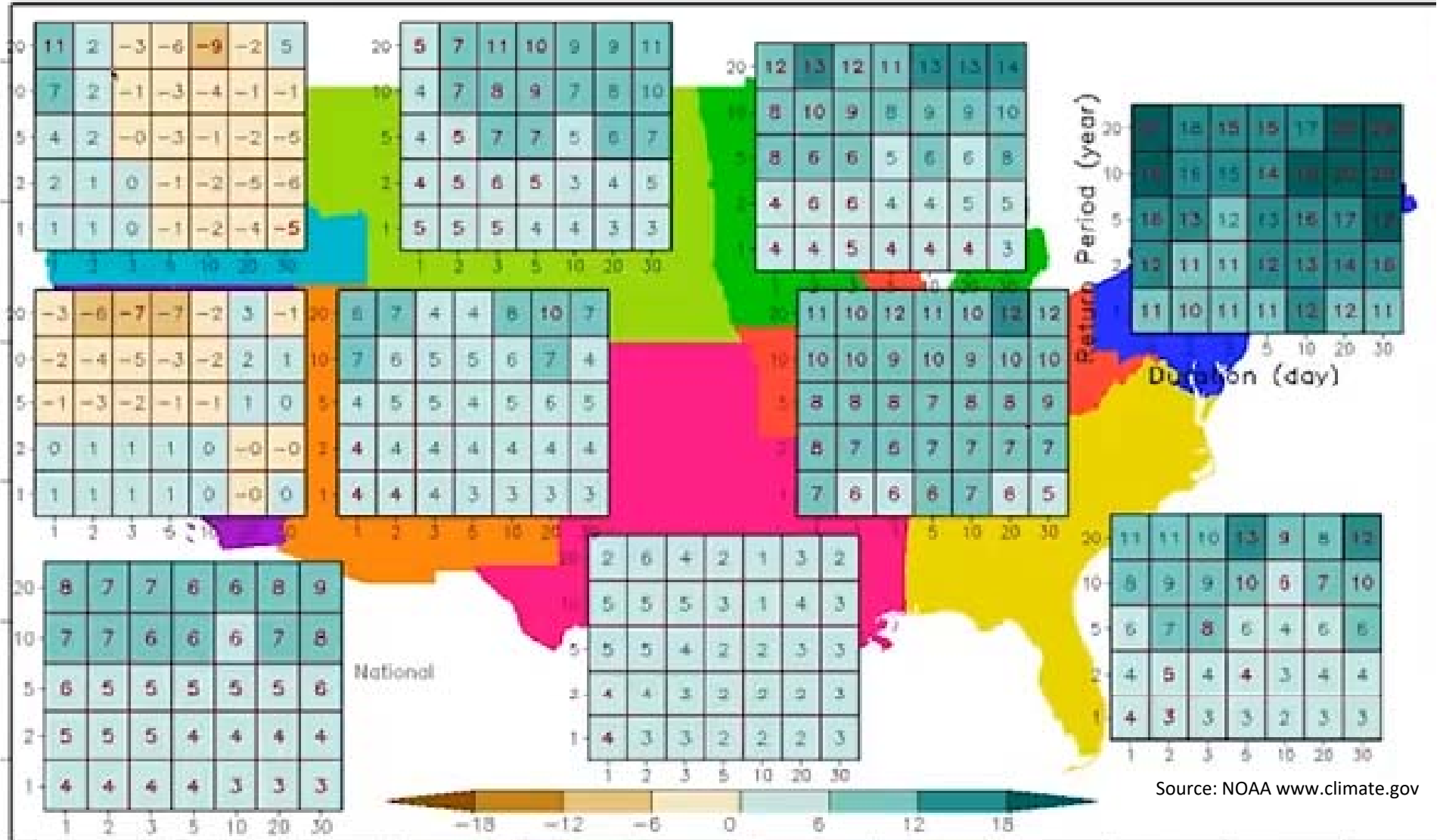
Source: NOAA www.climate.gov
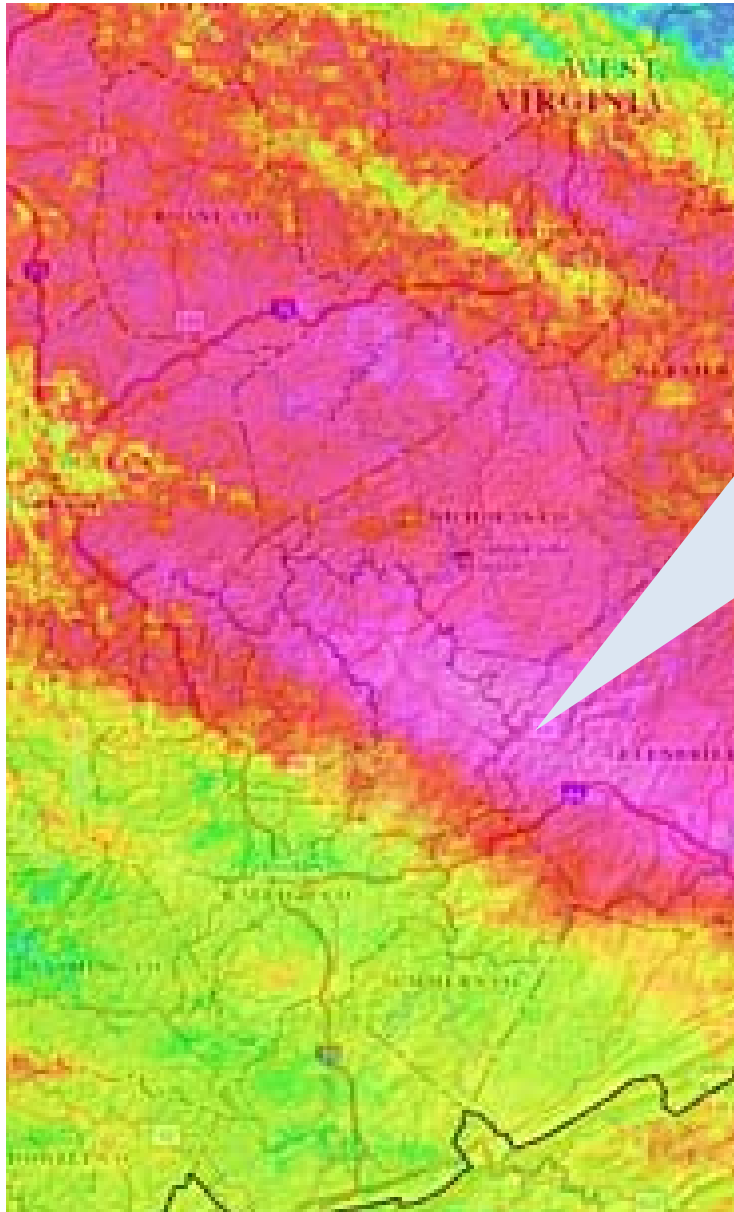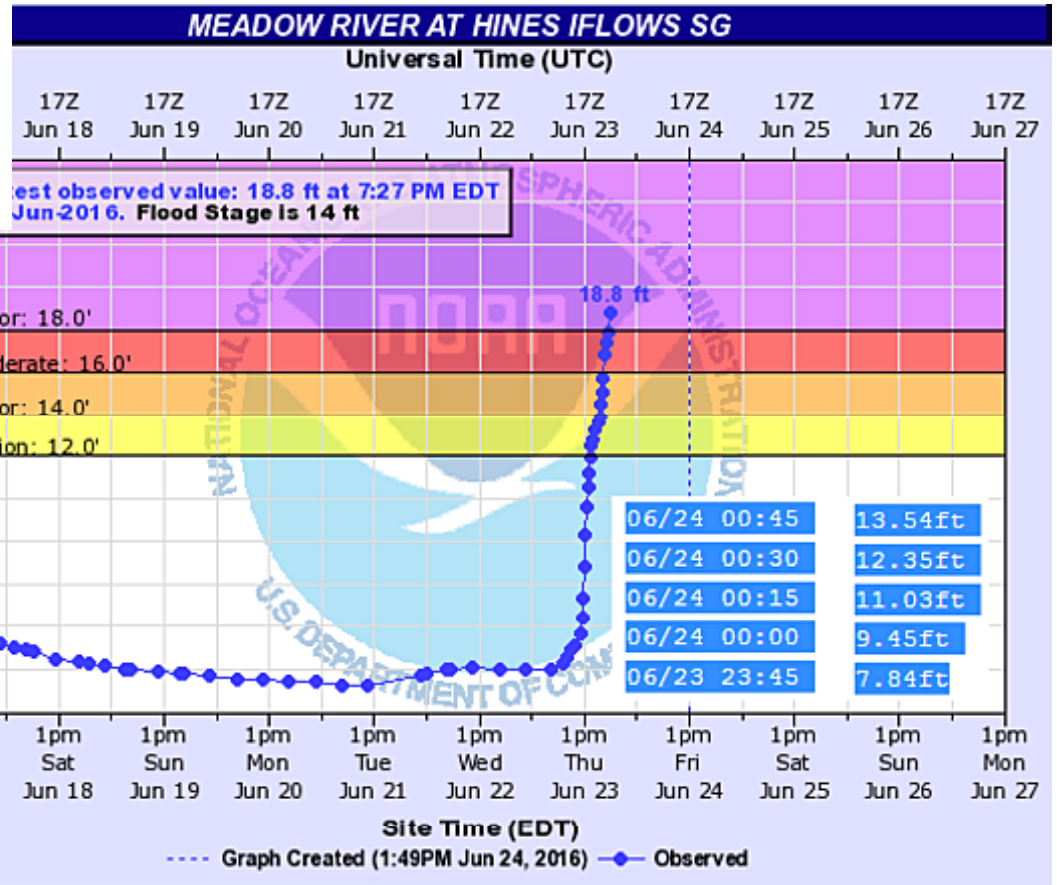
Extreme Weather is Becoming More Costly

Billion-Dollar Disaster Event Types by Year (CPI-Adjusted)

NOAA National Centers for Environmental Information (NCEI)(2016). https://www.ncdc.noaa.gov/billions/

Extreme Precipitation...
It happens!

MEADOW RIVER AT HINES IFLOWS SG

Highest observed value: 18.8 ft at 7:27 PM EDT Jun-2016. Flood Stage is 14 ft

Time	Stage
06/24 00:45	13.54ft
06/24 00:30	12.35ft
06/24 00:15	11.03ft
06/24 00:00	9.45ft
06/23 23:45	7.84ft

June 23, 2016 White Sulphur Springs, WV observed 8.29 inches in 24 hours !

Pilot Study Analysis Tools

- FEMA Hazus-MH 2.2 Flood Model
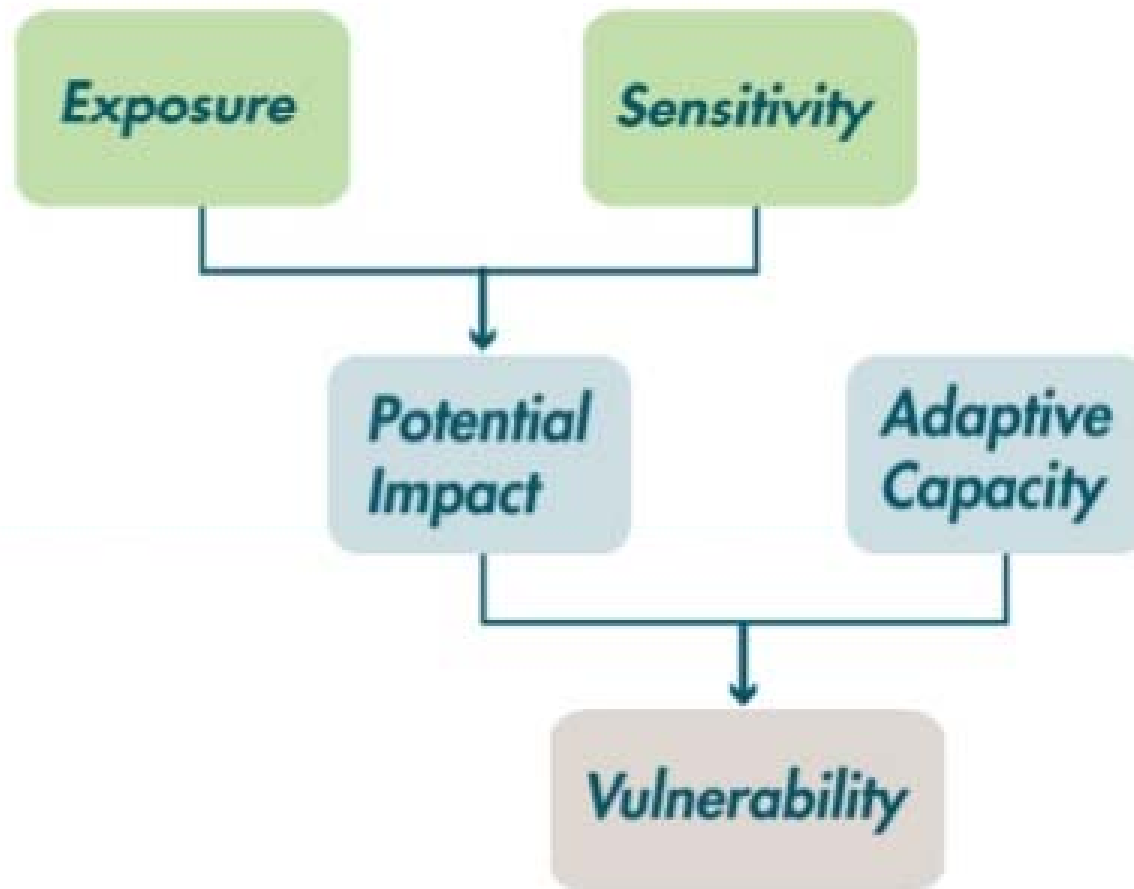
- ArcMap Spatial Analyst

- FHWA CMIP (Coupled Model Inter-comparison Project) Climate Data Processing Tool

- FHWA's VAST (Vulnerability Assessment Scoring Tool)

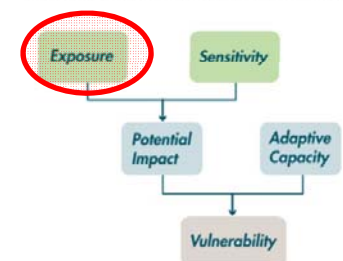# Assessing Extreme Weather Vulnerability

Glick et al. 2011

Redstone Creek Watershed
Transportation Infrastructure Exposure
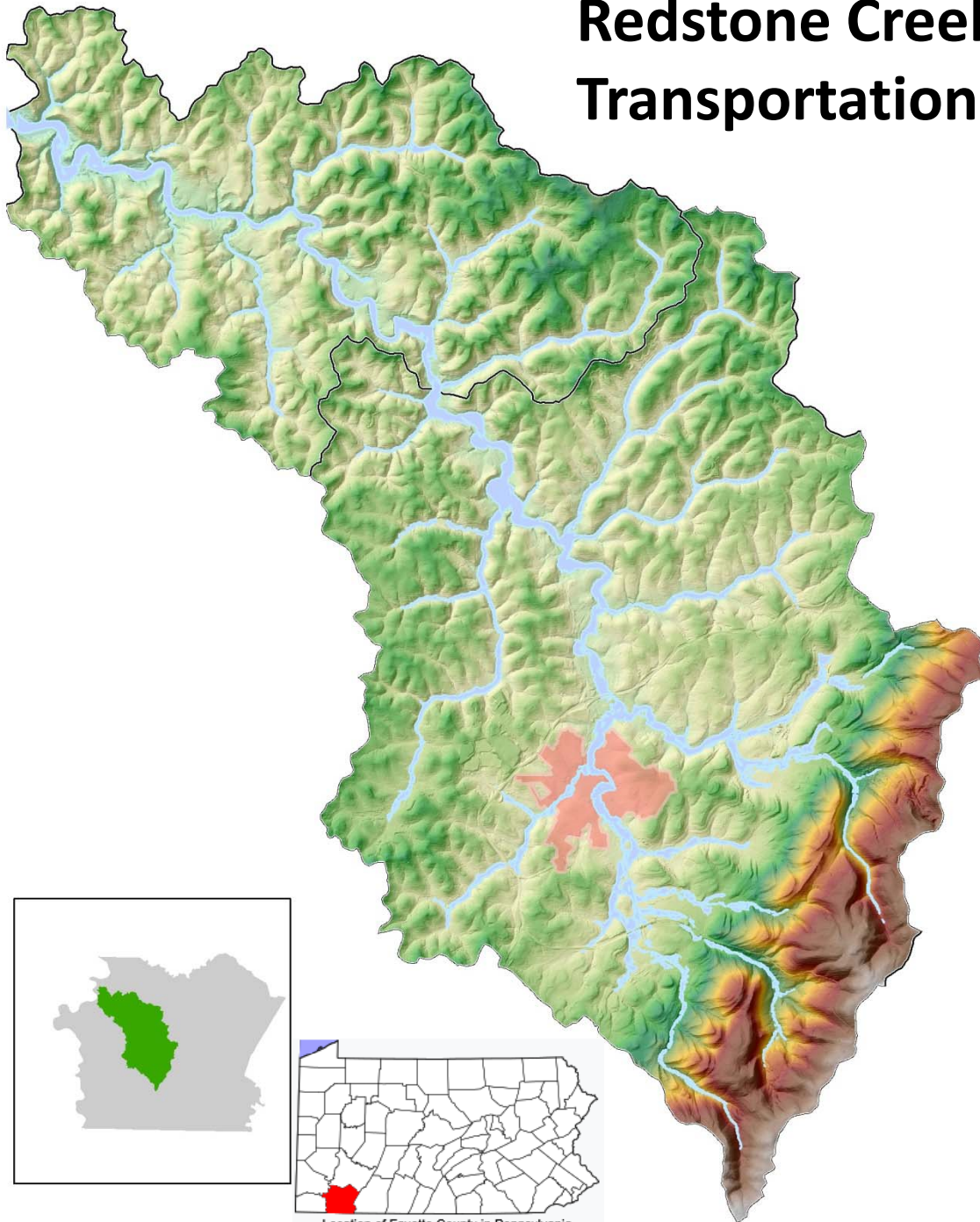
Exposure Analysis Results

- 105 Bridges over water >20ft length
- 14 miles of State Roads
- 4.5 miles of active rail lines
- 5 bus stops
- 7.5 miles of Bus Route
- Park n Ride lots
- Numerous Freight Facilities

Location of Fayette County in Pennsylvania

Assessing Climate Change Vulnerability

Exposure   Sensitivity

Potential Impact   Adaptive Capacity

Vulnerability

Exposure to various assets
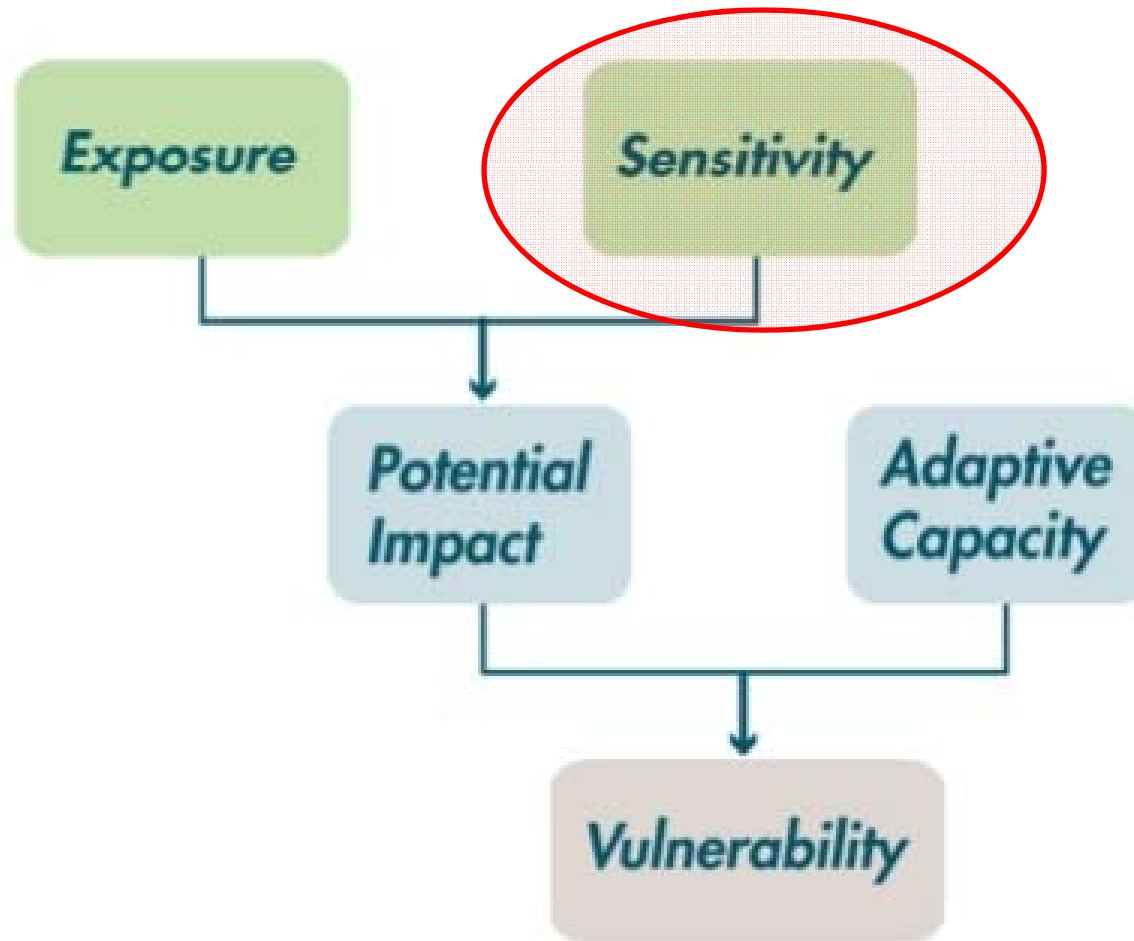
Transit Routes and Stops

Local Bridge

Freight Facility

State Roadway

State Bridge

Railroad

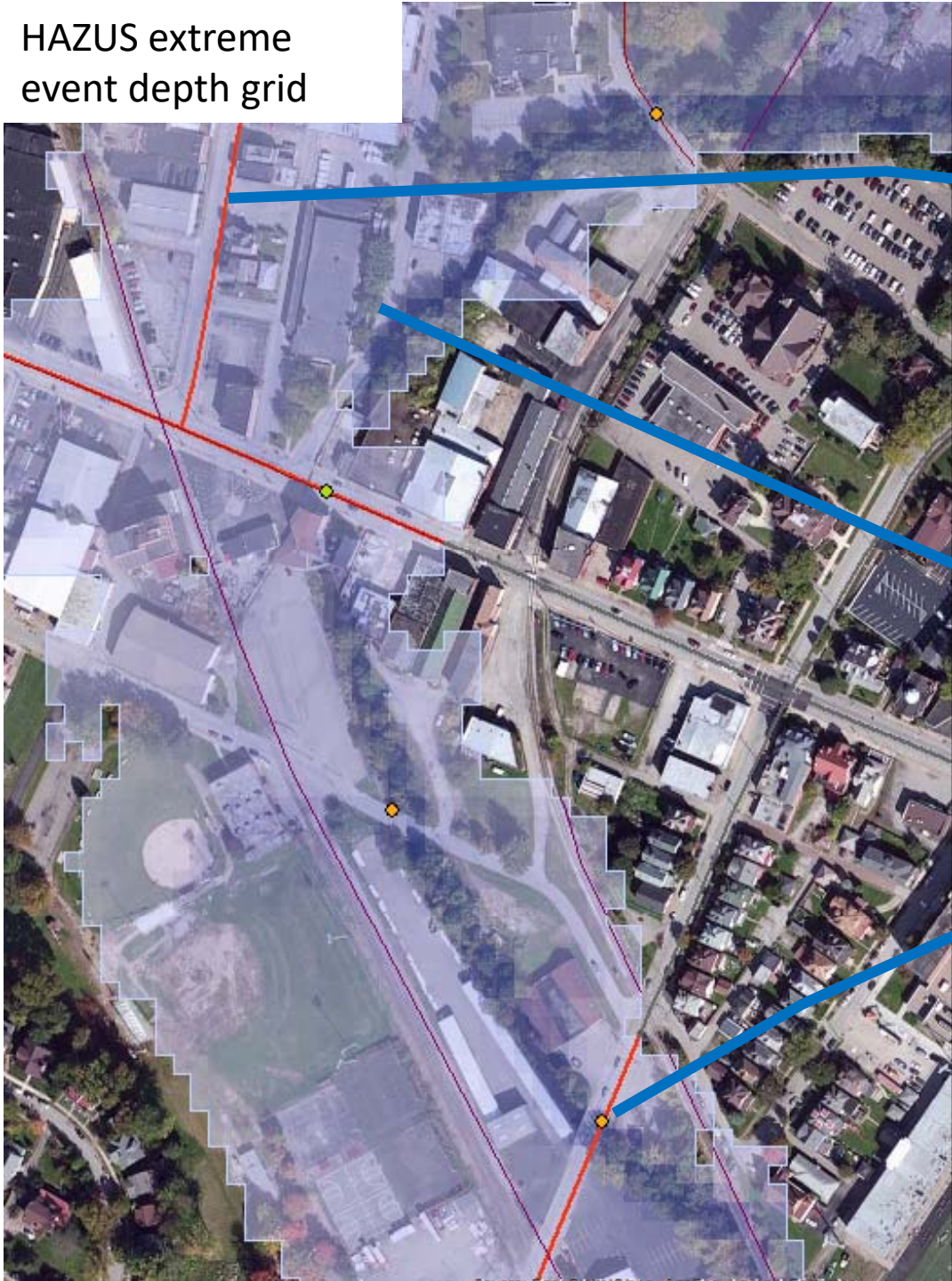# Assessing Extreme Weather Vulnerability

Glick et al. 2011

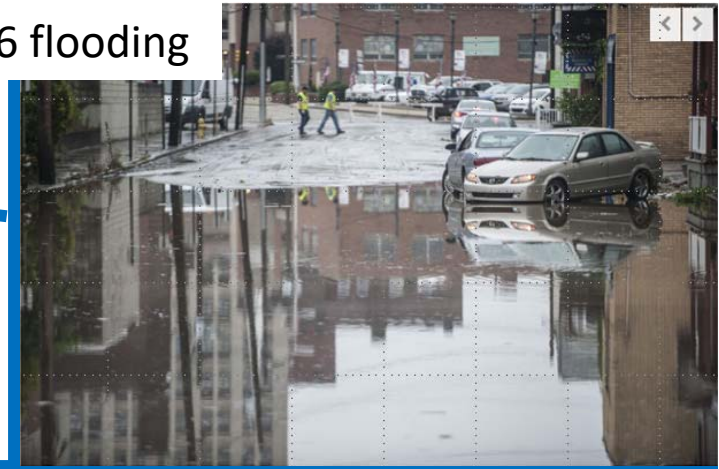# Indicators of Bridge Sensitivity to Heavy - Extreme Precipitation

- Location relative to flood boundary
- Bridge Age
- Experienced flooding in past
- Scour Rating
- Substructure Rating
- Drainage area topography and impervious surface %
- Approach Elevation
- Vertical Clearance
- Flood Depth

Ratio of Flood Depth to Vertical Clearance of the Bridge 500 year event
- > 1.00
- 0.90 - 1.00
- < 0.90

Location of Fayette County in Pennsylvania

HAZUS extreme event depth grid

2016 flooding

What about the impact of Climate Change on Extreme Precipitation Events?

FHWA VAST Tool
Indicator Data - Bridges
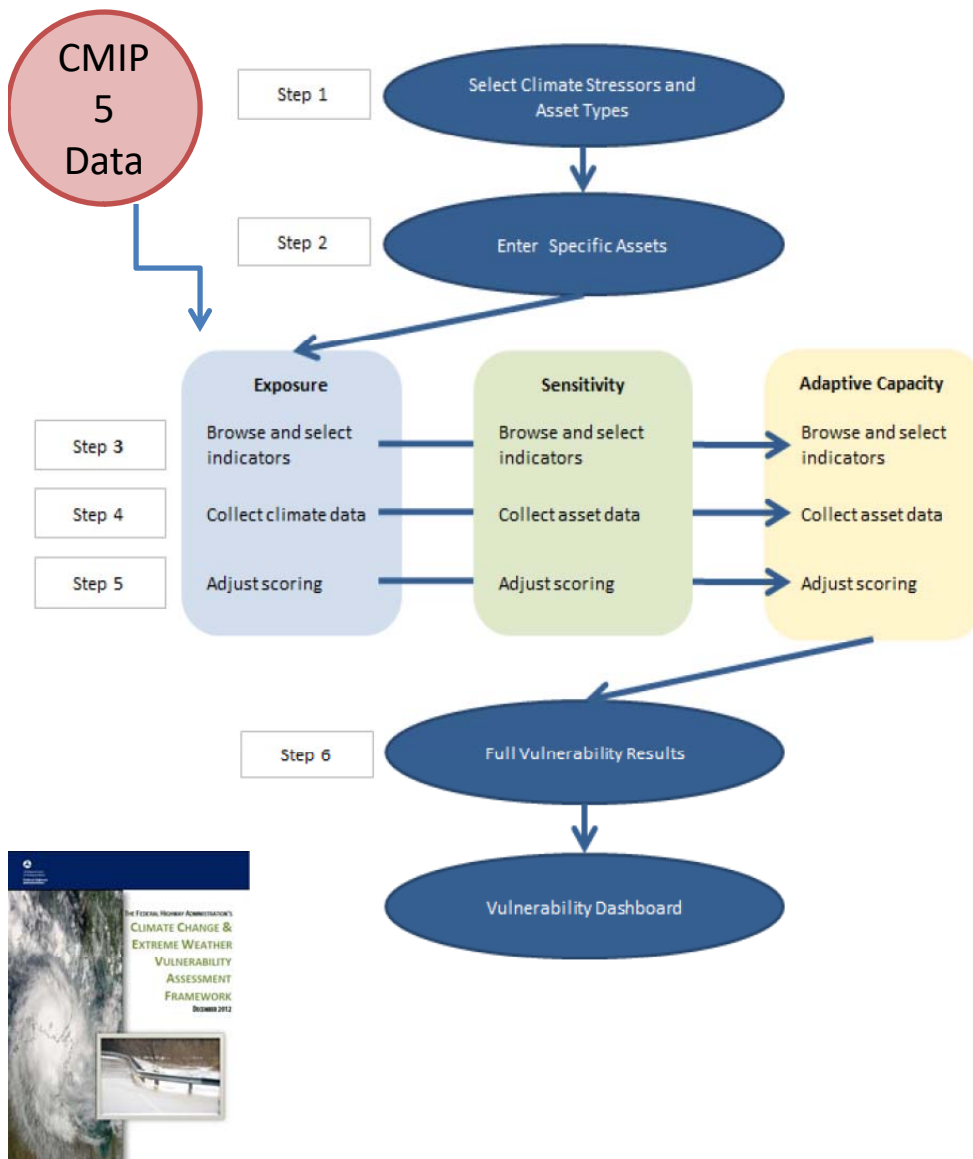
- ## Exposure Indicators
  - Total Change in Annual Precipitation
  - Total Change in Seasonal Precipitation
  - Location in 500 Flood Boundary

- ## Sensitivity Indicators
  - Scour Rating
  - Flooding Inspection
  - Bridge Age
  - Flood Depth to Vert Clearance Ratio

- ## Adaptive Capacity Indicators
  - AADT
  - Detour Length

VAST Vulnerability Score (Bridges)
Extreme Precipitation Scenario
Mid Century Projection

VAST Vulnerability Score
for Precipitation Change
Mid-Century Projection

- < 2.05
- 2.05 to 2.41
- 2.42 to 2.75
- > 2.75

- Exposure Indicators
  - Total Change in Annual Precipitation
  - Total Change in Seasonal Precipitation
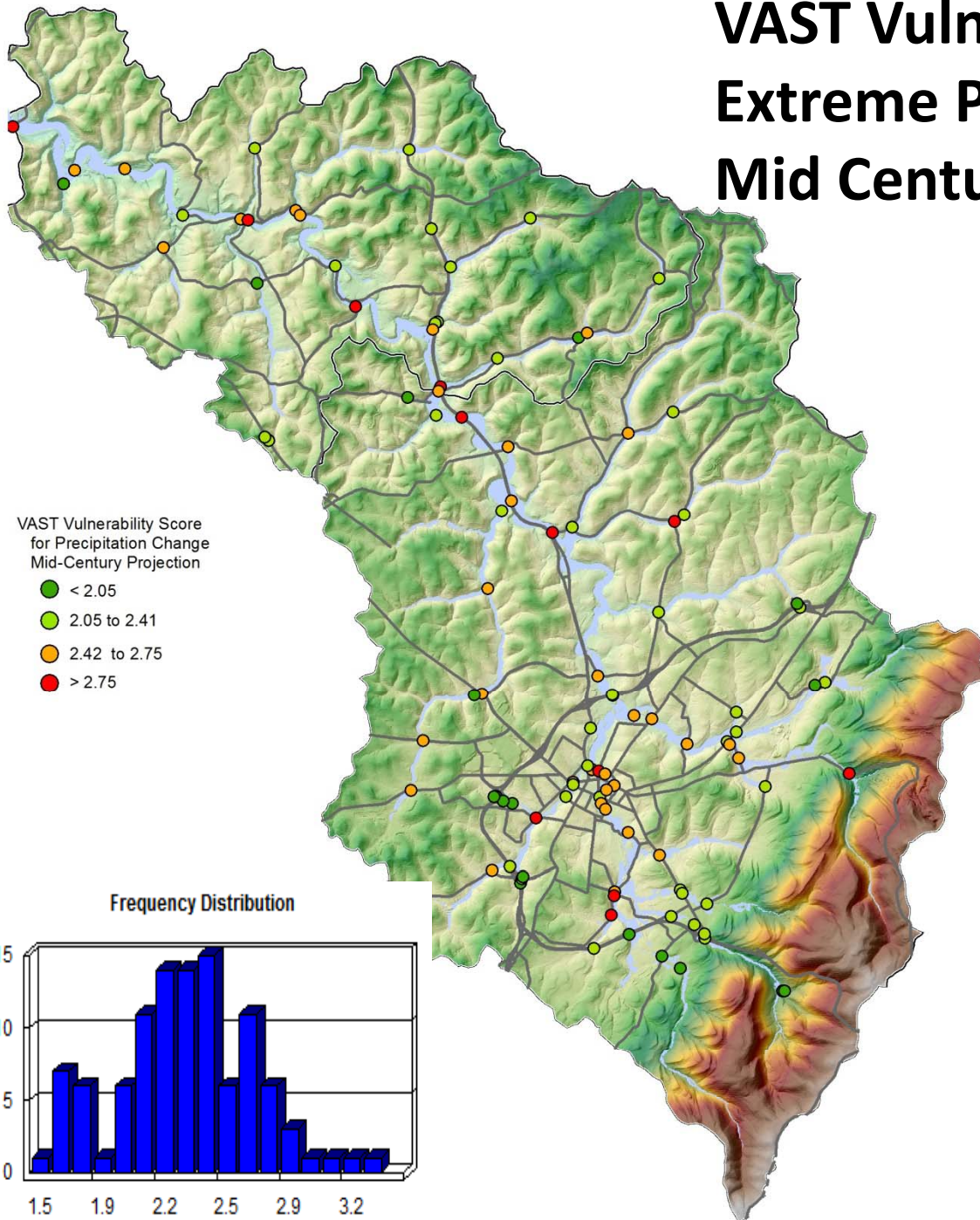 - Location in 500 Flood Boundary
- Sensitivity Indicators
  - Scour Rating
  - Flooding Inspection
  - Bridge Age
  - Flood Depth to Vert Clearance Ratio
- Adaptive Capacity Indicators
  - AADT
  - Detour Length

Frequency Distribution

VAST Vulnerability Score (Roadways)
Extreme Precipitation Scenario
Mid Century Projection

VAST Vulnerability Score for
Extreme Precip Impacts on Roads
Mid-Century Projection

— Low (Limited Exposure)
— Low (1.00 - 2.00)
— Medium (2.0 - 2.5)
— High (2.681 - 3.10)
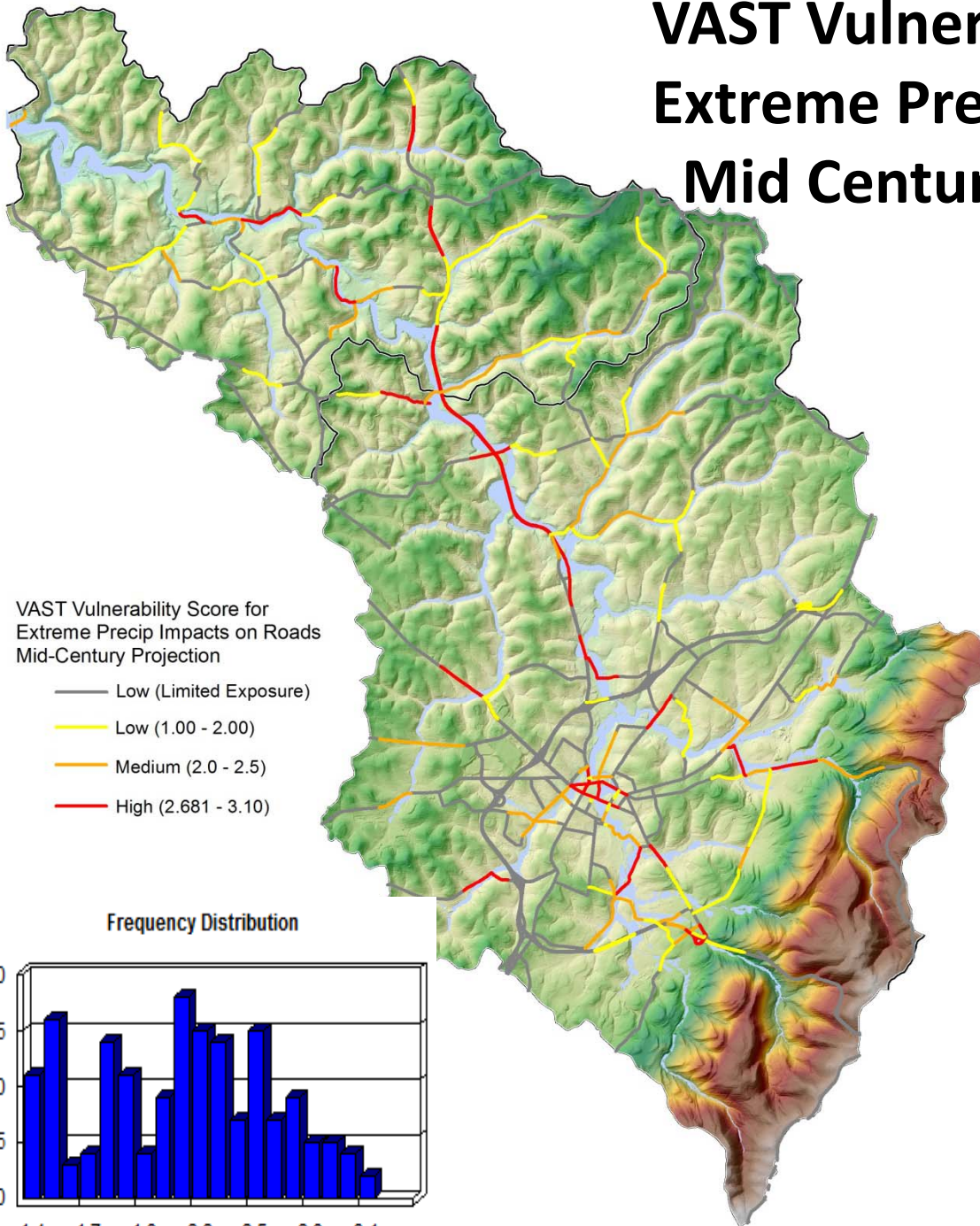
Frequency Distribution

- Exposure Indicators
  - Total Change in Annual Precipitation
  - Total Change in Seasonal Precipitation
  - Location in 500 Flood Boundary
- Sensitivity Indicators
  - Length of Roadway impacted by extreme event flood water
  - Max depth of extreme event flood water
  - Roadway condition
- Adaptive Capacity Indicators
  - AADT
  - Detour Length
  - Business Plan Network

Pilot Study Findings

- HAZUS can be utilized to model extreme precipitation events without requiring an expert hydrology modeler;

- CMIP and the FHWA data processing tool can be used to generate localized future precipitation projections;

- FHWA VAST tool can be used to evaluate the vulnerability of bridge and roadway assets… collaboration with PennDOT District staff is required to refine vulnerability ratings and assist in identifying the best available sensitivity and adaptive capacity indicators;

- Inadequate data exists on flooding history at bridge assets and for conducting vulnerability analysis on railroads and local roadway network.

Uses of Current Studies to Future Resiliency Work
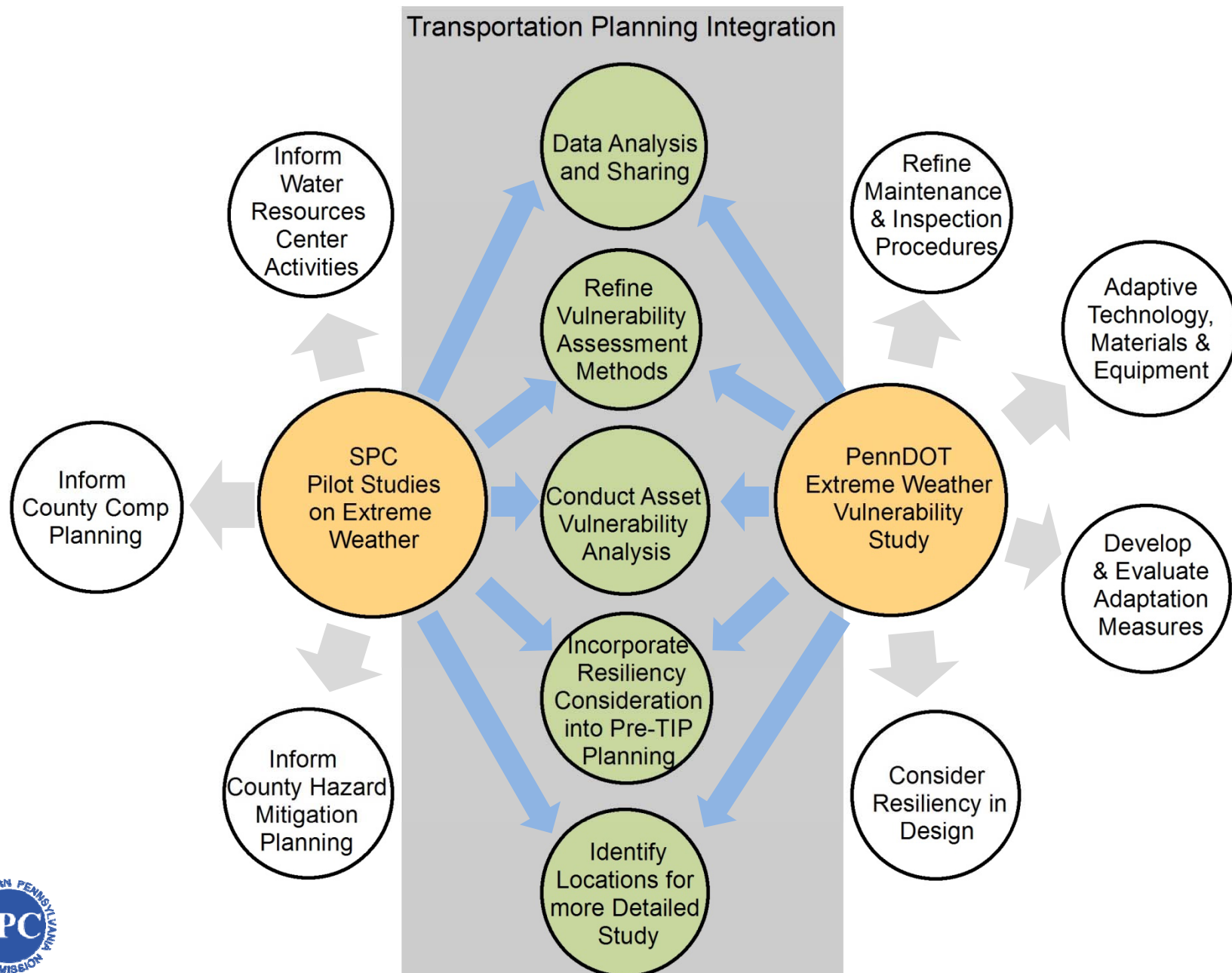
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