State of Texas
MPOs Resilience Working Group
October 19, 2021

Agency Resilience

Critical Transportation Infrastructure Protection

State

- Arizona State Emergency Response and Recovery Plan (SERRP)
- Planning Branch – AZ Department of Emergency and Military Affairs

ADOT

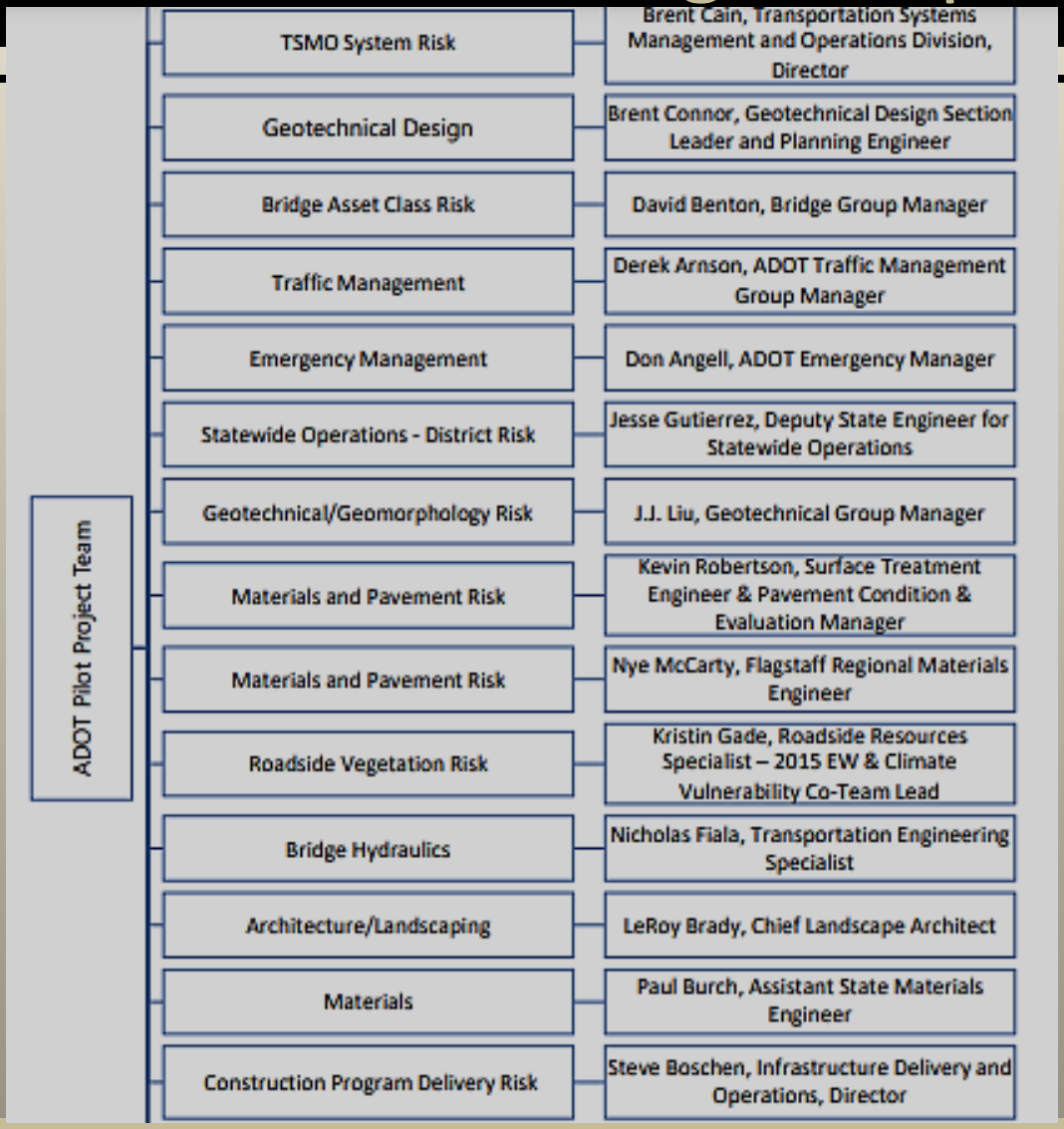
- Emergency Preparedness Management
- Business Continuity - pandemic - Director's Office revamp
- Roadway - Incident Response Unit
- Physical, chemical, biological – dedicated Emergency Manager
- Road Weather AZ 511 app / ADOT Alerts app
- Cyber - IT Security Risk Management & Compliance team
- Transportation Infrastructure - All Natural Hazard (Admin, P2P, Design Eng, Construction, Operations (TSMO), and Maintenance (Districts)

Transportation Infrastructure Resilience

FHWA 5520 - anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions

Program Definition - The management of assets (bridges, culverts, pavement, and roadside vegetation/stabilization) in relation to the extreme weather-climate risks of; intense precipitation, system flooding, wildfires, wildfire-induced floods, drought-related dust storms, rockfall incidents, slope failures, and measurable climate trends (especially as it relates to precipitation and direct effects of increased surface temperatures); by regions or specific segments, emphasized as critical to contribute to the safety of the traveling public, improve weather and natural hazard risk management, and improve the long term life cycle planning of transportation infrastructure.

Internal Working Group



Impacts Narrative

There is currently a multitude of natural hazard and weather related stressors present in Arizona, but they can largely be separated into two categories: extreme heat and extreme precipitation.

The negative impacts of extreme heat include: pavement deformation, shorter pavement construction windows, heat-related worker safety issues, and public safety during lengthy delays. Extreme heat can also lead to an increase in dust storms, due to a decrease in vegetation coverage on soil, as well as contributing to an increased number of wildfires. Areas affected by wildfires may see increases of runoff to levels that the current drainage system cannot handle. On the other hand, extreme heat has the benefit of reducing the amount of freeze-thaw impacts to pavements and a reduced amount of snow removal.

Impacts Narrative - continued

Precipitation levels are expected to remain consistent for the near future. However, if precipitation levels rise, the existing drainage and pump stations in the state may become overwhelmed. Another impact of oversaturated soils includes the increased likelihood of rock falls, subsidence, and landslides. Lower number of precipitation events but a higher intensity is a concern. This scenario can heavily impact rural and urban areas alike for safety and economic development.

Resilience GIS Database

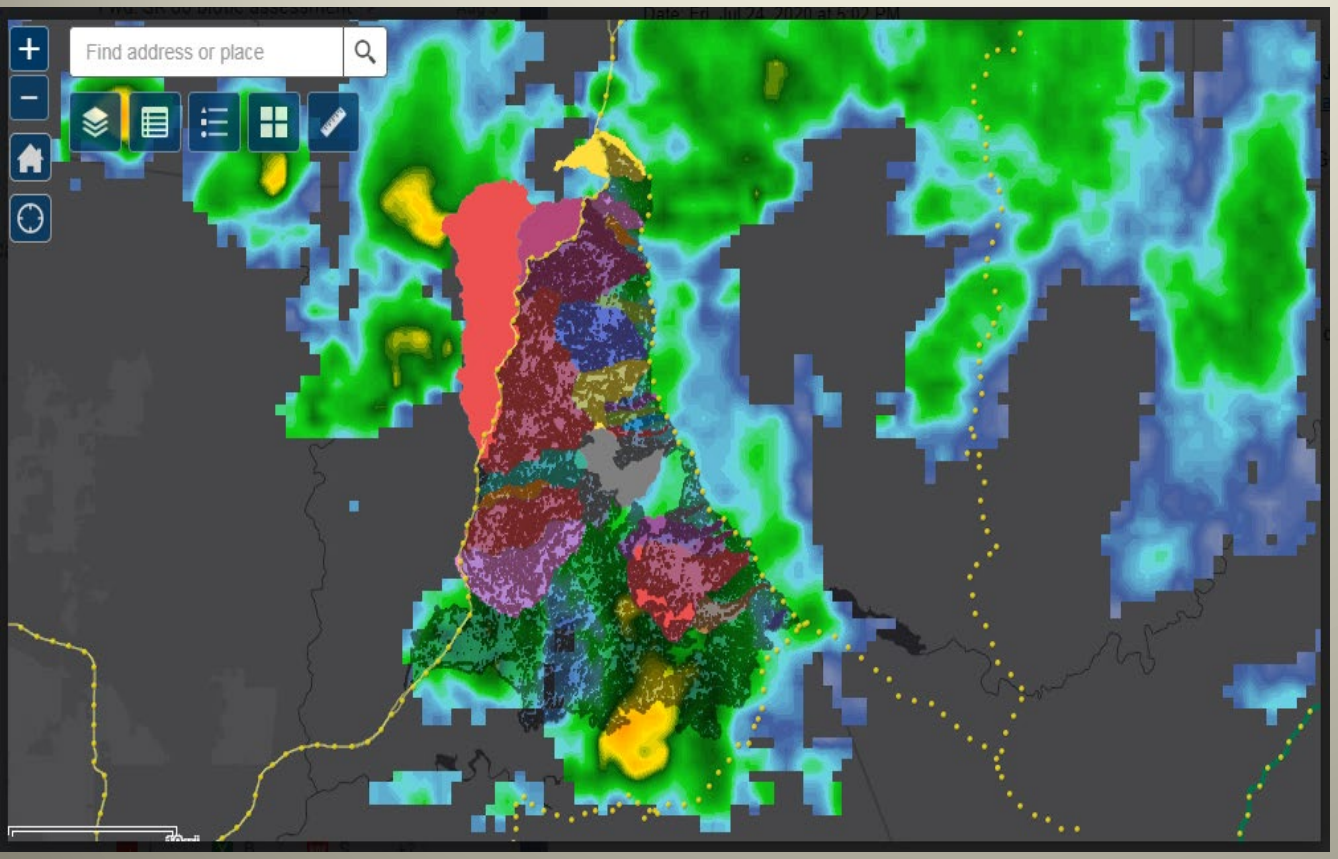
Data

- ADOT's USGS Data
- Drought & Wildfire
- Layers from ADOT's USGS Flood map
- Dust storm data (I-10 pilot)
- 5-yr program priority project information
- Bridges (including scour program)
- Culvert
- ADOT system base layers
- Geohazard locations
- Soils
- Live Feeds
- 500 locations of interest

Data

- ADOT/USGS Project Work
- Resilience (Extreme Weather and Climate) Building
- Resilience Investment Economic Analysis assessment locations
- Climate Engineering Assessment for Transportation Asset (CEA-TA) locations
- Every Day Counts CHANGE 2-D modeling projects
- 2050 and 2100 climate data downscaling mapping
- Statewide drainage dashboard
- Weather event dashboards

Resilience GIS Database Event Dashboards



Bush Fire impacted
SR 87 & 188
195,000 Acres

Dashboard layers:

- Debris Flow
- Bush Burn Severity
- Bush Fire Watersheds
- Rain Gages
- Pressure Transducers
- Roads with Mile Posts
- Main Highways
- Scour Critical Bridges
- NOAA Radar live feed
- Watches, Warnings, Advisories live feed
- NDFD Precipitation live feed
- Active Hurricanes live feed

Resilience I.D. and Decision Making Steps (1)

Resilience I.D. and Decision Making Steps (2)

- Funding confirmed - Project Resource Board, Project Management, Project Finance
- Resilience Scope of Work developed blending Risk/Science/Technology/Engineering
- Funded projects commences
- System resilience advances
- Lessons learned gained
- Feedback loop to TAM Program Manager and Resilience Program Manager
- Feedback loop to methodology - Risk/Science/Technology/Engineering

Planning to Programming

It is difficult to see another way to do resilience planning or resilience building or resilience funding unless you really have the appropriate tools, measures, scoring criteria, and selection process.

- ADOT program level planning focus centers on linking resilience to Transportation Programming, specifically:
- The 5-year construction program ($1.1B annually)
- The Transportation Asset Management Plan (TAMP)
- Major corridor studies
- The currently-underway next Long Range Transportation Plan
- Agency level adoption of new and novel science, engineering, risk, and technology adoption

Planning to Programming

- ADOT sees the main reasons for incorporating resilience in transportation planning as being related to (i) safety benefits, (ii) maintaining mobility and operations, (iii) natural hazard (weather and climate) adaptation planning, (iv) experience/past damage with catastrophic events, (v) sustainability and (vi) emergency response planning

- ADOT considers that long range planning, planning outreach, and program development provide a natural foundation for applying/integrating resilience approaches

Planning to Programming

- ADOT has incorporated resilience concepts and approaches into multiple transportation plans including, Long-Range Statewide Transportation Plans (LRTP), Transportation Improvement Programs (TIP/STIP), Transportation Asset Management Plans (TAMP) and its 5-year ($1.1bn) program to various levels

- The range of maturity in implementation is considered by ADOT to evolve in stages from (1) defining goals and objectives, (2) identifying problems and needs, (3) identification of resilience strategies, (4) implementation of resilience strategies, (5) defining appropriate evaluation criteria, performance measures and targets and (6) developing the processes and tools to facilitate appropriate monitoring and reporting.

Planning to Programming

- ADOT's Planning to Programming (P2P) Guidebook connects the LRTP to the 5-Year Construction Program through performance, as required by Arizona Revised Statutes (ARS) Title 28, Chapter 2, Article 7 (§ 28-501 through § 28-507), 23 USC Section 135(d)(2), and 49 USC Section 5304(d)(2) [7]
  https://azdot.gov/sites/default/files/media/2020/09/FY20_P2P_Guidebook.pdf
- The P2P Guidebook is the key planning entry point for resilience at ADOT. Indeed, in Section 2.0 Project Identification, it states that "Each May, the P2P Manager requests any new planning study recommendations from ADOT Planning staff, COGs, and MPOs, as well as any District project nominations
- Currently applying Resilience Program review to FY23-27 P2P List

Resilience Building Tracking

Project Number	Rt.	System Location	Resilience Work Completed	Project Cost	Resilience & Financial Decision-Making Outcome
Resilience Building Project #1	SR 191	Chinle, AZ	31 Drainage Structures Rehab	$6m	Roadway and embankment now protected to the 50-year storm event
Resilience Building Project #2	SR 160	Laguna Creek Bridge	Gabion basket bank protection	$1m	Bridge now protected to the 500-yr storm event - Tribal Partner - key corridor
Resilience Building Project #3	SR 95	Fortuna Wash Bridge	Bridge replace	$9.3m	Bridge now protected against Fortuna Wash floodwaters flowing over the road, secured the $500m in area economic impact, reduced/eliminated considerable detour
Resilience Building Project #4	I-8	Foothills Blvd to Dome Valley	Roadway deterioration and clogged and corroded drainage structures due to storm events and aging repaired	$14m	Vulnerable NHS asset improved - Access for City of Yuma, Yuma Port of Entry, State of California, Yuma International Airport, USMC Air Station Yuma, Barry M. Goldwater Air Force Base, Port of San Luis SR 95, MP .01 Mexico Border
Resilience Building Project #5	I-17	New River Bridges Structures - N and S	Concrete floor approximately 3 feet below the channel bed underneath the bridges. Cutoff walls at both upstream (approximately 4 feet deep) and downstream (approximately 6 feet deep)	$2m	Vulnerable NHS asset improved Maricopa County and its 4.2m residents
Resilience Building Project #6,7,8 underway					
Resilience #9,10 identified entering design					
Resilience Operating Project #1 (TSMO)	Phx		Pump Station Optimization Tool for operators and capital investment	$200K	Developing predictive model of probability of pumping station failure. Variable examples: season, condition, manufacturing date, date of last repair, size, sufficiency of capacity, precipitation magnitude, and manufacturer type.

Tools Projects through 2021

Four Partnerships – Trinity College Dublin, , North Carolina State, and Texas A&M Transportation Institute CARTEEH consortium:

- Finalize Resilience Performance Measures, Indicators, Metrics
- Map sustainable infra to the UN Sustainable Development Goals
- Further Economic Analysis Processes
- Further Life Cycle models to monitor resilience investment
- Account for the differences in the deterioration model with new climate-informed asset management models
- Customized intensity-duration-frequency (IDF) curves to consider in projects and large area drainage studies

Future Analysis Tools Needs

While different methods to quantify the economic impact of weather & natural hazard for infrastructure exist, advancing resilience tools for:

- Cost benefit analysis
- Return on investment
- Risk thresholds identification (fortify – rebuild – or absorb event risk)
- Identifying specific durability limit states
- Major rehabilitation timeline analyses
- Resilience bond adoption - Improved public agency awareness

are needed that incorporate probabilistic approaches, and minimize regret by DOTs under changing extremes and climates.

Resources

Just a few

- Preliminary Study of Climate Adaptation for the Statewide Transportation System https://apps.azdot.gov/ADOTLibrary/publications/project_reports/PDF/AZ696.pdf
- Extreme Weather Vulnerability Assessment https://www.fhwa.dot.gov/environment/sustainability/resilience/pilots/2013-2015_pilots/arizona/arizonafinal.pdf
- Asset Management, Extreme Weather, and Proxy Indicators Infrastructure Resilience Report https://azdot.gov/sites/default/files/2019/07/Asset-Mgmt-Extreme-Weather-and-Proxy-Indicators-Pilot-Project.pdf
- Transportation Research Board - NCHRP 08-129 https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4741
- Transportation Research Board - NCHRP 08-129
- Transportation Research Board - NCHRP 23-09
- Arizona DOT Resilience Program https://azdot.gov/business/environmental-planning/programs/sustainable-transportation/resilience-program
- Arizona DOT Planning to Programming https://azdot.gov/planning/transportation-programming/planning-programming