

A photograph of a flooded urban street at dusk or dawn. Two people are riding bicycles through the water. The street is lined with trees and streetlights, and the water reflects the ambient light. The image is split diagonally, with the top-left portion showing the flooded street and the bottom-right portion being a solid dark blue background where the text is located.

# Flooding, Warm Nights, and Wildfires:

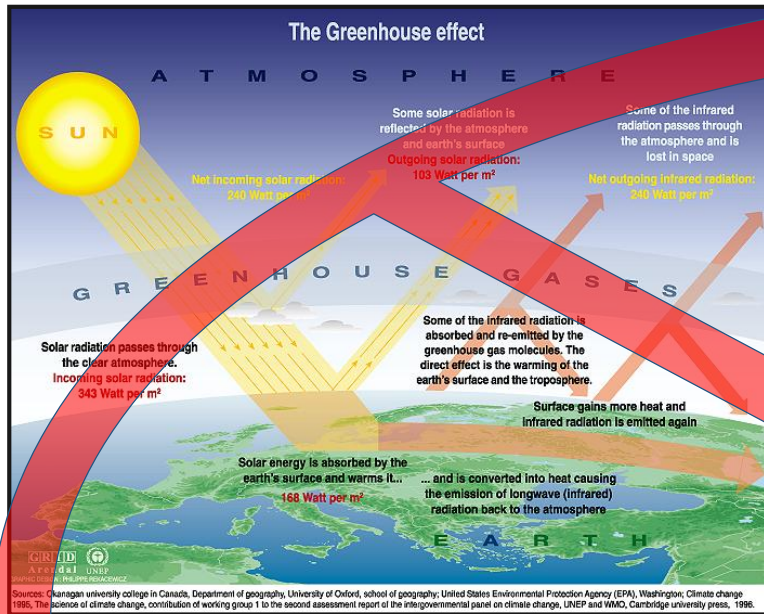
Using Community Defined Critical  
Thresholds for Extreme Events to Build  
Climate Resilience

Pacific Northwest Climate Conference 2017  
Sascha Petersen - Adaptation International  
[Sascha@adaptationinternational.com](mailto:Sascha@adaptationinternational.com)

Sharing –

One key thing you care about in your community, that might be affected by climate change.

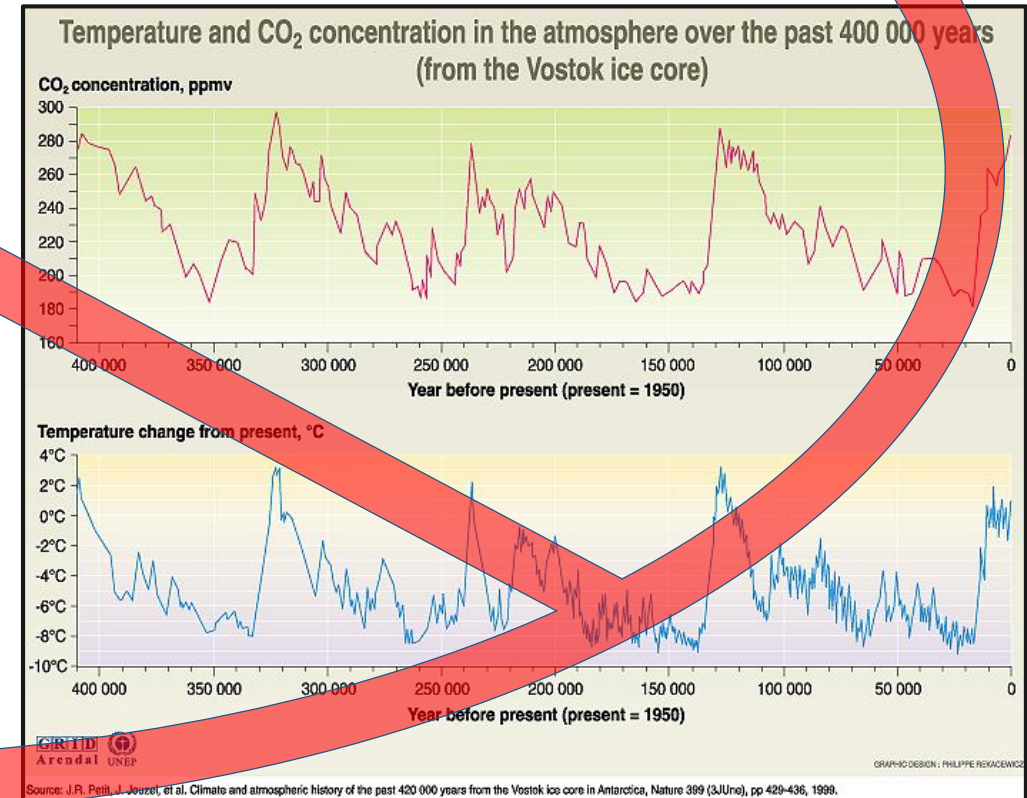




**“Evidence for climate change abounds, from the top of the atmosphere to the depths of the oceans.” - NCA 2014**



**“Some impressive and very authoritative quote from the forthcoming National Climate Assessment – 2018....”**



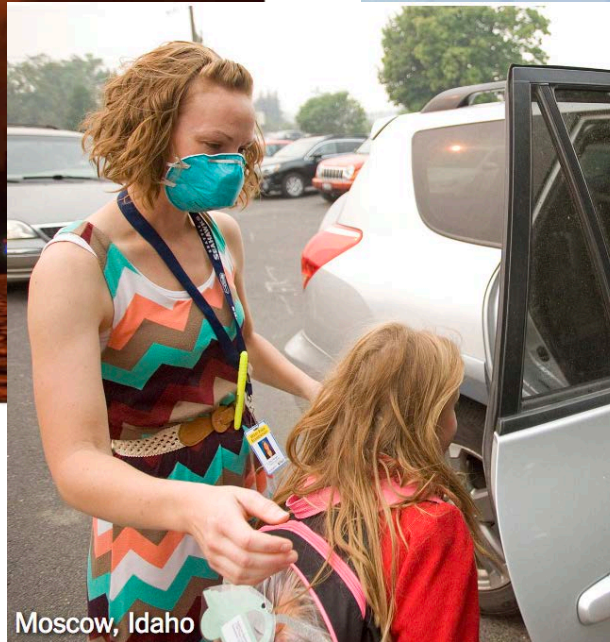
# When does weather become a problem?



<https://www.theatlantic.com/photo/2017/09/wildfires-rage-across-the-american-west/538977>



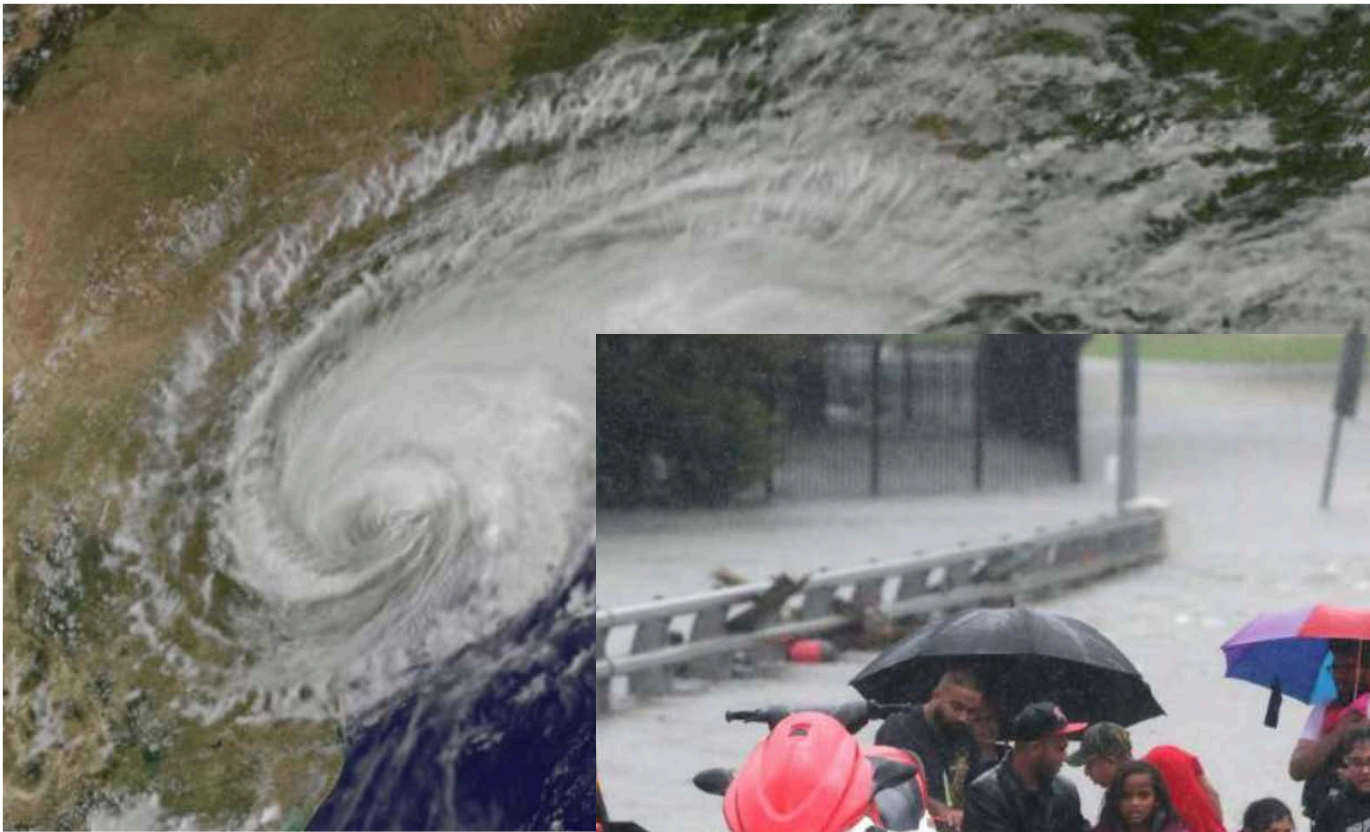
<https://www.usnews.com/news/best-states/washington/articles/2017-09-02/new-evacuation-notice-issued-for-state-wildfire>



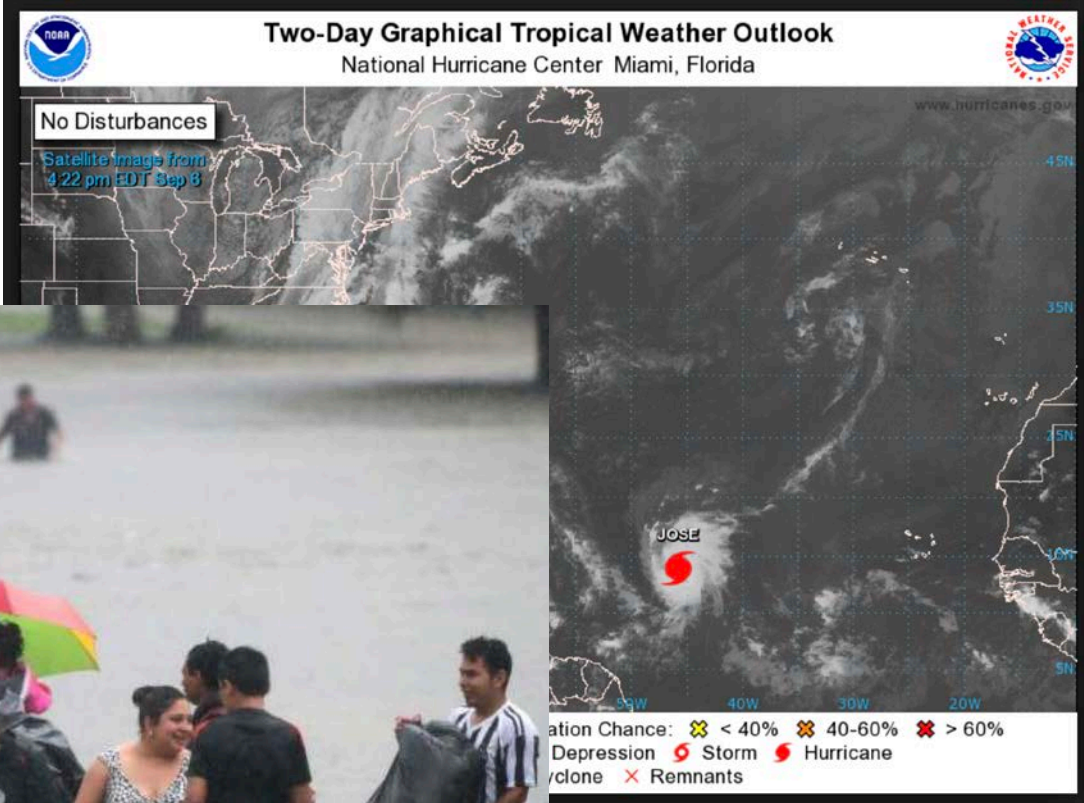
Moscow, Idaho

<https://www.nytimes.com/interactive/2017/09/16/us/wildfires-smoke-pacific-northwest.html>





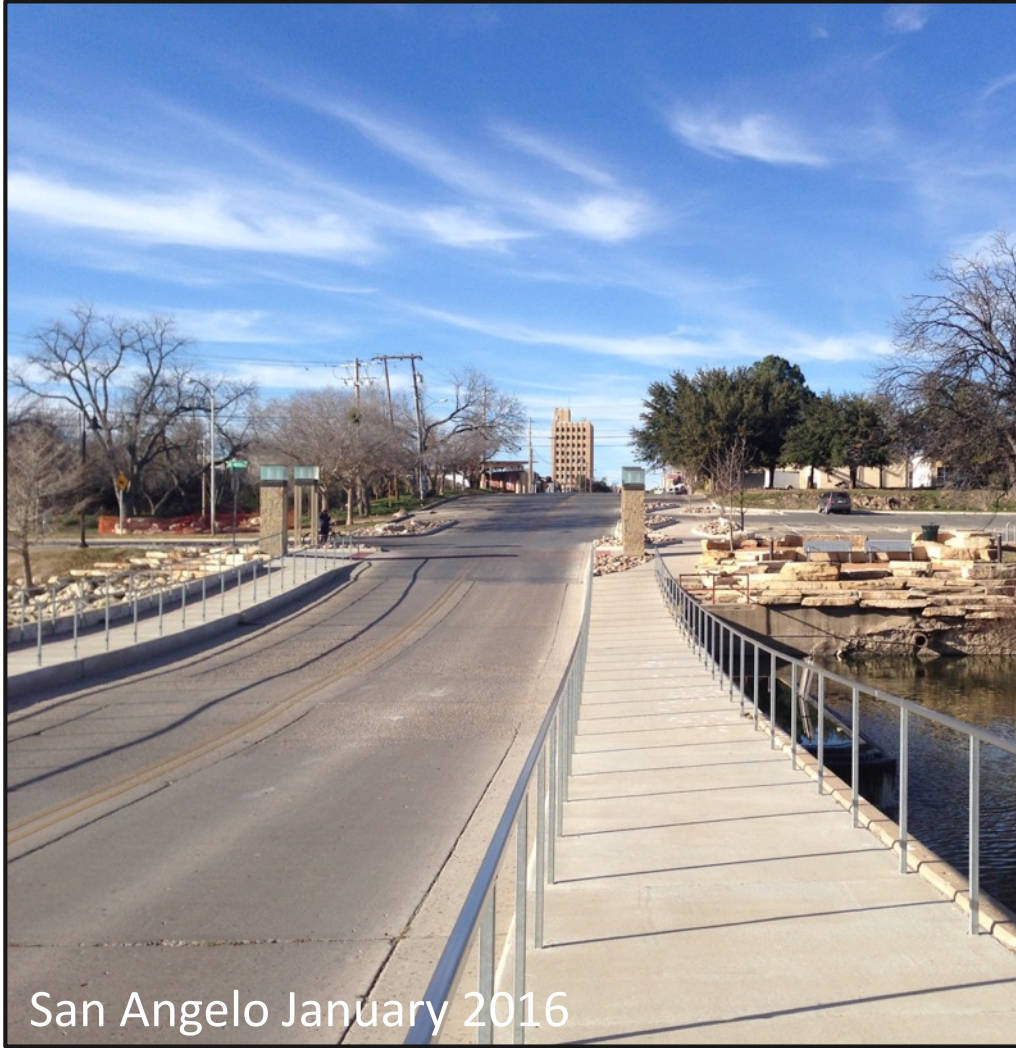
NOAA's GOES-East satellite captured this visible image of H (2245 UTC). Credit: NASA/NOAA GOES Project  
<https://phys.org/news/2017-08-nasa-slow-moving-tropical-storm-h>



<http://www.chron.com/news/houston-weather/hurricaneharvey/article/houston-shelters-hurricane-harvey-12012951.php#prev>



# When does weather become a problem?



# Lessons Learned



# Lessons Learned

- **User-defined thresholds make the climate information relevant and initiate conversations on resilience.**
- **There are significant differences between "scientifically-defined" thresholds and "user-defined" thresholds.**
- **Communities are opportunistic when acting to build resilience.**



# Project Overview



# Project Process

---

## Collaboration of:



## Funded by:



# Project Process

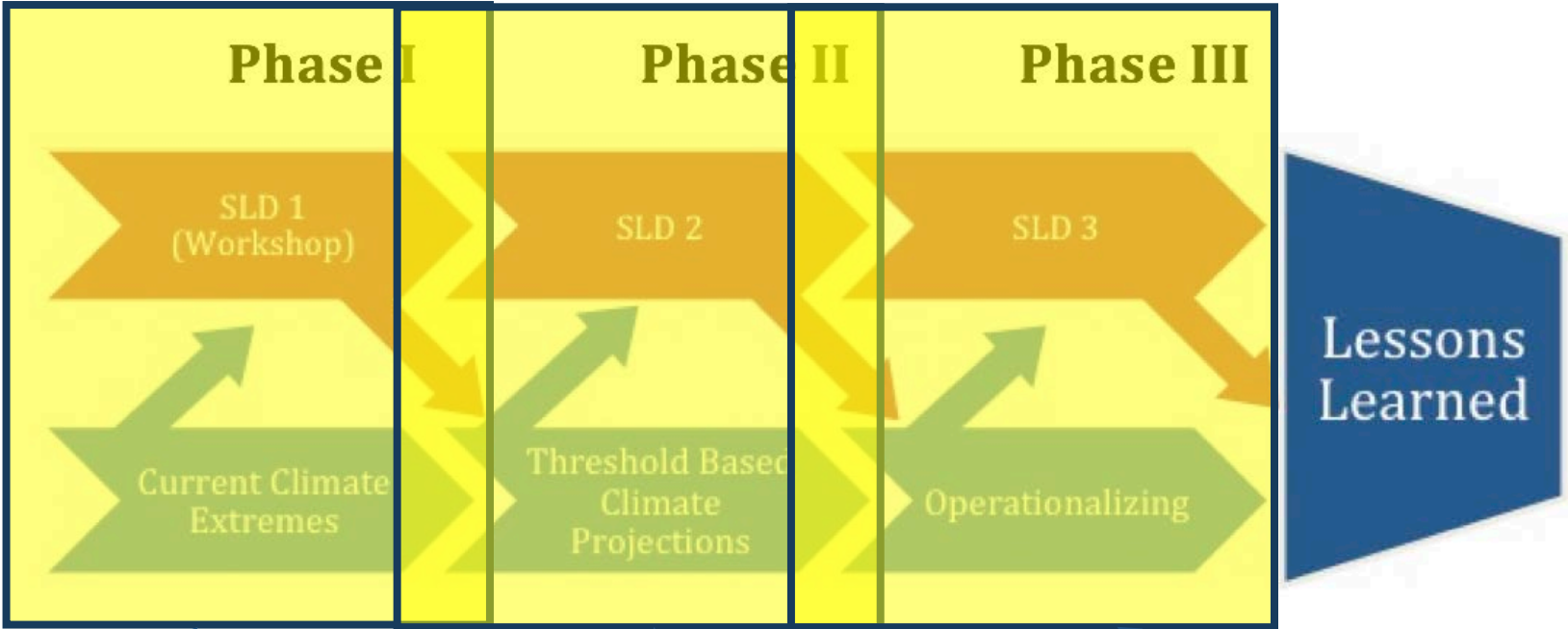


## Four Pilot Cities

- Boulder, CO
- Miami, OK
- San Angelo, TX
- Las Cruces, NM



# Project Process



**Shared Learning Dialogues and project flow**

Identifying when weather goes from a nuisance to a problem

Providing climate projections around specific thresholds

Selecting project to build resilience & take action



# User-Defined Thresholds



# Starting the Conversation

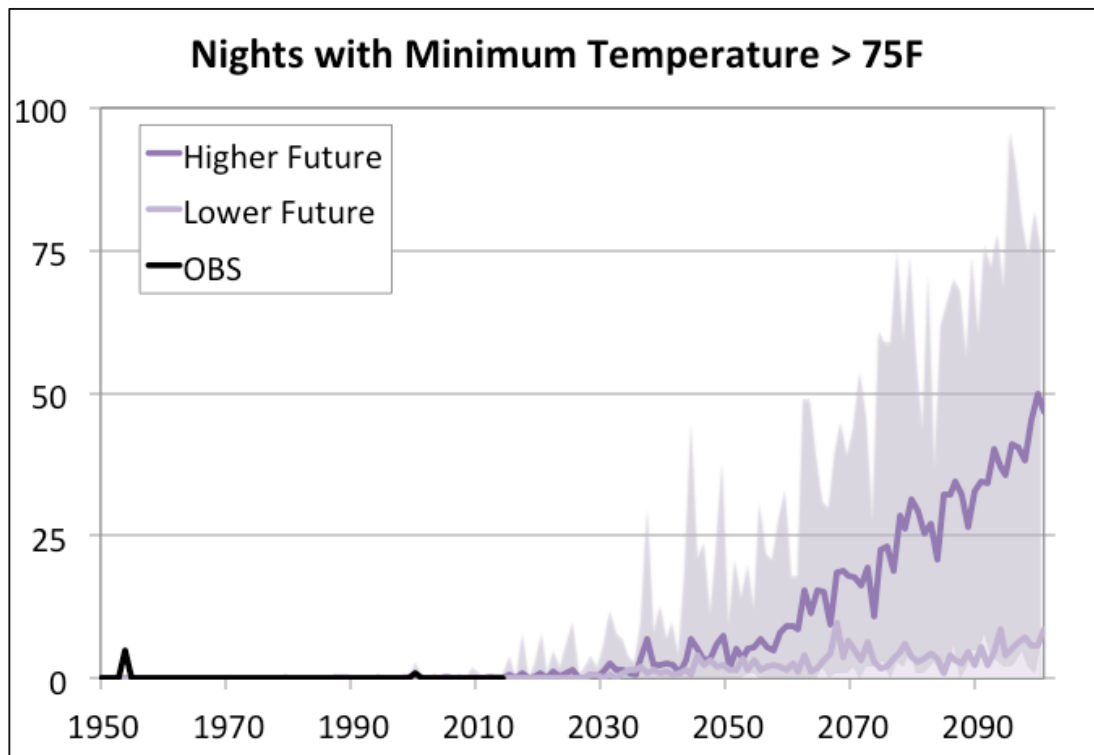


When does weather go from a nuisance to a problem?

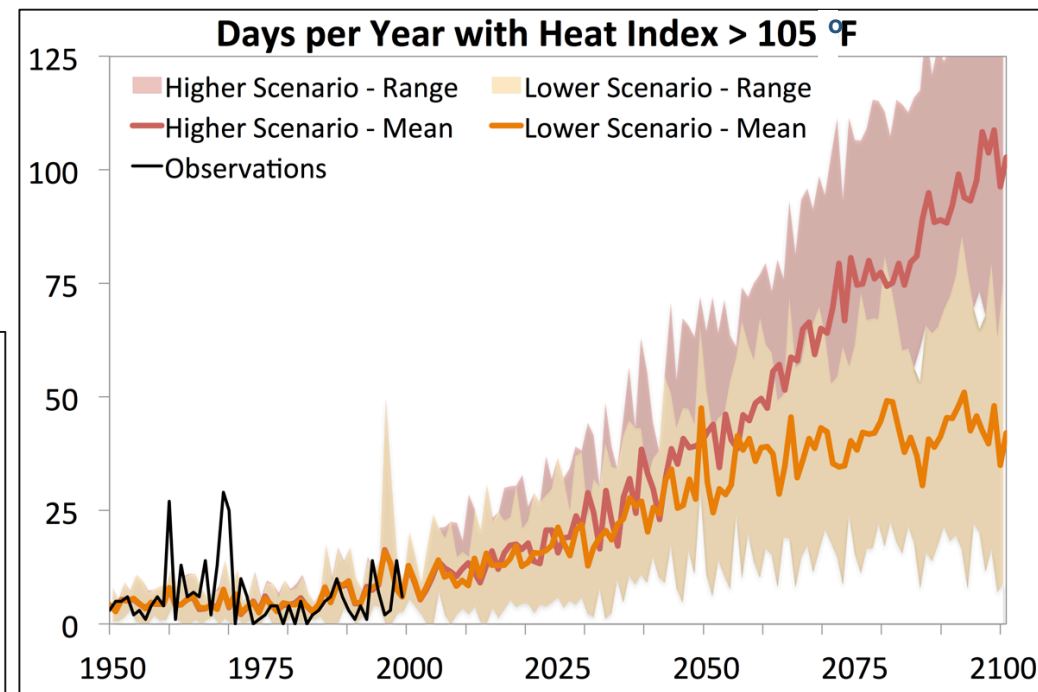


# Identifying Critical Weather Thresholds

- Max Temp > 95°F, 100°F or 105°F
- Nights over 80°F
- Days with 2" Rain



Boulder, CO



San Angelo, TX

Figures from Atmos Research



# Science vs. User-Defined Thresholds



# World Meteorological Organization Temperature Indices

---

- *Number of frost days:* Days when daily minimum temperature  $< 32^{\circ}\text{F}$ .
- *Number of icing days:* Days when daily maximum temperature  $< 32^{\circ}\text{F}$ .
- *Number of summer days:* Days when daily maximum temperature is  $> 77^{\circ}\text{F}$ .
- *Number of tropical nights:* Days when daily minimum temperature is  $> 68^{\circ}\text{F}$ .
- *Growing season length*
- *Percentage of days when daily maximum/minimum temperature is  $> 90^{\text{th}}$  percentile*
- *Percentage of days when daily maximum/minimum temperature is  $< 10^{\text{th}}$  percentile*
- *Warm spell duration index:* at least 6 consecutive days when maximum temp  $> 90^{\text{th}}$  percentile
- *Cold spell duration index:* at least 6 consecutive days when minimum temp  $< 10^{\text{th}}$  percentile
- *Daily temperature range:* Monthly mean difference between maximum and minimum temp
- *Monthly maximum value of daily maximum/minimum temperature*
- *Monthly minimum value of daily maximum/minimum temperature*



# World Meteorological Organization Temperature Indices

---

- *Number of frost days:* Days when daily minimum temperature  $< 32^{\circ}\text{F}$ .
- *Number of icing days:* Days when daily maximum temperature  $< 32^{\circ}\text{F}$ .
- *Number of summer days:* Days when daily maximum temperature is  $> 77^{\circ}\text{F}$ .
- *Number of tropical nights:* Days when daily minimum temperature is  $> 68^{\circ}\text{F}$ .
- *Growing season length*
- *Percentage of days when daily maximum/minimum temperature is  $> 90^{\text{th}}$  percentile*
- *Percentage of days when daily maximum/minimum temperature is  $< 10^{\text{th}}$  percentile*
- *Warm spell duration index:* at least 6 consecutive days when maximum temp  $> 90^{\text{th}}$  percentile
- *Cold spell duration index:* at least 6 consecutive days when minimum temp  $< 10^{\text{th}}$  percentile
- *Daily temperature range:* Monthly mean difference between maximum and minimum temp
- *Monthly maximum value of daily maximum/minimum temperature*
- *Monthly minimum value of daily maximum/minimum temperature*



# World Meteorological Organization Temperature Indices

---

- *Number of frost days:* Days when daily minimum temperature  $< 32^{\circ}\text{F}$ .
- *Number of icing days:* Days when daily maximum temperature  $< 32^{\circ}\text{F}$ .
- *Number of summer days:* Days when daily maximum temperature is  $> 77^{\circ}\text{F}$ .
- *Number of tropical nights:* Days when daily minimum temperature is  $> 68^{\circ}\text{F}$ .
- *Growing season length*
- *Percentage of days when daily maximum/minimum temperature is  $> 90^{\text{th}}$  percentile*
- *Percentage of days when daily maximum/minimum temperature is  $< 10^{\text{th}}$  percentile*
- *Warm spell duration index:* at least 6 consecutive days when maximum temp  $> 90^{\text{th}}$  percentile
- *Cold spell duration index:* at least 6 consecutive days when minimum temp  $< 10^{\text{th}}$  percentile
- *Daily temperature range:* Monthly mean difference between maximum and minimum temp
- *Monthly maximum value of daily maximum/minimum temperature*
- *Monthly minimum value of daily maximum/minimum temperature*



# World Meteorological Organization Temperature Indices

---

- *Number of frost days:* Days when daily minimum temperature  $< 32^{\circ}\text{F}$ .
- *Number of icing days:* Days when daily maximum temperature  $< 32^{\circ}\text{F}$ .
- *Number of summer days:* Days when daily maximum temperature is  $> 77^{\circ}\text{F}$ .
- *Number of tropical nights:* Days when daily minimum temperature is  $> 68^{\circ}\text{F}$ .
- *Growing season length*
- *Percentage of days when daily maximum/minimum temperature is  $> 90^{\text{th}}$  percentile*
- *Percentage of days when daily maximum/minimum temperature is  $< 10^{\text{th}}$  percentile*
- *Warm spell duration index:* at least 6 consecutive days when maximum temp  $> 90^{\text{th}}$  percentile
- *Cold spell duration index:* at least 6 consecutive days when minimum temp  $< 10^{\text{th}}$  percentile
- *Daily temperature range:* Monthly mean difference between maximum and minimum temp
- *Monthly maximum value of daily maximum/minimum temperature*
- *Monthly minimum value of daily maximum/minimum temperature*



# Resilience Action Projects



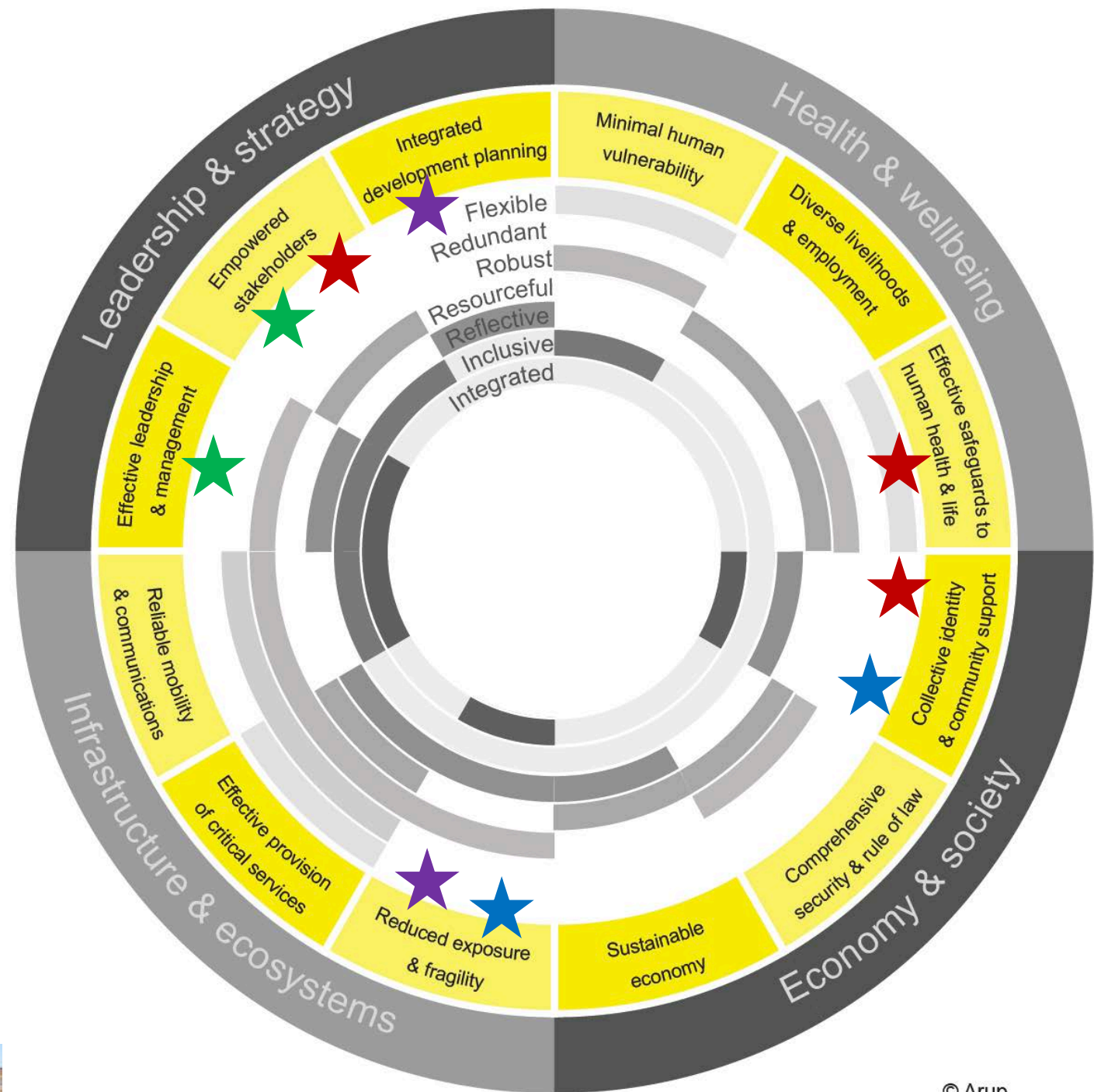
# Taking Action



Photo Credits – Sascha Petersen, Danny Mattox, Russ Sands

- ★ Boulder
- ★ Miami
- ★ San Angelo
- ★ Las Cruces

Las Cruces, NM leveraged a \$15,000 Resilience Action Grant from this project to secure a **\$400,000 investment** in green infrastructure in a historically underserved neighborhood.



# More Information

- Adaptation International

[www.adaptationinternational.com](http://www.adaptationinternational.com)

- SCIPP

[www.southernclimate.org/pages/past-research/using-critical-thresholds-to-customize-climate-projections-of-extreme-event](http://www.southernclimate.org/pages/past-research/using-critical-thresholds-to-customize-climate-projections-of-extreme-event)

- CLIMAS

[www.environment.arizona.edu/extreme\\_events\\_project](http://www.environment.arizona.edu/extreme_events_project)

- NOAA SARP Program

[www.cpo.noaa.gov/Meet-the-Divisions/Climate-and-Societal-Interactions/SARP/Extreme-Events-Thresholds](http://www.cpo.noaa.gov/Meet-the-Divisions/Climate-and-Societal-Interactions/SARP/Extreme-Events-Thresholds)

- YouTube

[www.youtube.com/playlist?list=PLUW3OY4eDJIqun0hPgNjxTFvMpZRnb9pn](http://www.youtube.com/playlist?list=PLUW3OY4eDJIqun0hPgNjxTFvMpZRnb9pn)



# Wrap-up

---



- Thresholds Matter
- Community Collaboration Is Important
- Opportunistic Actions can Still Build Resilience



# Thank You!

## Sascha Petersen

**Adaptation International**

*Sascha@adaptationinternational.com*

## Acknowledgements

Project funding provided by the National Oceanic and Atmospheric Association through the SARP program.

Collaborators include: the City of Boulder, the City of San Angelo, the City of Miami, the City of Las Cruces, the Southern Climate Impacts Planning Program (SCIPP) at the University of Oklahoma, Climate Impacts of the Southwest (CLIMAS) at the University of Arizona, ATMOS Research, the Institute for Societal and Environmental Transition (ISET) and Picher Allen Associates LLC.



# Single-Day Temperature Thresholds

WMO	BOULDER	LAS CRUCES	MIAMI	SAN ANGELO
Max Temp > 77°F	80°F, 90°F, 95°F	90°F, 100°F, 105°F	95°F, 100°F, 105°F	90°F, 100°F, 105°F
Max Temp > 90 <sup>th</sup>	89°F	96°F	93°F	97°F
	74 <sup>th</sup> , 92 <sup>nd</sup> , 98 <sup>th</sup>	75 <sup>th</sup> , 97 <sup>th</sup> , 99.9 <sup>th</sup>	93 <sup>rd</sup> , 98 <sup>th</sup> , 99.7 <sup>th</sup>	72 <sup>nd</sup> , 95 <sup>th</sup> , 99.5 <sup>th</sup>
Min temp < 10 <sup>th</sup>	18°F	26°F	23°F	30°F
	26 <sup>th</sup> , 35 <sup>th</sup>	23 <sup>rd</sup>	25 <sup>th</sup>	13 <sup>th</sup>
Min Temp > 68°F	75°F	80°F, 85°F	80°F	80°F



# Temperature Related Thresholds from the Four Communities

	Boulder, CO	Miami, OK	San Angelo, TX	Las Cruces, NM
Heat	Days per year with maximum daytime temperature $T_{\max} \geq 85^{\circ}\text{F}$ , $90^{\circ}\text{F}$ , and $95^{\circ}\text{F}$ .	Days per year with $T_{\max} \geq 95^{\circ}\text{F}$ , $100^{\circ}\text{F}$ , $105^{\circ}\text{F}$ .	Days per year with $T_{\max} \geq 90^{\circ}\text{F}$ (occupational exposures), $100^{\circ}\text{F}$ and $105^{\circ}\text{F}$ for 1-2 consecutive days.	Days per year with $T_{\max} > 95^{\circ}\text{F}$ , $100^{\circ}\text{F}$ and $105^{\circ}\text{F}$ . Human health issues emerge at $95^{\circ}\text{F}$ . At $100^{\circ}\text{F}$ , the El Paso International Airport short runway closes.
Heat	Nights per year with minimum nighttime temperature $T_{\min} > 75^{\circ}\text{F}$ .	Nighttime $T_{\min} > 80^{\circ}\text{F}$ for two days or longer. NWS Tulsa WFO Heat Advisory temperature criterion.	$T_{\min} > 80^{\circ}\text{F}$ for two or more nights.	$T_{\min} > 80^{\circ}\text{F}$ for 2 or more nights, or $>$ than $85^{\circ}\text{F}$ for one night.
Heat	Multi-day (3+) heat waves defined by $T_{\max} > 90^{\circ}\text{F}$ , $95^{\circ}\text{F}$ or $T_{\min} > 75^{\circ}\text{F}$ .			$T_{\max} > 100^{\circ}\text{F}$ for 3+ and 5+ days. Changes to the maximum & average length of heat waves.
Cool	Nights per year with $T_{\min} < 32^{\circ}\text{F}$ .			Number of nights of freeze ( $32^{\circ}\text{F}$ ), hard freeze ( $28^{\circ}\text{F}$ ).
Cool				Maximum and average length of cold snaps. Feb. 2011 freeze event, $T_{\max} < 32^{\circ}\text{F}$ for two or more days.
Cool				Timing of first/last freeze ( $32^{\circ}\text{F}$ ) and hard freeze ( $28^{\circ}\text{F}$ ) in the fall/spring.
Temp Swings	Temperature swings $> 50^{\circ}\text{F}$ , $60^{\circ}\text{F}$ , $70^{\circ}\text{F}$ in 3 days and $T_{\min} < 20^{\circ}\text{F}$ . Important for urban tree mortality.			
Heat & Moisture				Temperatures $\geq 90^{\circ}\text{F}$ and relative humidity $\geq 35\%$ . The threshold at which evaporative cooling is no longer effective.



# Precipitation Related Thresholds from the Four Communities

	Boulder, CO	Miami, OK	San Angelo, TX	Las Cruces, NM
<b>Precip</b>	Likelihood of daily precipitation exceeding the 99 <sup>th</sup> percentile of Historic record.		Daily precipitation $\geq 2"$ .	Daily precipitation $\geq 2.5"$ 10-year event threshold similar to Aug. 1, 2006.
<b>Precip</b>	Rain total on the wettest day, 3 days & 5 days of the year.	Precipitation $\geq 2.7"$ in 2 days Precipitation $\geq 3.5"$ in 3 days Precipitation $\geq 3.8"$ in 7 days City officials didn't define exact values, but noted the association between rain events and floods. Project team used flood records to identify thresholds.	Daily precipitation $\geq 4"$ .	Three or more consecutive days of $\geq 0.1"$ of precipitation per day.
<b>Snow/ice</b>				Potential recurrence of events of record: April 5-7, 1983; December 13-14, 1987; Dec 26-27, 2015. Historic snow events.
<b>Dryness</b>	Dry years matching rainfall in 2002 and 2012 or 2000-2006.			Summers that have less precipitation than the driest summer on record.
<b>Water resources</b>			24-month water supply, 18-month water supply, 12-month water supply. City of San Angelo water management thresholds.	The occurrence of 3+ days of 100°F or higher temperatures combined with no precipitation. Related to water demand.

