Flooding, Warm Nights, and Wildfires:

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

Pacific Northwest Climate Conference 2017
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Sharing –

One key thing you care about in your community, that might be affected by climate change.
“Some impressive and very authoritative quote from the forthcoming National Climate Assessment – 2018….”

“Evidence for climate change abounds, from the top of the atmosphere to the depths of the oceans.” - NCA 2014
When does weather become a problem?


NOAA's GOES-East satellite captured this visible image of Hurricane Harvey (2245 UTC). Credit: NASA/NOAA GOES Project


Meteorologist monitoring three storms in the Atlantic.

When does weather become a problem?

San Angelo January 2016

San Angelo Aug. 11th, 2011 - NWS
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

Four Pilot Cities
- Boulder, CO
- Miami, OK
- San Angelo, TX
- Las Cruces, NM
Project Process

**Phase I**
- SLD 1 (Workshop)
- Current Climate Extremes

**Phase II**
- SLD 2
- Threshold Based Climate Projections

**Phase III**
- SLD 3
- Operationalizing

**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 > 95ºF, 100ºF or 105ºF
- Nights over 80ºF
- Days with 2” Rain

Figures from Atmos Research

- San Angelo, TX
- Boulder, CO
Science vs. User-Defined Thresholds
World Meteorological Organization Temperature Indices

- **Number of frost days**: Days when daily minimum temperature < 32°F.
- **Number of icing days**: Days when daily maximum temperature < 32°F.
- **Number of summer days**: Days when daily maximum temperature is > 77°F.
- **Number of tropical nights**: Days when daily minimum temperature is > 68°F.
- **Growing season length**
- **Percentage of days when daily maximum/minimum temperature is > 90th percentile**
- **Percentage of days when daily maximum/minimum temperature is < 10th percentile**
- **Warm spell duration index**: at least 6 consecutive days when maximum temp > 90th percentile
- **Cold spell duration index**: at least 6 consecutive days when minimum temp < 10th 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**
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Resilience Action Projects
Taking Action

Photo Credits – Sascha Petersen, Danny Mattox, Russ Sands
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

- SCIPP

- CLIMAS
  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

- YouTube
  www.youtube.com/playlist?list=PLUW30Y4eDJlqun0hPGnJxFvMzpZ mn9pn
Wrap-up

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

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Acknowledgements

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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

<table>
<thead>
<tr>
<th>WMO</th>
<th>BOULDER</th>
<th>LAS CRUCES</th>
<th>MIAMI</th>
<th>SAN ANGELO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Temp &gt; 77°F</td>
<td>80°F, 90°F, 95°F</td>
<td>90°F, 100°F, 105°F</td>
<td>95°F, 100°F, 105°F</td>
<td>90°F, 100°F, 105°F</td>
</tr>
<tr>
<td>Max Temp &gt; 90&lt;sup&gt;th&lt;/sup&gt;</td>
<td>89°F</td>
<td>96°F</td>
<td>93°F</td>
<td>97°F</td>
</tr>
<tr>
<td></td>
<td>74&lt;sup&gt;th&lt;/sup&gt;, 92&lt;sup&gt;nd&lt;/sup&gt;, 98&lt;sup&gt;th&lt;/sup&gt;</td>
<td>75&lt;sup&gt;th&lt;/sup&gt;, 97&lt;sup&gt;th&lt;/sup&gt;, 99.9&lt;sup&gt;th&lt;/sup&gt;</td>
<td>93&lt;sup&gt;rd&lt;/sup&gt;, 98&lt;sup&gt;th&lt;/sup&gt;, 99.7&lt;sup&gt;th&lt;/sup&gt;</td>
<td>72&lt;sup&gt;nd&lt;/sup&gt;, 95&lt;sup&gt;th&lt;/sup&gt;, 99.5&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Min temp &lt; 10&lt;sup&gt;th&lt;/sup&gt;</td>
<td>18°F</td>
<td>26°F</td>
<td>23°F</td>
<td>30°F</td>
</tr>
<tr>
<td></td>
<td>26&lt;sup&gt;th&lt;/sup&gt;, 35&lt;sup&gt;th&lt;/sup&gt;</td>
<td>23&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>25&lt;sup&gt;th&lt;/sup&gt;</td>
<td>13&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Min Temp &gt; 68°F</td>
<td>75°F</td>
<td>80°F, 85°F</td>
<td>80°F</td>
<td>80°F</td>
</tr>
</tbody>
</table>
# Temperature Related Thresholds from the Four Communities

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

<table>
<thead>
<tr>
<th></th>
<th>Boulder, CO</th>
<th>Miami, OK</th>
<th>San Angelo, TX</th>
<th>Las Cruces, NM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Precip</strong></td>
<td>Likelihood of daily precipitation exceeding the 99th percentile of Historic record.</td>
<td></td>
<td>Daily precipitation $\geq 2^\text{&quot;}.$</td>
<td>Daily precipitation $\geq 2.5^\text{&quot;} 10$-year event threshold similar to Aug. 1, 2006.</td>
</tr>
<tr>
<td></td>
<td>Rain total on the wettest day, 3 days &amp; 5 days of the year.</td>
<td>Precipitation $\geq 2.7^\text{&quot;}$ in 2 days</td>
<td>Daily precipitation $\geq 4^\text{&quot;}$.</td>
<td>Three or more consecutive days of $\geq 0.1^\text{&quot;}$ of precipitation per day.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Precipitation $\geq 3.5^\text{&quot;}$ in 3 days</td>
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<tr>
<td></td>
<td></td>
<td>Precipitation $\geq 3.8^\text{&quot;}$ in 7 days</td>
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<tr>
<td></td>
<td></td>
<td>City officials didn’t define exact values, but noted the association between rain events and floods. Project team used flood records to identify thresholds.</td>
<td></td>
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</tr>
<tr>
<td><strong>Dryness</strong></td>
<td>Dry years matching rainfall in 2002 and 2012 or 2000-2006.</td>
<td></td>
<td></td>
<td>Summers that have less precipitation than the driest summer on record.</td>
</tr>
<tr>
<td><strong>Water resources</strong></td>
<td></td>
<td></td>
<td>24-month water supply, 18-month water supply, 12-month water supply. City of San Angelo water management thresholds.</td>
<td>The occurrence of 3+ days of 100°F or higher temperatures combined with no precipitation. Related to water demand.</td>
</tr>
</tbody>
</table>