Assessing Arid Area Extreme Precipitation Using Doppler Radar and Rain Gages

Investigators

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Overview

• The San Bernardino County Hydrology manual was written initially in 1987.

• This effort is aimed at analyzing the rainfall events over the last 2 decades and make recommendations to the County.
Use RADAR estimated precipitation data, from NWS, to assess possible correlation between Doppler Radar precipitation estimates and rain gage measurements. Focus is on the Arid Southwest United States.
San Bernardino County is the largest Mainland county in the US (20,105 sq miles) and fifth largest in population (2M)
The Weather Surveillance Radar (WSR-88D) is the technical name for the 159 high resolution S-band Doppler weather Radar, which are part of the NEXRAD (Next Generation Radar) network.
Radars of Interest

KNKX – San Diego
KESX – Las Vegas
KSOX – Santa Ana
KYUX - Yuma
KEYX - Edwards
Key Radar Aerial Coverage
• Identify key storm events with RADAR coverage that are affecting the San Bernardino County

• The precipitation data (one hour data) was downloaded off the NOAA website (www.ncdc.noaa.gov/nexradinv/) for each of the storms

• The LVL3-one-hour data summarizes 1-hour precipitation intensity by assigning the precipitation amounts to a 2km by 2km grid
Processing the Rainfall Data

- For each of the storms, three days of data (when available) were downloaded.

- Create a Doppler animation for the storm using the NOAA Weather and Climate Toolkit.

- From these animations, the 3-hr, 2-hr, 1-hr, 30-minute and 15-minute peak rainfall peak durations were identified.
Case Study

Peak Rainfall Durations for 2/19/2005 storm for KEYX

<table>
<thead>
<tr>
<th>Time</th>
<th>Start</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 hour</td>
<td>15:51</td>
<td>18:59</td>
</tr>
<tr>
<td>2 hour</td>
<td>16:03</td>
<td>18:06</td>
</tr>
<tr>
<td>1 hour</td>
<td>17:06</td>
<td>18:06</td>
</tr>
<tr>
<td>30 min</td>
<td>17:16</td>
<td>17:46</td>
</tr>
<tr>
<td>15 hour</td>
<td>17:23</td>
<td>17:38</td>
</tr>
<tr>
<td>Peak time</td>
<td>17:31</td>
<td></td>
</tr>
</tbody>
</table>
Peak Rainfall Durations for 11/30/2007 storm for KEYX

<table>
<thead>
<tr>
<th>Duration</th>
<th>Start Time</th>
<th>End Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Hours</td>
<td>18:03</td>
<td>21:02</td>
</tr>
<tr>
<td>2 Hours</td>
<td>18:13</td>
<td>20:12</td>
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<tr>
<td>1 Hour</td>
<td>18:33</td>
<td>19:33</td>
</tr>
<tr>
<td>30 min</td>
<td>18:43</td>
<td>19:13</td>
</tr>
<tr>
<td>15 min</td>
<td>18:53</td>
<td>19:08</td>
</tr>
<tr>
<td>Peak time</td>
<td>18:58</td>
<td></td>
</tr>
</tbody>
</table>
Number of Storms Analyzed

• Candidate Storm Count
  • 1999-2006 – 156 Candidate Storms
  • 2007-2015 – 55 Candidate Storms

• Nine (9) Possible Significant Storms Identified
Some storms were eliminated from further consideration for one of the following reasons:

a) no Radar data available for the date
b) available Radar data was corrupt
c) no storm appeared on the Radar as being recorded at the rain gauges
d) if same storm was measured on multiple Radar sites, the site with the best coverage was selected.
Analyzed storm locations (1997-2015)
Correlation of DOPPLER RADAR Data to Aerial Extent versus Published DARF Curves
Comparison of 1 hour Uncalibrated DARF curves
<table>
<thead>
<tr>
<th>1H Comparison</th>
<th>50 mi²</th>
<th>100 mi²</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/25/2013 (KNKX)</td>
<td>0.99</td>
<td>0.89</td>
</tr>
<tr>
<td>9/7/2014 (KESX)</td>
<td>0.87</td>
<td>0.78</td>
</tr>
<tr>
<td>8/25/2013 (KSOX)</td>
<td>0.84</td>
<td>0.63</td>
</tr>
<tr>
<td>4/13/2012 (KEYX)</td>
<td>0.83</td>
<td>0.73</td>
</tr>
<tr>
<td>8/25/2013 (KYUX -La Quinta Storm 1)</td>
<td>0.82</td>
<td>0.73</td>
</tr>
<tr>
<td>8/13/2004 (KESX)</td>
<td>0.80</td>
<td>0.65</td>
</tr>
<tr>
<td>Riverside County Manual (NOAA Atlas 2)</td>
<td>0.80</td>
<td>0.73</td>
</tr>
<tr>
<td>9/19/2004 (KESX)</td>
<td>0.79</td>
<td>0.73</td>
</tr>
<tr>
<td>9/8/2014 (KYUX - La Quinta Storm 2)</td>
<td>0.78</td>
<td>0.61</td>
</tr>
<tr>
<td>9/11/2004 (KESX)</td>
<td>0.71</td>
<td>0.53</td>
</tr>
<tr>
<td>Nevada 90% DOT (Vieux)</td>
<td>0.68</td>
<td>0.55</td>
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<tr>
<td>10/15/2015 (KEYX-Palmdale)</td>
<td>0.61</td>
<td>0.46</td>
</tr>
<tr>
<td>12/22/2010 (KSOX-Highland)</td>
<td>0.51</td>
<td>0.42</td>
</tr>
<tr>
<td>San Bernardino County Depth Area Curve</td>
<td>0.50</td>
<td>0.40</td>
</tr>
</tbody>
</table>
9/8/14
Peak Duration RADAR Rainfall - Area Averaged
(1-minute data)

Peak 1-hour rainfall at Subject Watershed: 2.39”
Radar Analysis for Design
Storm Application

Anjanette Dodd, Kimley-Horn, Inc.
Brian Wilson, Nevada Department of Transportation

Depth-Area
North American Monsoon 2014

Storm Total - 6-hr Aggregations from 8-Sep-14 to 9-Sep-14

WSR-88D Stations

Radar Stations and Data (2005 – 2014)
- KRGX (Reno, NV)
- KLRX (Elko, NV)
- KESX (Las Vegas, NV)
- KICX (Cedar City, UT)
DARFs at 90th and 50th Percentile

HHA 1 – 1hr

HHA 1 – 12hr

HHA 8 – 1hr

HHA 8 – 12hr

~0.4
NVDOT/Imperial County Manual DARF

West Consultants, Imperial County
Comparison of 1 hour DARF and Uncalibrated DARF curves
Comparison of 6 hour DARF and Uncalibrated DARF curves
Comparison of 24 Hour DARF and Uncalibrated DARF Curves
Rainfall in Phoenix

Monthly precipitation for each September since 1933

La Quinta Storm 2 (9-08-2014)

https://www.climate.gov/news-features/event-tracker/record-breaking-rain-arizona
Path of Hurricane Nobert

AZ - CA - NV
MOISTURE BEING PULLED NORTH

T'STORM CHANCES INCREASE

HEAVY RAIN & FLASH FLOODING POSSIBLE
Thunderstorms produced by the remnants of Hurricane Norbert

3-D satellite view of the intense rainfall in Arizona on Monday. Some thunderstorm tops reached heights of about 8.4 miles.
The authors would like to thank Rene Perez for his help in identifying key storms and for developing the animations/visuals; Hany Peters and Ken Eke for their insights as the work matured, and Howard McInvale for reviewing the document.
The county’s participation in the funding of this research was an academic exercise to understand the relationship between radar data and rainfall rates and must not be used for design considerations in the County of San Bernardino. The District has embarked on an aggressive program to install more rain gages in the arid regions of the County of San Bernardino which will provide more localized rainfall data for a future research project.