When Normal Isn’t Good Enough: Surface Water and Runoff Along the Colorado River of Western and Central Texas

John W. Nielsen-Gammon
Texas State Climatologist
Texas A&M University
Drought: Year 1

12 Month SPI Blend
September 27, 2011
Drought, Year 2

12 Month SPI Blend
October 2, 2012

Legend:
- Exceptional dryness
- Extreme dryness
- Abnormal wetness
- Moderate wetness
- Severe dryness
- Severe wetness
- Moderate dryness
- Moderate wetness
- Abnormal dryness
- Exceptional wetness
- Normal
Drought, Year 3.5

6 Month SPI Blend
June 2, 2014
Current Texas Reservoir Levels
Current Texas Reservoir Levels
Lake Travis

[Graph showing reservoir storage from 1947 to 2007 with indications for Dead Pool, Conservation Pool, Flood Pool, and Missing Data.]
(our) Colorado River Basin
Inflow 0.7 Maf: New record

Three-Year Inflows vs. Precipitation

Inflows (acre-feet)

Precipitation (in)

R² = 0.36
-0.7 Maf explained by precip
Why Record Low Inflows?

- Upstream water supply reservoirs
- Surface water capture
- Groundwater capture
- Land use changes
- Climate change
- Bad luck
Hypothesis

- Lack of flooding events is causing below-normal runoff
- Simple test of hypothesis:
  - Monthly precipitation from climate stations
  - Compute excess over amount required for soil saturation
    - 3” winter/spring, 5” summer, 4” transition
  - Sum over stations in basin
Middle Colorado Basin Precipitation (in.)

- Total
- Excess

-0.5 Maf explained by excess p.
Errors: Negative $\rightarrow$ Positive

Excess Precipitation Model vs. Observations
Residuals have downward trend
Residuals (Excess Precipitation Model), Floods Removed

\[ R^2 = 0.17 \]
Three-Year Inflows vs. Precipitation

Inflows (acre-feet)

Precipitation (in)

R² = 0.36
Full Model vs. Observations

\[ R^2 = 0.53 \]
<table>
<thead>
<tr>
<th>Inflow: 0.7 Maf; Normal: 3.8 Maf</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Low Precipitation</td>
</tr>
<tr>
<td>- 0.7 Maf</td>
</tr>
<tr>
<td>• Unusually Regular Precipitation</td>
</tr>
<tr>
<td>- 0.5 Maf</td>
</tr>
<tr>
<td>• Surface and groundwater capture, land use changes, climate change</td>
</tr>
<tr>
<td>- 1.0 Maf</td>
</tr>
<tr>
<td>• Unexplained</td>
</tr>
<tr>
<td>- 0.9 Maf</td>
</tr>
</tbody>
</table>
Summary

• Highland Lakes 2011-2013: unexpectedly low inflow, even with drought
• Partly from unusual lack of extreme rainfall
• Partly from downward inflow trend, controlling for precipitation
• Partly unexplained
Rain gauge data