Are the Great Plains Going Dry?

Daniel L. Devlin
Director of the Kansas Center for Agricultural Resources and the Environment and the Kansas Water Resources Institute

Kansas State University
The Great Plains

Montana

North Dakota

South Dakota

Nebraska

Colorado

Kansas

Oklahoma

Texas
Average Annual Reference Evapotranspiration (ET)

Disclaimer: This map may depict isolated measurement errors, thus skewing the results creating gradient phenomena.

Legend
- K-State Weather Station
- Average ET (inches per year)
  - 30.51 - 45.00
  - 45.01 - 55.00
  - 55.01 - 65.00
  - 65.01 - 75.00
  - 75.01 - 87.00

KU
Kansas Geological Survey
The University of Kansas
University of Kansas – Lawrence, KS
Kansas State University Weather Library
ESRI Spline Interpolation
NAD 1983 UTM Zone 14 12 Jun 2012
Impact of Predicted Climate Change

- Expecting temperature increases of 1 to 4 degrees F over the next 50 years
- Extreme Events: total rainfall similar, but an increase in the frequency and severity of extreme events.

Statewide Annual Climate Trends (1895-2009)

<table>
<thead>
<tr>
<th>State</th>
<th>Average Temperature</th>
<th>Maximum Temperature</th>
<th>Minimum Temperature</th>
<th>Precipitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Dakota</td>
<td>2.9</td>
<td>2.4</td>
<td>3.2</td>
<td>4%</td>
</tr>
<tr>
<td>South Dakota</td>
<td>2.2</td>
<td>1.3</td>
<td>3.0</td>
<td>2%</td>
</tr>
<tr>
<td>Nebraska</td>
<td>1.2</td>
<td>0.3</td>
<td>1.8</td>
<td>3%</td>
</tr>
<tr>
<td>Kansas</td>
<td>1.1</td>
<td>0.6</td>
<td>1.5</td>
<td>7%</td>
</tr>
<tr>
<td>Wyoming</td>
<td>1.8</td>
<td>2.6</td>
<td>1.1</td>
<td>-14%</td>
</tr>
<tr>
<td>Colorado</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>1%</td>
</tr>
<tr>
<td>Average</td>
<td>1.7</td>
<td>1.4</td>
<td>1.9</td>
<td>0%</td>
</tr>
</tbody>
</table>

Source: High Plains Regional Climate Center
Ogallala Aquifer

Figure 14. Saturated thickness of the High Plains aquifer, 2000. (Modified from Weeks and Gutenson, 1981.)
Accumulated Water Level Change, 1996 to 2012
Estimated Usable Lifetime for Ogallala/High Plains Aquifer in Kansas Using Average
## Estimated and Predicted Water Storage in Kansas Portion of Ogallala Aquifer

<table>
<thead>
<tr>
<th>District</th>
<th>Predevelopment Storage ($10^9$m$^3$)</th>
<th>1960</th>
<th>2010</th>
<th>2060</th>
<th>2110</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northwest</td>
<td>93.1</td>
<td>90.6 (97%)</td>
<td>73.1 (78%)</td>
<td>42.2 (45%)</td>
<td>25.3 (27%)</td>
</tr>
<tr>
<td>West Central</td>
<td>31.1</td>
<td>28.4 (91%)</td>
<td>12.3 (39%)</td>
<td>5.7 (18%)</td>
<td>3.7 (12%)</td>
</tr>
<tr>
<td>Southwest</td>
<td>267.4</td>
<td>260.6 (97%)</td>
<td>187.0 (70%)</td>
<td>73.0 (27%)</td>
<td>21.9 (8%)</td>
</tr>
<tr>
<td>Total</td>
<td>391.6</td>
<td>379.6 (97%)</td>
<td>272.3 (70%)</td>
<td>120.9 (31%)</td>
<td>50.9 (13%)</td>
</tr>
</tbody>
</table>

## Impact of Water Reduction Scenarios on Estimated and Predicted Water Storage in the Kansas Portion of Ogallala Aquifer, 2110

<table>
<thead>
<tr>
<th>District</th>
<th>Groundwater in Storage With Different Water Reduction Strategies (% reduction from current use)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>(% in storage compared to predevelopment)</td>
</tr>
<tr>
<td>Northwest</td>
<td>27%</td>
</tr>
<tr>
<td>West Central</td>
<td>12%</td>
</tr>
<tr>
<td>Southwest</td>
<td>8%</td>
</tr>
</tbody>
</table>

Are the Great Plains Going Dry?

YES
Irrigation and the Ogallala/High Plains Aquifer
The Kansas High Plains Aquifer

- Ogallala
- Equus Beds
- Great Bend Prairie
Background

- Expansion of irrigation began after WWII.
- The aquifer is very heterogeneous.
- Recharge is minimal in much of the central and southern parts of the aquifer.
- Is recognized as a local and regional issue.
- Common pool resource.
- Some areas/farmers have already stopped irrigating. Many areas have experienced great declines in well capacity.
Points of Diversion - Development Over Time

1940
- Total Water Rights: 3
  - Surface-Water Rights: 3
  - Ground-Water Rights: 0

1950
- Total Water Rights: 442
  - Surface-Water Rights: 82
  - Ground-Water Rights: 360

1960
- Total Water Rights: 7,659
  - Surface-Water Rights: 1,235
  - Ground-Water Rights: 6,424

1970
- Total Water Rights: 16,114
  - Surface-Water Rights: 1,790
  - Ground-Water Rights: 14,324

1980
- Total Water Rights: 32,404
  - Surface-Water Rights: 2,657
  - Ground-Water Rights: 29,747

1990
- Total Water Rights: 36,555
  - Surface-Water Rights: 3,155
  - Ground-Water Rights: 33,400

2000
- Total Water Rights: 40,378
  - Surface-Water Rights: 3,694
  - Ground-Water Rights: 36,684

2010
- Total Water Rights: 45,190
  - Surface-Water Rights: 5,892
  - Ground-Water Rights: 39,308

Legend
- Water Rights
- High Plains Aquifer

KU Kansas Geological Survey - Geohydrology
University of Kansas - Lawrence, KS
Water Rights from KS Dept of Agriculture:
Division of Water Resources 09 Jun 2011
NAD 1983 UTM Zone 14 02 Aug 2012
1st district has 83.6% of state total market value of ag products sold

Top 8 counties account for 39.2% of 1st district total

Top 8 counties account for 32.8% of state total

Value in the top 8 counties is 84% livestock, 16% crops
Corn is by far the primary irrigated crop in Kansas.
2011 Kansas All Cattle

Number of Head

- Unpublished
- 20,001 - 30,000
- 30,001 - 60,000
- 60,001 - 100,000
- 100,001 - 200,000
- 200,001 +
Options

- Keep using until gone.
- Reduce withdrawal rates to extend the useful life of the aquifer.
- Increase irrigation efficiency to maintain and/or increase productivity to minimize effects.
- Go to a sustainable yield.
Irrigated Yields are Increasing 2.4X Faster Than Dryland and have Much Less Variability

Kansas Corn Yield Trend

Irrigated Yield Regression: $y = 2.5753x + 105.9$

Dryland Yield Regression: $y = 1.0792x + 59.315$
Final Thoughts

- Central and Southern Great Plains are getting drier
  - Irrigation
  - Climate change
  - Changes in cropping systems

- Crop production systems will transition from “full” irrigation to limited irrigation to dryland cropping systems.
  - Major impacts on food production and rural economies.