Measuring and Predicting Drought in Oklahoma: A Decision-Support and Educational Model

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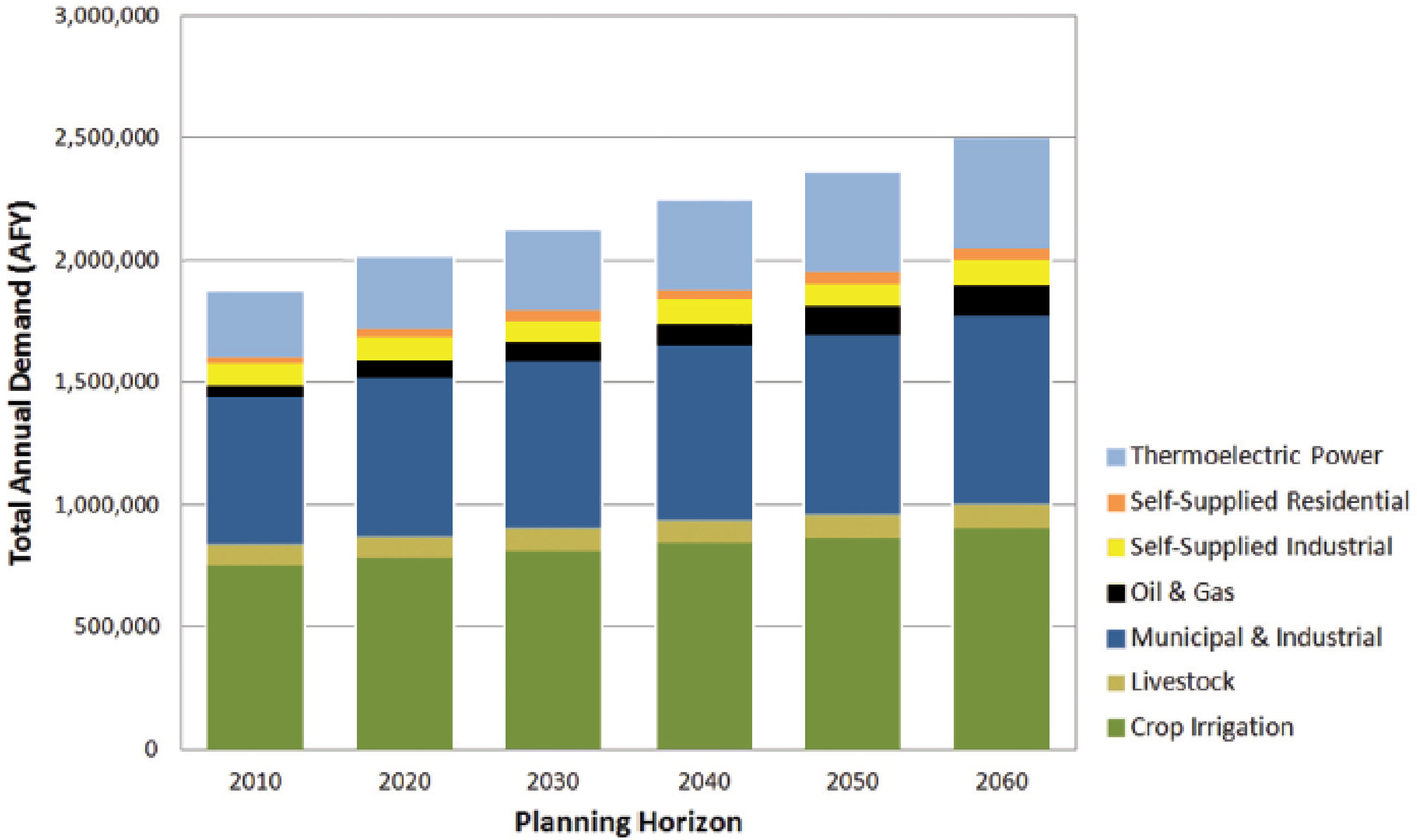
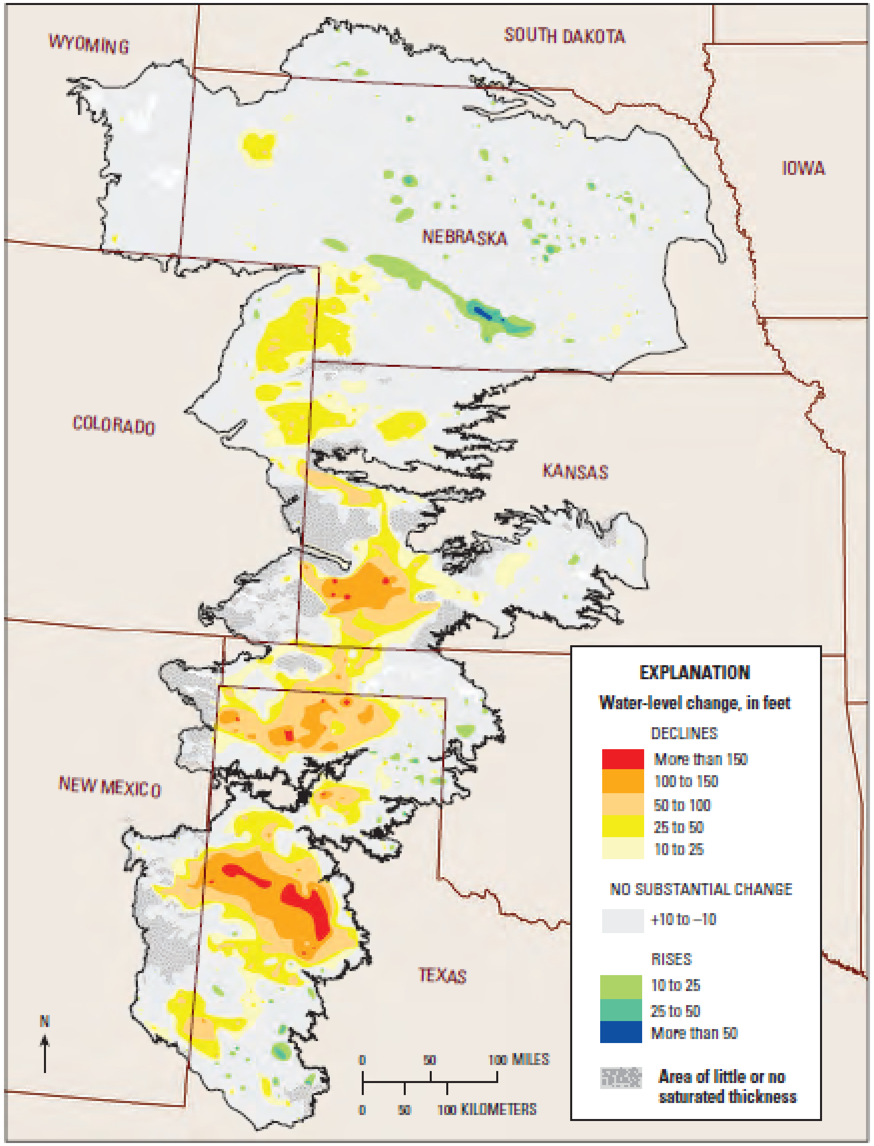
OK water issue 1 – **Growing water demand**



Source: OWRB (2015)

OK water issue 2 – **Decreasing supply/availability**



Source: USGS (2008), McGuire (2007)

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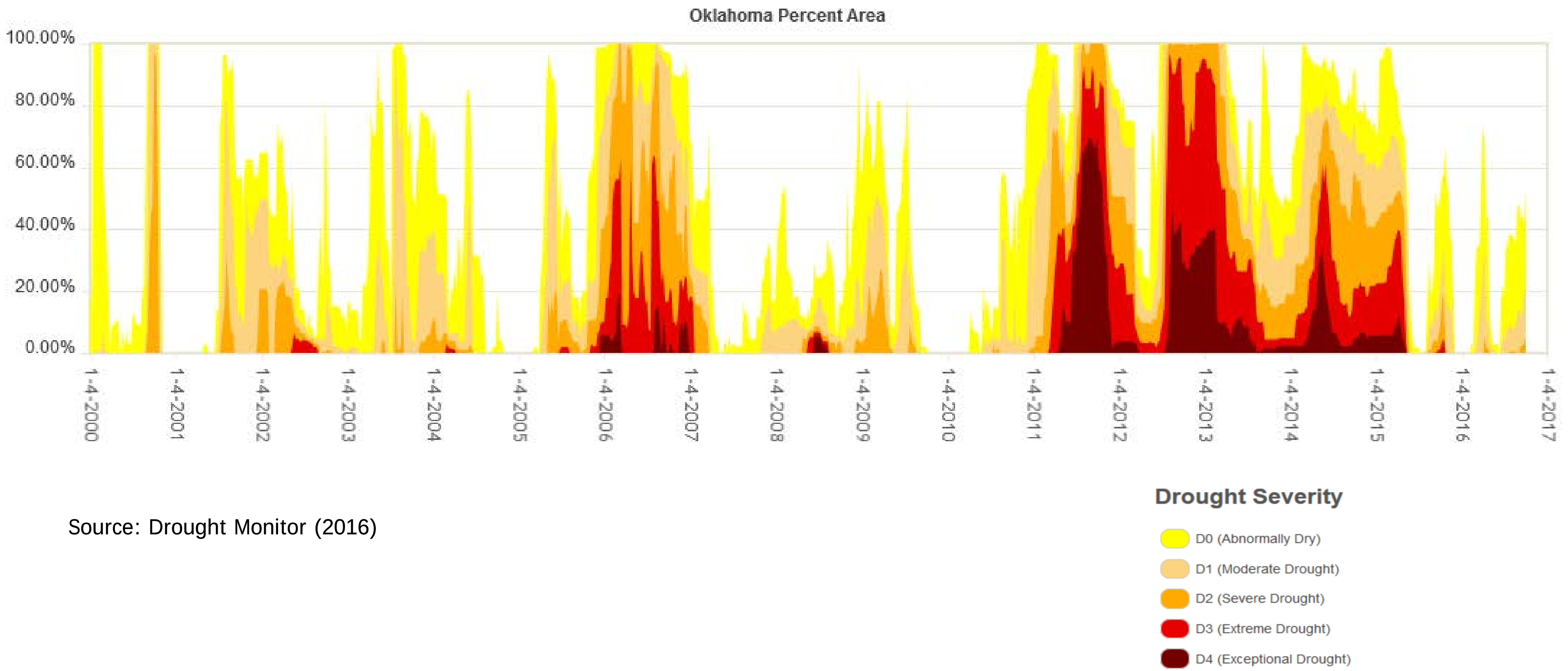
OK water issue 3 – **Weather variability**



Source: Drought Monitor (2016)

Research problem

- Since 2011: multiple and multi-year extreme and exceptional droughts in OK
- Economic losses in all sectors (especially agriculture)
- 73% of irrigation water comes from groundwater sources
- Groundwater supplies expected to fall by 30% in the next 50 years (OWRB; TWDB, 2012)
- Information on aquifer water levels missing – monitoring of water availability limited

What do we know about groundwater in Oklahoma?

Can we predict future water availability?

Research objective

Objective

Develop model to monitor and predict drought in Oklahoma in long-term

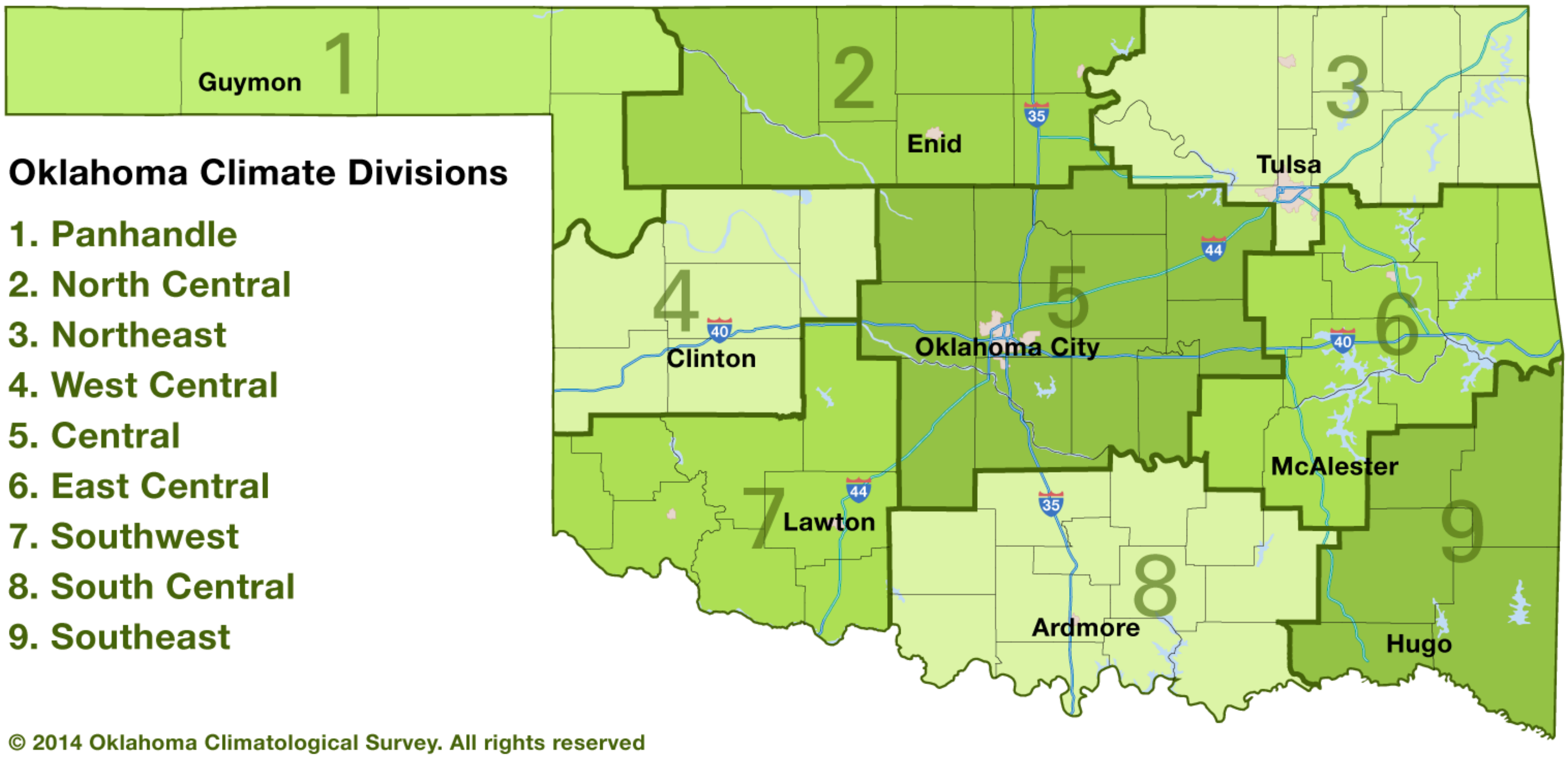
Hypothesis

Groundwater well levels and soil moisture are accurate indicators and predictors of drought in OK in 2003-2014

Proceeding to verify the hypothesis

1. Analyze changes in **groundwater well** and **soil moisture levels**
2. Use the **Palmer Drought Index** as validation (statistical and visual geospatial correlations)

Oklahoma climate regions



Methodology and data

- USGS water data base - Oklahoma groundwater well numbers
- Identified 20,162 groundwater wells in Oklahoma; selected 390 wells (with 3,169 samples)
- Rules for selecting wells:

  a) at least 1 sample/ 3 time sections: 2003-2006, 2007-2010, 2011-2014

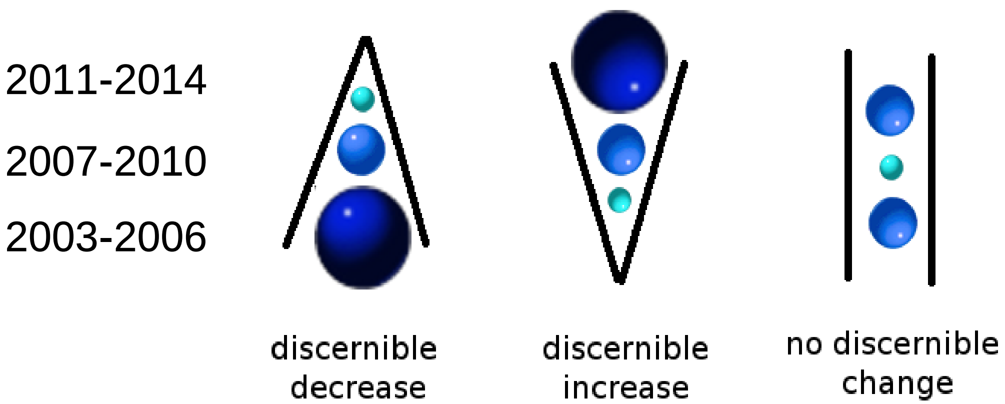
  b) at least 5 samples minimum
- Soil moisture data from OK Mesonet
- 4D visualization model - Natural ternary visual shape logic:

  a) Identify regional differences in water well changes (geospatial dimension)

  b) Evaluate changes over time (2003-2014) (temporal dimension)

Methodology 1 – Groundwater well levels

– Natural ternary visual shape logic (NTVSL) method (compare: Russian computer Setum with 3 states: positive, negative, and neutral)

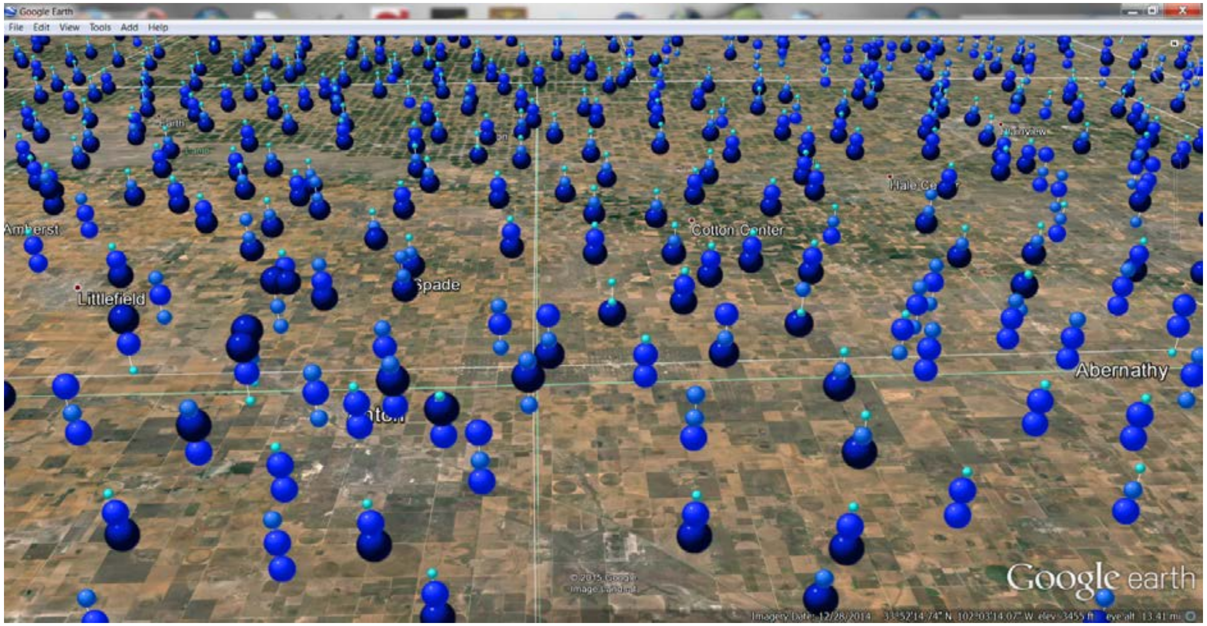


– Visual detection of statically relevant and discernible well water decreases, increases, and no discernible changes

– C++ language used to code the data, read the statistical results and output them as a KML file

Results – Groundwater well levels in OK

– Subset of 4 year interval sections: 2003-2006, 2007-2010, 2011-2014
– The values for each well are normalized statistically in 2003-2014



http://www.hitechmex.org/OK_TX/index.html

http://www.hitechmex.org/OK_TX/OK_TX_wells_Palmer2003_2014v3.kmz

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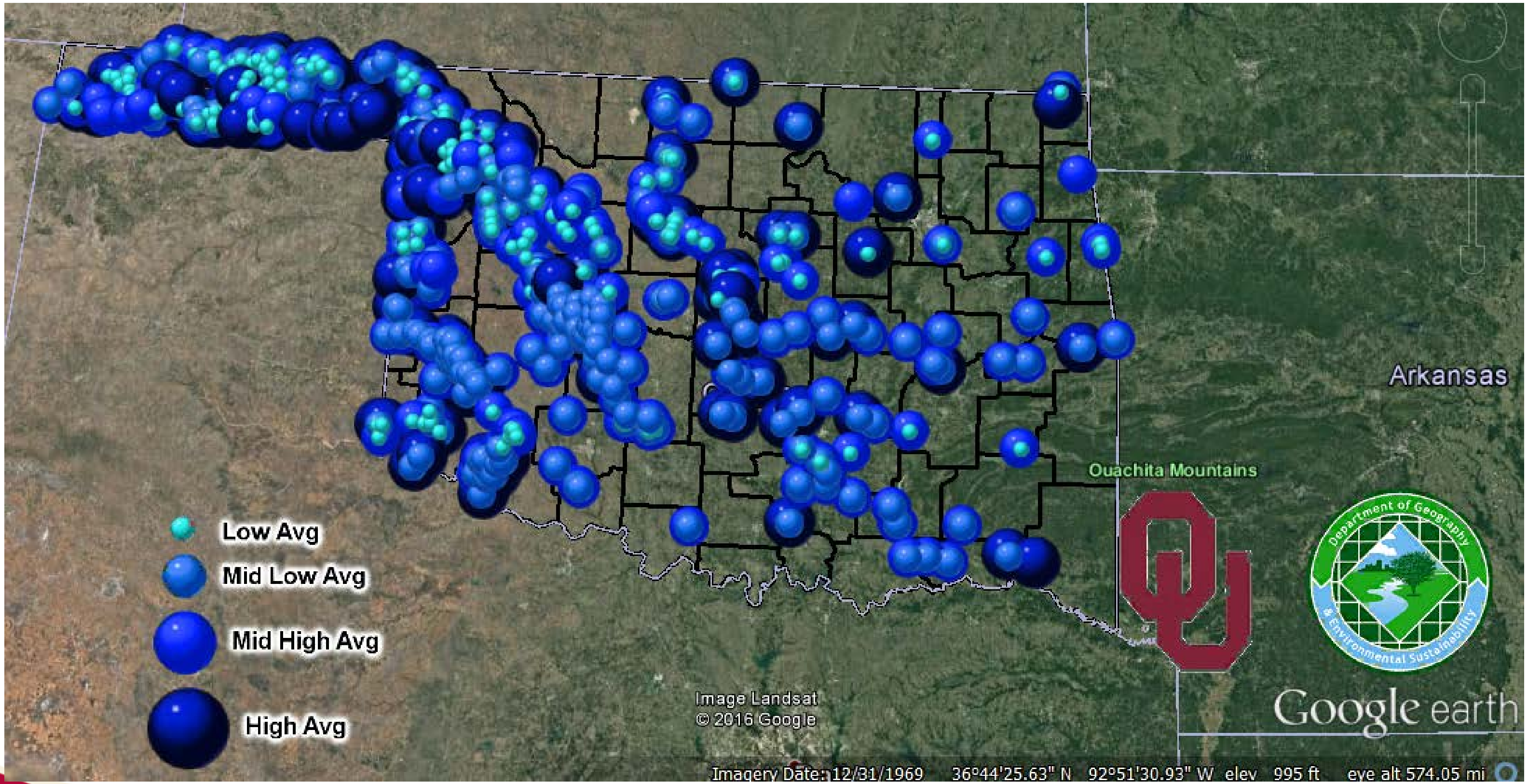
Results – Groundwater well levels in OK

– Spheres are clickable & bring up a balloon information window with statistical information

– Water levels in most of the wells have been decreasing → potential indicator of recent droughts (witch's hat cone shape)



Methodology 2 – Palmer Drought Index

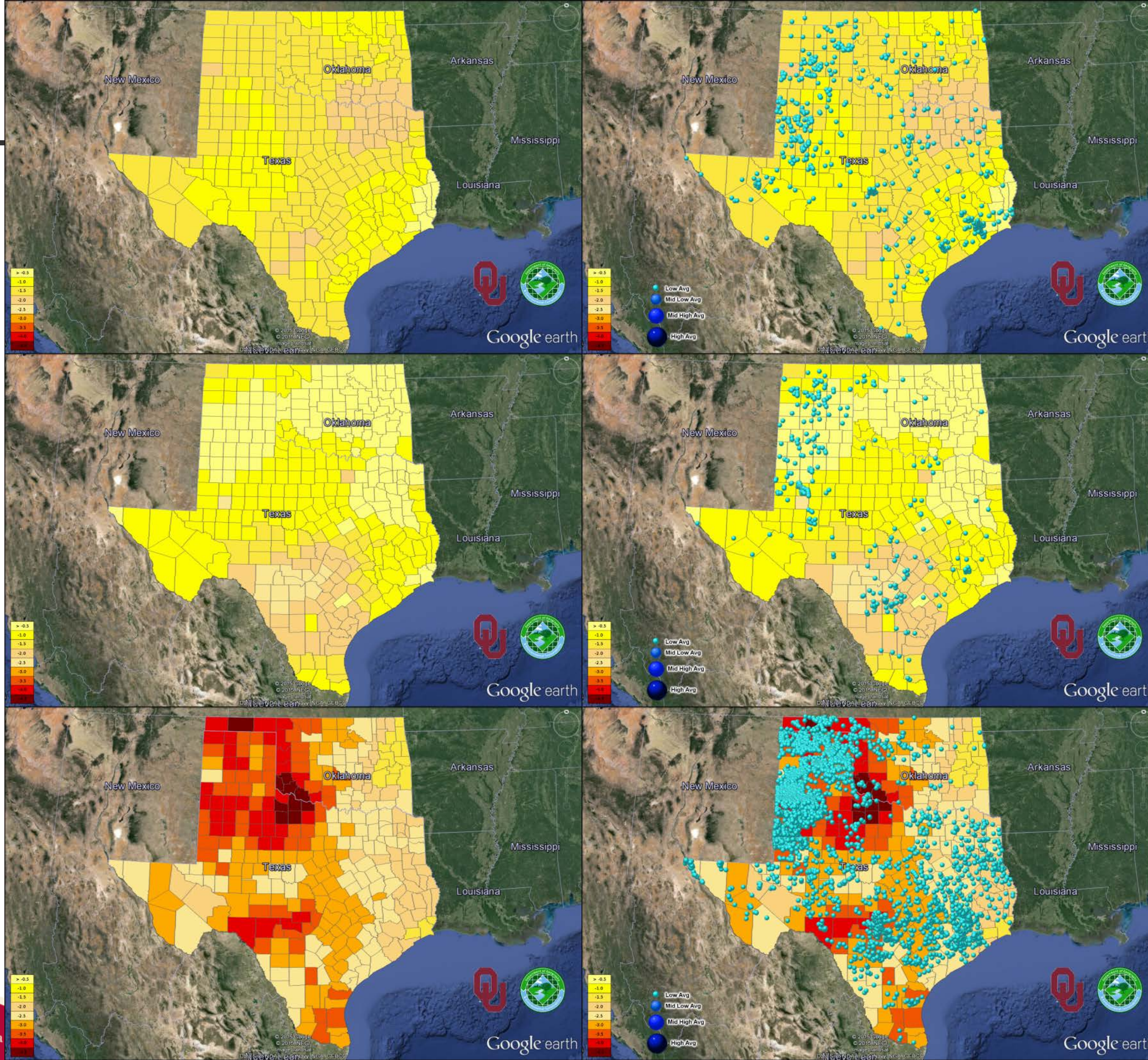
- **Palmer Drought Severity Index** uses temperature and precipitation data to calculate water supply and demand & incorporates soil moisture
- More extensive and complex than other drought indicators (Standardized Precipitation Index, Keetch-Byram Drought Index, Crop Moisture Index, Drought Monitor) to reflects long-term drought

Ziolkowska, J.R.; Reyes, R. (2017): Groundwater Level Changes due to Extreme Weather - An Evaluation Tool for Sustainable Water Management. *Water* 9(2) 117
http://www.mdpi.com/2073-4441/9/2/117

2003-2006

2007-2010

2011-2014



Methodology 3 - Soil moisture levels

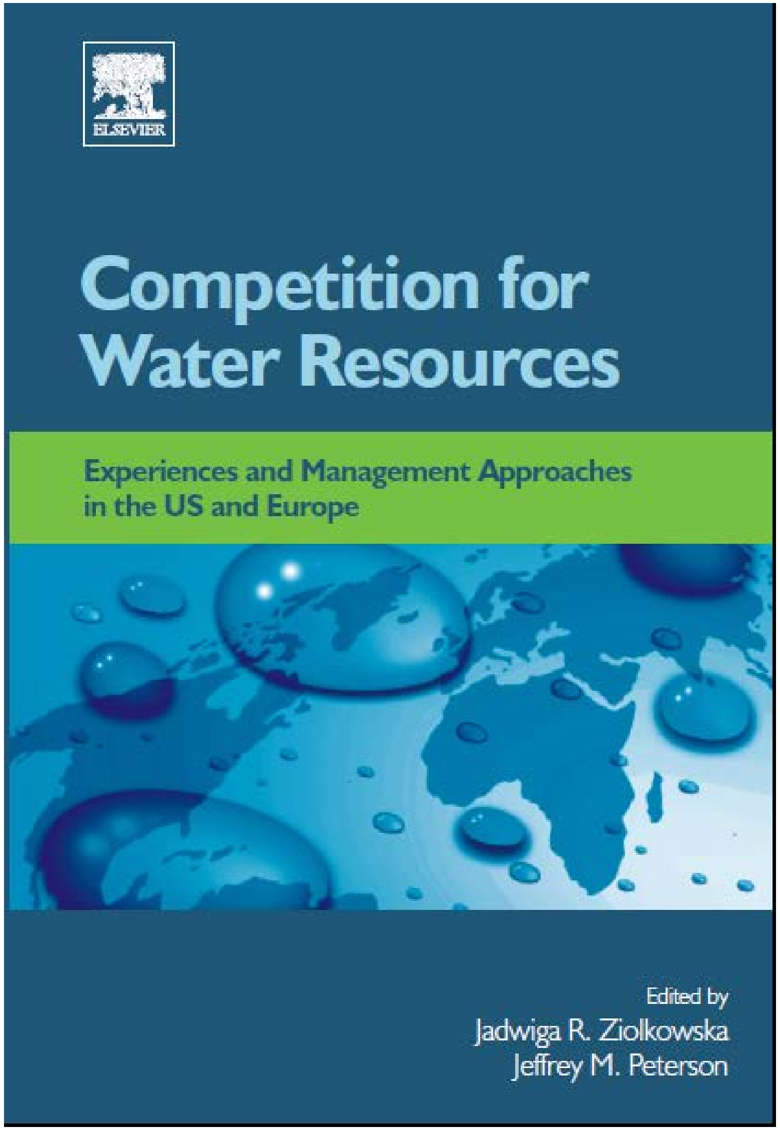
This presentation has been modified for website purposes as this part of the research is still work in progress.

We will make it available as soon as it is completed and published.
Thank you for your understanding.

Please contact Dr. Ziolkowska if you have questions about this research project at jziolkowska@ou.edu

Conclusions and outlook

- Groundwater well levels and soil moisture levels are highly correlated with Palmer → hypothesis positively verified
- Correlations between groundwater and soil moisture, groundwater and Palmer index, groundwater + soil moisture + Palmer index
- GRACE results as another possible drought indicator and predictor
- Hybrid drought indicator
- Interactive geospatial visual representation is helpful for scientific and decision-making purposes
- Models available to view in a virtual globe on any modern computer system application (Windows, Mac, Linux, and smartphones) (no license fees)
- Socio-economic impacts of drought in Oklahoma



New book on water resources

edited by

Dr. Jad Ziolkowska & Dr. Jeff Peterson

KEY FEATURES

- Provides a national and regional perspective through the use of country specific case study examples
- Includes a comparative analysis between the US and Europe, illustrating experiences in water management from two sides of the Atlantic
- Covers interdisciplinary topics related to water, such as agriculture and energy

International perspective on water scarcity problems and useful management methods and best practices in the US and Europe