ASSESSING AGRICULTURAL DROUGHT IN SUMMER OVER OKLAHOMA MESONET SITES USING LSWI FROM MODIS

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INTRODUCTION AND RATIONALE:

- Land surface water index (LSWI), calculated as a normalized ratio between near infra-red (NIR) and short wave infra-red (SWIR), is sensitive to vegetation and soil water content.
- Because agricultural drought occurs due to lack of soil moisture and the consequent water stress in the vegetation, a water-based index should also be used along with NDVI and EVI.
- This study examined the potential of a LSWI- based drought monitoring algorithm to assess summer drought over 113 Oklahoma Mesonet stations comprising various land cover and soil types in Oklahoma.

HYPOTHESIS AND RESEARCH QUESTIONS:

Hypothesis: the water related vegetation index LSWI computed from time series MODIS images offers a new and improved capacity for drought monitoring

Questions:

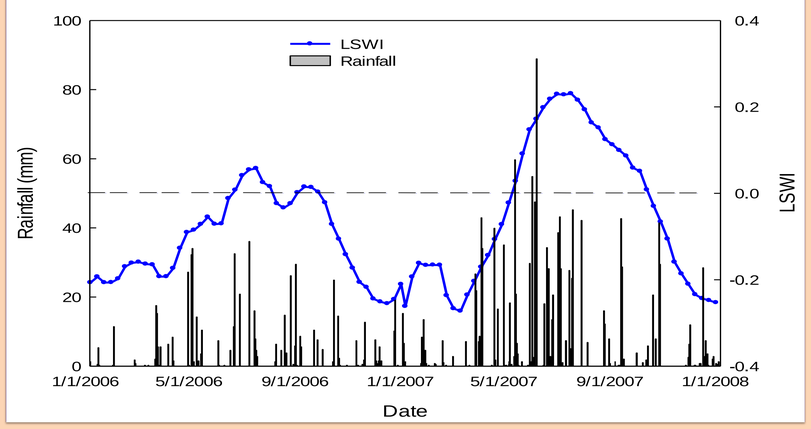
- Is LSWI anomaly able to capture the drought events across multiple sites over years?
- Is LSWI-based drought monitoring algorithm developed for two tallgrass prairie sites (Bajgain et al., 2015) applicable to quantify drought intensity over 113 Mesonet sites comprising various land cover and soil types in Oklahoma?
- What is the relationship between the DNLSWI to drought intensity classified by USDM?

MATERIALS AND METHODS:

- Study site: 113 Mesonet stations that have continuous measurements of meteorological parameters from 2000-2013.
- Time series vegetation indicies (MOD091) data were downloaded from the data portal at the Earth Observation and Modelling Facility (EOMF), University of Oklahoma (http://eomf.ou.edu/visualization/gmap)
- **United States Drought Monitor (USDM) data:** weekly USDM drought maps for Jun-Aug (2000 to 2013) were provided by the National Drought Mitigation Center (NDMC) in shape file format and then rasterized to the 10-km ALEXI CONUS grid

(http://www.drought.unl.edu/MonitoringTools/USDroughtMonitor.aspx)

- **LSWI-based agricultural drought monitoring algorithm**



RESULTS:

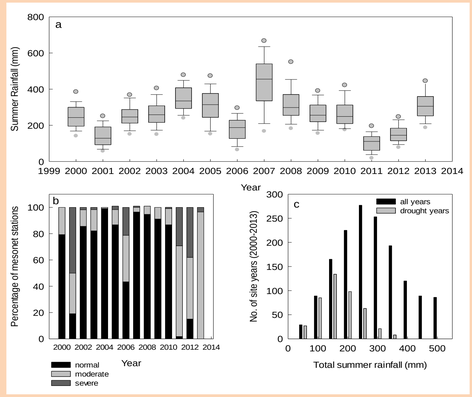


Fig. 1. Summer rainfall across 113 Mesonet sites during 2000-2013 (a). Yearly summer drought analysis by rainfall deficiency: percentage of the Mesonet stations under three drought categories (severe, moderate and normal) for 2000 -2013 (b) .The frequency distribution of site-year grouped under different summer rainfall regimes (c) for whole study period (2000 -2013) and for drought years (2001, 2006, 2011, and 2012).
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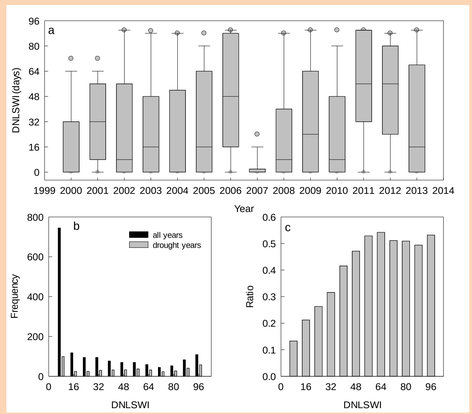

Fig. 2. Duration of LSWI < 0 (DNLSWI) across 113 Mesonet sites during 2000-2013(a). The frequency distribution of the Mesonet stations (113 stations times 14 years) with associated DNLSWI for 2000 -2013 (b) and the ratio of number of stations with drought years to total years (drought and normal) for respective DNLSWI bins (c)

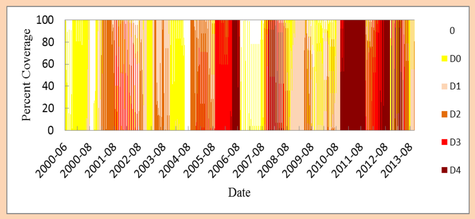

Fig. 3. Percent of Oklahoma area covered by a USDM drought designation from 2000-2013. The designations 0 (no drought), D0 (Abnormally dry), D1 (Drought-Moderate), D2 (Drought-Severe), D3 (Drought-Extreme), and D4 (Drought-Exceptional) are the drought intensity classes defined by USDM)

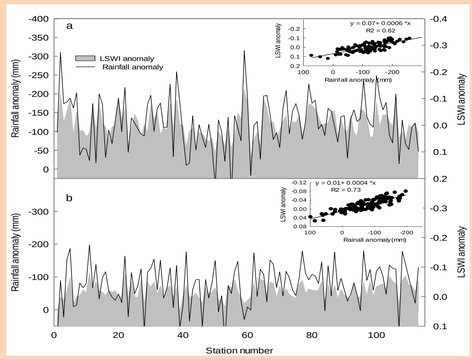

Fig. 4. Dynamics of summer rainfall and LSWI anomalies in drought years: at 113 Mesonet stations. The inset graphs are the regression analyses between summer rainfall and LSWI anomalies (n=113)

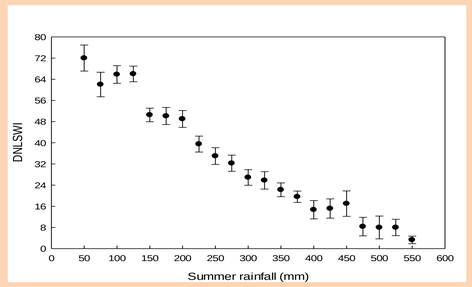

Fig. 5. Relationship between summer rainfall and duration of LSWI < 0. Each point is an average for all Mesonet stations binned by 50 mm of summer rainfall

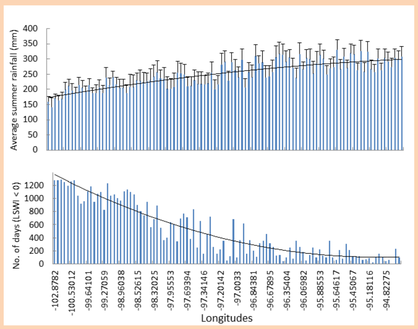

Fig. 6. The performance of LSWI to track East-West rainfall gradient of Oklahoma: (a) average summer rainfall gradient from East to West and (b) DNLSWI (total number of days with LSWI < 0 during summer months) from 2000-2013 for 113 Mesonet stations

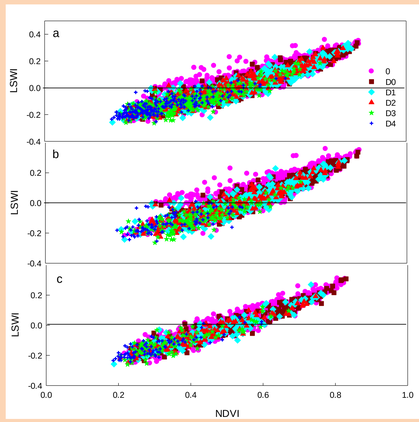

Fig. 7. Relationship between: NDVI and LSWI for individual pixels of the all types (a), grasslands (b), and croplands (c) land cover sites for Jun – Aug over a 14-year study period (2000-2013). Each point in the plot represents the weekly observation of drought intensity from U.S. drought monitor (USDM) drought maps

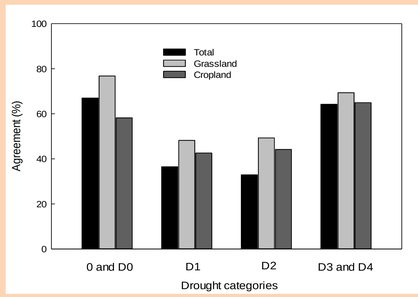

Fig. 8. Agreement of the drought intensity class to the LSWI-based classification adapted from Bajgain et al. 2015

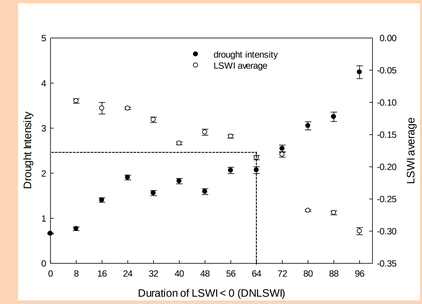

Fig. 9. Relationship between USDM based drought intensity classes, DNLSWI (duration of LSWI < 0) and average LSWI. The USDM drought intensity classes 0, D0, D1, D2, D3, and D4 are set to 0, 1, 2, 3, 4, and 5 respectively

CONCLUSIONS:

- Results of LSWI analysis for the period of 2000-2013 for the OK Mesonet stations revealed valuable information within the context of drought tracking.
- LSWI is sensitive to rainfall variations and can be an indicator of drought occurrence in an ecosystem.
- the LSWI-based drought intensity class was reliable for low and high intensity classes defined by USDM.
- By counting the number of DNLSWI, drought intensity thresholds can be established and used as a simple complementary tool in several applications .

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