INTRODUCTION AND RATIONALE:

Grassland vegetation is sensitive to variability in precipitation and soil moisture and is affected by the frequently occurring drought events. The assessment of agricultural drought often uses greenness-related vegetation indices (VIs) such as normalized difference vegetation index (NDVI), and enhanced vegetation index (EVI). There is a need to evaluate the sensitivity of water-related vegetation index such as land surface water index (LSWI) to assess drought. This poster reports the results from a data analysis of (1) vegetation indices derived from the Moderate Resolution Imaging Spectroradiometer (MODIS), (2) climate and soil moisture data from OK Mesonet station and (3) US Drought Monitor.

OBJECTIVES:

- explore the relationship between seasonal and inter-annual rainfall variability and dynamics of grassland vegetation growth
- ascertain the sensitivity of VIs (NDVI, EVI and LSWI) to rainfall and soil moisture variations
- investigate additional drought information rendered by land surface water index (LSWI), based on episodic drought events over time series (2000-2013)

MATERIALS AND METHODS:

Study site: Native grassland ecosystem located at Marena and El Reno, Oklahoma. Time series vegetation indices (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). Daily precipitation, and soil moisture data from 2000-2013 at the Oklahoma Mesonet Marena and El Reno stations, were downloaded from the Oklahoma Mesonet website http://www.mesonet.org/index.php/weather/daily_data_retrieval.

The drought categories (D0, D1, D2, D3 and D4) for the study areas were determined based on the weekly drought maps published by the U.S. drought monitor (USDM) (http://droughtmonitor.unl.edu/MapsAndData/).

RESULTS:

Fig. 1. The variability of annual rainfall at study sites over time (2000-2013). The anomaly of rainfall is calculated as percentage change from a 14-year average rainfall.

Fig. 2. Inter-annual variation of soil water content (SWC) and vegetation indices. The vertical bars represent the total growing season (March–October) rainfall.

Fig. 3. Sensitivity analysis of three vegetation indices (NDVI, EVI, and LSWI) to drought. The change in percentage of vegetation indices is computed based on 14 years average values deviated from mean.

Fig. 4. Schematic diagram showing seasonal dynamics of air temperature, NDVI and LSWI in drought (2006) and non-drought year (2007). The inset table (below) presents the designation of drought types based on LSWI values and seasons.

Fig. 5. Comparison of seasonal patterns of NDVI, EVI and LSWI (mean monthly values) between dry, wet and 14-year average; a, b and c represents 2006 (dry), 2007 (wet) and 14-year average and d, e and f represent 2012 (dry), 2013 (wet) and 14-year average for Marena site.

Fig. 6. Relationship between duration of negative LSWI and cumulative rainfall during summer (June-August).

Fig. 7. Relationship between: NDVI and LSWI and EVI and LSWI for individual pixels of the grassland study sites for June–August over a 14-year study period (2000-2013). Drought severity categories defined by USDM, Palmer Drought Severity Index (PDSI) and LSWI-based drought categories (inset table).

Fig. 8. Seasonal soil moisture dynamics between dry and wet years and sensitivity of NDVI (a,b) EVI (c,d) and LSWI (e,f) to declining soil moisture at 5 cm depth (Marena).

Fig. 9. Seasonal dynamics and inter-annual variation of COSMOS- based soil moisture and vegetation indices: (a) NDVI (b) EVI and (c) LSWI.

CONCLUSIONS:

- LSWI values decreased more in response to drought conditions than commonly used NDVI and EVI, indicating that LSWI was more sensitive than NDVI and EVI to the drought events over grassland.
- The number of days with LSWI < 0 was found higher during the summer droughts of 2006 and 2012 and negative LSWI represented the higher intensity drought categories (D2, D3 and D4) defined by USDM.
- A new approach, counting day’s frequency with LSWI < 0 and LSWI-based drought severity classification, for assessing drought is proposed in this study.