Calculating SPEI to contextualize our sampling times within drought

steppe

The AIM sample design is split into five panels, one for each year, with the intention that temporal analyses can be conducted across the panels (*see X.X for more info*). Ideally, these panels will reflect consistent natural climatic variation. In others words, some years will be drier while other years will be wetter. However, we felt, and our constant monitoring of the University of Nebraska-Lincolns Drought Monitor over this period, supported the notion that we sampled during a period of immense drought. Here we contextualize our sampling period within the known climatic variation in the field office, and discuss why we dismiss calculating AIM metrics separately for each year.

Contrary to the concept of Agricultural drought, the exploration and understanding of Ecological drought is nascent and not as well defined (Crausbay et al. ([2017](#ref-crausbay2017defining))).

“**ecological drought** … an episodic deficit in water availability that drives ecosystems beyond thresholds of vulnerability, impacts ecosystem services, and triggers feedbacks in natural and/or human systems”

— Crausbay et al. 2017

To calculate Sun hours the r.sun function from GRASS GIS was used to calculate the sun hours for across the field office for the year 2010.

The means of each month was taken and used as sun values across the entirety of the temporal domain.

Variables required to calculate SPEI (using the SPEI package), via the Penman equation

| Variable | Source |
| --- | --- |
| precipitation sum (mm) | GridMET (pr) |
| mean max temp (ºC) | GridMET (tmmx) |
| mean min temp (ºC) | GridMET (tmmn) |
| mean rel. humidity |  |
| mean wind speed (km h-1) | GridMET (vs) |
| mean sun hours (hours) | r.sunhours (’sunhour) |
| mean solar radiation (MJ-m-d) | r.sun (‘beam\_rad’) |
| mean cloud cover (percent) | Wilson, EarthEnv |
| elevation in meters | EarthEnv 250 |

SPEI was calculated for all 42 years between 1979-2021. Cells in rasters which contained missing (NA) values, these resulting from missing a value required for either the penman or SPEI calculations, were filled using the ‘focal’ function from the r package ‘Terra’. This function calculated the mean of the 9. SPEI was calculated using moisture balances of the: 6, 12, 24 months preceding the current month of analysis. For example, the SPEI value for the Month of January 1981, under a scenario with a 6 month window, would go back as far as June 1980, while for a longer window such as 24 months, would go back to January 1979. Because our SPEI calculations included these windows, each data set could not-natively start at the same date. For example our dataset with the longest SPEI window, 24 months, exceeded the shortest windows by 18. Accordingly, we removed any months of values preceding the origin date for the start of the longest SPEI calculation intervals, and for ease of analysis and reporting began our background climate dataset in 1981.

We subset the drought data so that the beginning period for all temporal extents has the same start date, January 1981. It is recommended to have 30 years of climate data to compare local conditions to. We will span the years from 1981-2015 as our 34 year background data. This will also allow a slight degree of buffering between our data sets, so that the starting times between our two datasets, the occurrence of drought during the AIM sampling, and the historic climate variables are not temporally replicated.

Crausbay, Shelley D, Aaron R Ramirez, Shawn L Carter, Molly S Cross, Kimberly R Hall, Deborah J Bathke, Julio L Betancourt, et al. 2017. “Defining Ecological Drought for the Twenty-First Century.” *Bulletin of the American Meteorological Society* 98 (12): 2543–50.