Defining (and observing) Drought for Resource Management?

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The NC CASC is the climate change research, information, and support center for resource managers and decision makers in the North Central region.

**Mission:**

- Provide **climate-informed** management options which bridges local to regional needs and institutions, and integrates across **multiple scales of climate, ecosystem services and sectors** of interest across 7 state region.

So **DROUGHTS** matter to Resource Managers, but in different ways.
Drought Risk and Adaptation in the (DOI) Interior (DRAI)

Field sites in region:
Northwest CO Yampa River Basin
Southwest South Dakota
Wind River Indian Reservation
(plus developing other study areas)

Resource areas include wildlife, livestock (e.g., cattle and bison), forage, water, croplands, landscapes
Current Challenges

• Dealing with non-stationarity
• Emergence of regime shifts contributing to “flash-droughts” and chronic drought conditions
• Multiple resources and multi-criteria decision making across agencies
Assessing Climate Change Impacts
Trade-Offs and/or Opportunities

Wildlife

Livestock Production

Ecosystem Integrity

Ranching, Farming, Other Livelihoods
Social Ecological Context of Drought

• Drought affects managers differentially depending on conservation or management targets

• Spatial and temporal timing of drought affect species, landscapes, and ecosystems in different ways

• Livelihood needs differ relative to adaptive capacity of the household, ranch, community
How do we monitor DROUGHT?

- Drought Forecasts using remote sensing products (SSEBop), meteorological data (EDDI: Hobbins and Rangwala), and ecosystem modeling (Grasscast: Parton later today)
- Increasing spatial pattern of drought representation
- Spatial and temporal timing of drought affect species, landscapes, and ecosystems in different ways
ET Estimations (PET to Eta)

Step I: PET

VegETA vs Flux LE: Arizona 2005
cover: grassland

Step II: ETA
PET: Evaporative Demand Drought Index (EDDI)

https://www.esrl.noaa.gov/psd/eddi/
(details provided by Hobbins and Rangwala)

- Standardized anomalies in “evaporative demand” (i.e. Penman-Monteith PET)
- Near real-time (5 day lag)
- 12km NLDAS-2 meteorological driving variables

EDDI Web Utility contains:
- Current EDDI Maps
- Historical (1980-current) Time-series Data
Particularly strong in capturing precursor signals of drought at weekly to monthly timescales

EDDI 2015 Growing Season in Wind River Indian Reservation, WY (Rangwala and Dewes)
Operational Simplified Surface Energy Balance (SSEBop) Modeling Approach

Adapted the “hot” and “cold” pixel concept from SEBAL (Bastiaanssen et al., 1998) and METRIC (Allen et al., 2007) to calculate ET fraction...

**SSEB:** Senay, et al., 2007 Sensors; 2011 AWM; **SSEBop:** 2013 JAWRA; 2016, 2017 RSE
Pre-defined hot/dry and cold/wet limits are KEY!

Transect:
Ts = MODIS LST
Tc = Cold boundary (c.Ta_max)
Th = Tc + dT

310 k = 99 F
330 k = 135 F

G. Senay USGS
Daily ETr for Maricopa and Grand Junction, 2014

PET 40% higher

Elevation:
MC: 358 m
GJ: 1,397 m

ETr processed from GRIDMET (Abatzoglou, 2012)
Rangeland Seasonal SSBEBop Anomalies

SSEBop Growing Season ET Anomaly
April - October
2010

iSEBop Growing Season ET Anomaly
April - October
2011

SEBop Growing Season ET Anomaly
April - October
2012

ET Anomaly (%)
- <= 50
- 50 - 70
- 70 - 90
- 90 - 110
- 110 - 130
- 130 - 150
- > 150

Maps showing the seasonal SSBEBop anomalies in rangeland ecosystems for the years 2010, 2011, and 2012, with varying color schemes indicating different ET anomaly percentages.
Validation of Drought Dynamics
Oklahoma Flux towers
Validation of Drought Dynamics
Wind River Reservation - Drought Year 2012 Growing Season ETa vs Drought Monitor

Provided by Gabriel Senay (USGS)
Remarks on SSEBop Approach

• SSEBop ET is a physically-based ET model that relies on LST for spatial variability and ETo for seasonality.

• “Satellite Psychrometry” appears to explain the mechanics of SSEBop.

• SSEBop ET anomaly is currently used for operational drought monitoring and early warning.

• At least, one-time validation with independent data is recommended on new hydro-climatic region for bias removal.
Next Steps

• Co-design drought indicators with different resource managers in our region
• Further explore ecosystem dynamics at various landscape and seasonal scales to assess drought affected areas linked to management needs
• Evaluate ecosystem level precursors for these drought indicators such as soil moisture conditions, long-term climate trends affecting potential evapotranspiration fluxes)
• Develop adaptation options for different natural resource management objectives
SUMMARY

- Drought effects and pre-conditions need to be linked to management targets
- Remote sensing and meteorological products can provide improved spatial and temporal insights of drought events
- Ecosystem modeling enhances mechanistic representation of drought development
THANK YOU

http://nccsc.colostate.edu/
North Central Climate Science Center