EDDI

A Powerful Tool for Early Drought Warning

Green River, Wyoming. Photo: K. Miller, USGS.

What is EDDI?

EDDI, which stands for *Evaporative Demand Drought Index*, is a drought index that can serve as an indicator of both rapidly evolving “flash” droughts (developing over a few weeks) and sustained droughts (developing over months but lasting up to years).

Why use EDDI?

EDDI has been shown to offer early warning of drought stress relative to current operational drought indicators, such as the US Drought Monitor (USDM) (***see Figure 1***). A particular strength of EDDI is in capturing the precursor signals of water stress at weekly to monthly timescales, which makes EDDI a potent tool for drought preparedness at those timescales. EDDI also uses the same classification scheme as the USDM to define drought conditions, so it is easy to read EDDI maps.

Does EDDI work in real time?

Yes. At present, EDDI is generated every week by analyzing a real-time atmospheric dataset. There is also an ongoing effort to forecast EDDI based on seasonal climate-forecast information.

What is the physical basis for EDDI?

EDDI exploits the strong physical relationship between evaporative demand (**E_0**) and actual loss of water from the land surface through evapotranspiration. **E_0** is the “thirst of the atmosphere,” estimated by the amount of water that would evaporate from the soil and be transpired by plants if the soil were well watered. EDDI measures the signal of drought using information on the rapidly evolving (daily) conditions of the atmosphere to estimate their impact on land-surface moisture, and vice versa. EDDI’s effectiveness in reflecting the moisture conditions on the land surface is based on feedbacks between the atmosphere and land that are particularly strong during the warm season, when drought is of greatest concern.

EDDI is sensitive to two distinct land-surface atmosphere interactions: (i) increased **E_0** drives increased evapotranspiration until the available soil moisture becomes limiting, potentially leading to flash droughts; and (ii) as surface water becomes increasingly scarce in sustained droughts, evapotranspiration declines, which leads to higher air temperature and lower humidity, and thereby increases **E_0**.

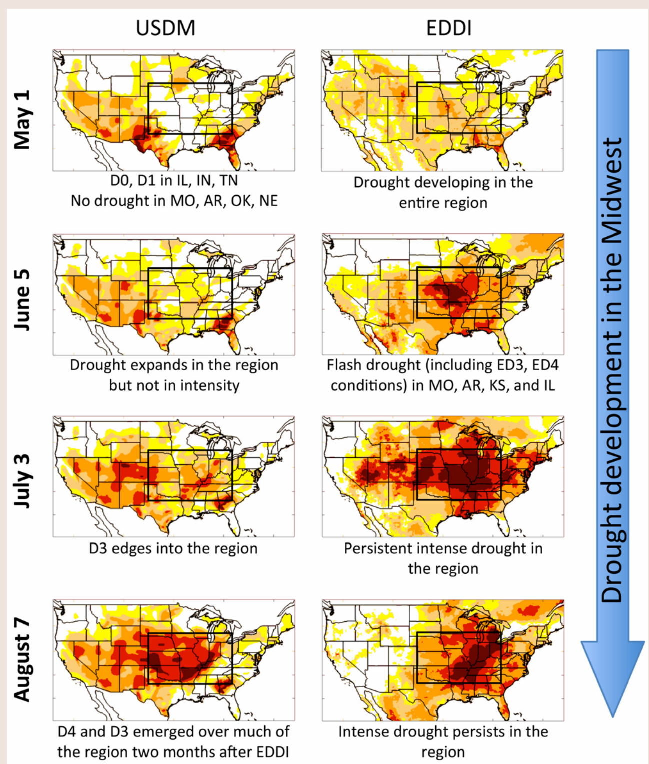

Figure 1

Development of a flash drought in the Midwest in 2012. The 2-week EDDI (right) is compared at 5-week intervals to the US Drought Monitor (USDM) (left). EDDI captures the severe drought condition two months ahead of the USDM. Image: Mike Hobbins.

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Is the calculation of EDDI sensitive to land-surface type?

No, EDDI is based on relative changes in E_0, so it is not sensitive to land-surface type and is a valid drought indicator for all regions.

How is EDDI calculated?

EDDI is a measure of the departure of E_0 aggregated across a time-window of interest relative to historical conditions (from a 30-year climatology). E_0 is calculated as reference evapotranspiration based on the FAO-56 Penman-Monteith formulation. At each point in space, the rank of aggregated E_0 relative to its climatology is converted to a percentile, which is then assigned to different drought categories – e.g., ED0, ED1, etc. – that are equivalent to the categories used by the USDM. The time-window of interest could be specific weeks or months in any given year, up to the present. For example, a 2-week EDDI will aggregate two weeks of E_0 and estimate its departure relative to the historical aggregation of E_0 for those two weeks. ***Figure 2*** shows an example of 2-week EDDI for the Wind River Indian Reservation in central Wyoming between May 26, 2015, and September 29, 2015.

What time-window information on EDDI is most appropriate?

The optimal time-window for EDDI will be user- and sector-dependent. For example, an irrigator may be interested in short-term EDDI – say across a 2-week window – to track and respond to weather-scale changes, whereas a reservoir operator more interested in interseasonal variations in snowpack may find more utility in a 6-month EDDI that examines the behavior across the snow accumulation and snowmelt periods. Given the natural and physical linkages between E_0 and wildfire risk, work is ongoing to establish the optimal timescales for fire-weather prediction. Indeed, the US Forest Service Rocky Mountain Research Station uses 1-month EDDI in their seasonal forecasting of the numbers of large fires and of fire-suppression costs. For other cases, consideration of EDDI information at multiple timescales would be useful.

Where can I get EDDI data and maps?

EDDI is an experimental product. To receive EDDI data and maps, please contact Mike Hobbins (mike.hobbins@noaa.gov). Currently, EDDI maps for the Rocky Mountain region are being presented in the weekly NIDIS Upper Colorado River Basin Drought and Water Assessment (http://climate.colostate.edu/~drought). In the near future, we hope to make EDDI data available through the WWA Climate Dashboards and, looking further out, to have EDDI data distributed nationally by the National Weather Service.

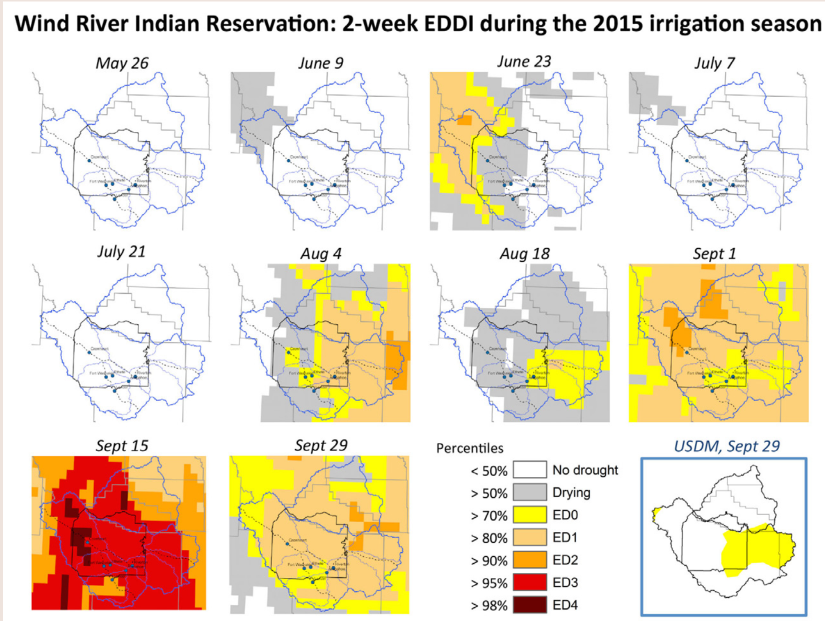

Figure 2

Drought development in the Wind River Indian Reservation across the irrigation season, as observed by a 2-week EDDI at 2-week intervals. Drying did not appear in the US Drought Monitor until September 29 (blue-outlined map at bottom right). Image: Mike Hobbins.

References

Hobbins MT, Wood A, McEvoy D, Huntington J, Morton C, Anderson M, Hain C, and Verdin, The Evaporative Demand Drought Index: Part I - Linking drought evolution to variations in evaporative demand. Journal of Hydrometeorology (In revision).

McEvoy D, Huntington J, Hobbins MT, Wood A, Morton C, Anderson M, Hain C, and Verdin J, The Evaporative Demand Drought Index: Part II - CONUS-wide assessment against common drought indicators. Journal of Hydrometeorology (In revision).

Hobbins, MT (2014), Measuring the Atmosphere's Thirst. Dry Times: National Integrated Drought Information System Newsletter 4 (Apr. 2014): 14-15. http://www.drought.gov/media/pgfiles/NIDIS-Newsletter-April-2014.pdf

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