Flash Drought: From Early Warning to Early Action

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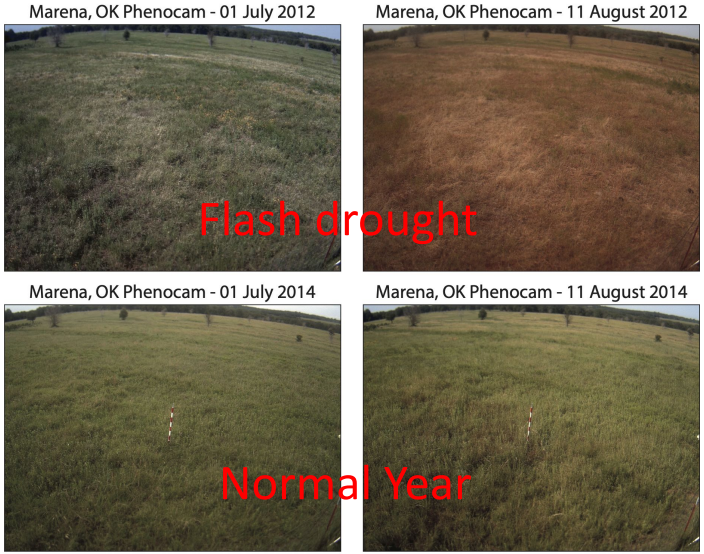
Otkin, J., M. Woloszyn, H. Wang, M. Svoboda, M. Skumanich, R. Pulwarty, J. Lisonbee, A. Hoell, M. Hobbins, T. Haigh, and A. Cravens, 2022: Getting ahead of flash drought: From early warning to early action. *Bull. Am. Meteorol. Soc.*, in press.

Drought Classifications

- Drought is a naturally feature of the climate system that refers to a water deficit
  - Meteorological drought – precipitation deficits
  - Agricultural drought – impacts of soil moisture on vegetation
  - Hydrological drought – surface and ground water deficits
  - Socioeconomic drought – impacts on availability of economic goods
  - Ecological drought – impacts on natural ecosystems
  - Snow drought – below-normal snowpack
  - Flash drought – drought that develops quickly over a few weeks

Why Are Flash Droughts Important?

- Notable flash drought events in recent years:
  - 2012 Midwest, 2017 Montana, 2021 Missouri River Basin



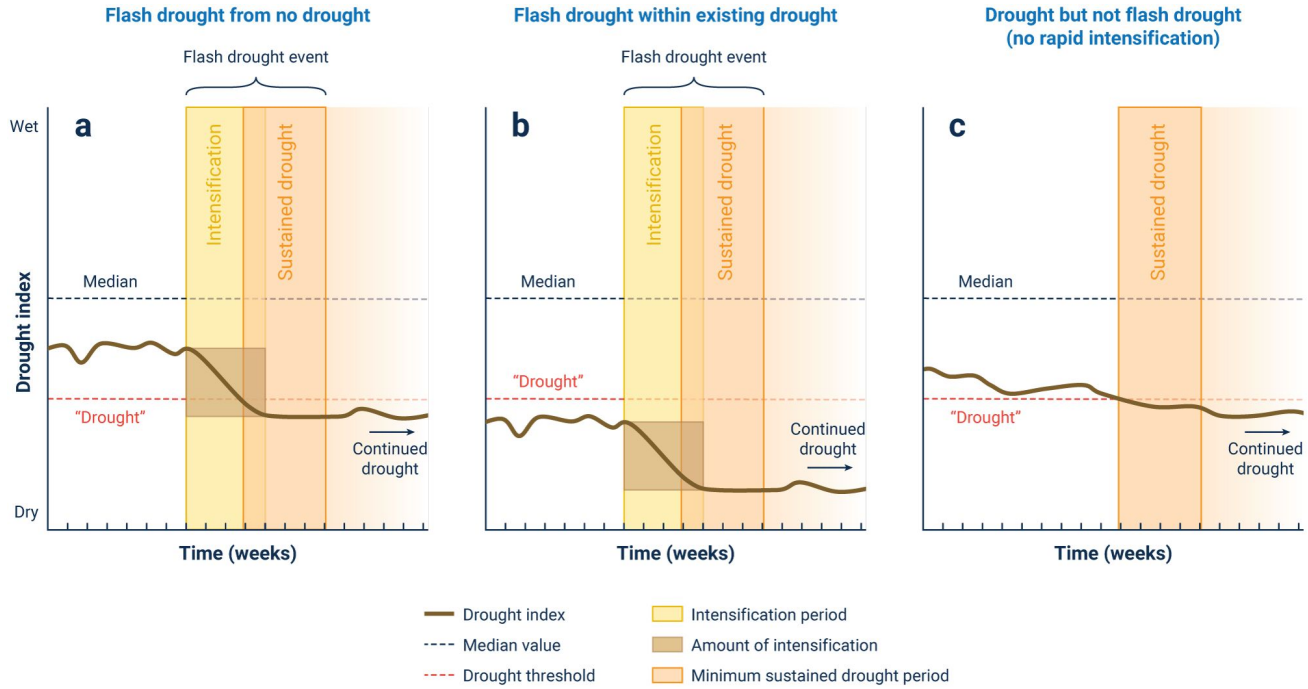
- Flash droughts occur most often during the growing season
- Can lead to rapid browning and potential death of plants
- Lower crop yields, less forage for livestock, and larger and more intense wildfires

Flash Drought Early Warning System

- Five topics constitute the pillars of a robust flash drought earning warning system
  - Physically based identification framework
  - Comprehensive flash drought monitoring capabilities
  - Improved prediction of flash drought
  - Flash drought impact assessments
  - Decision-making and policy
- Requires engagement between physical scientists, social scientists, operational monitoring and forecast centers, practitioners, and policy makers to be successful

Flash Drought Identification Framework

- Definitions should account for rapid rate of intensification and moisture limitation leading to impacts



- Rapid intensification can occur at drought onset or during an ongoing drought
- Both cases should be considered flash droughts because the period of rapid intensification led to new or worsening drought impacts

Flash Drought Monitoring

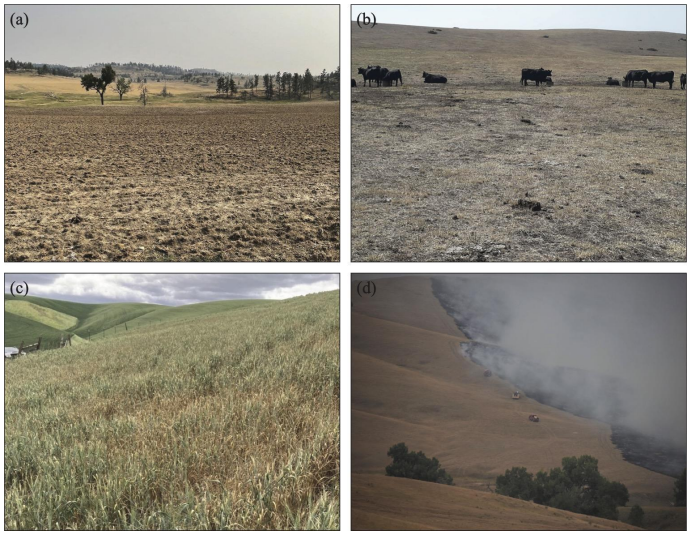
- More likely to develop when multiple weather extremes occur at the same time
    - Low rainfall, hot temperatures, low humidity, strong winds, sunny skies
- Flash droughts are usually identified based on rapid changes in evaporative demand, soil moisture, evapotranspiration, or vegetation health
- Flash drought monitors should account for all environmental anomalies from the onset of flash drought until its demise
- Multiple lines of evidence should be used to generate a measure of consensus about the occurrence and intensity of flash drought
- Existing operational drought monitoring tools may not be sufficiently responsive to flash drought because they were designed for slower developing droughts

Flash Drought Prediction

- Accurate and reliable predictions of flash drought have proven to be elusive
    - Little to no early warning of 2012 Midwest and 2017 Northern Plains events
- Considerable knowledge gaps remain regarding how local and remote drivers in the earth system cause flash drought
    - Incomplete understanding of physical drivers means that a process-level evaluation of earth system models cannot be performed
- New research is needed to improve dynamical and statistical models
- Recommend that operational flash drought outlooks should be probabilistic, issued at least weekly, and aligned with sector-specific flash drought impacts

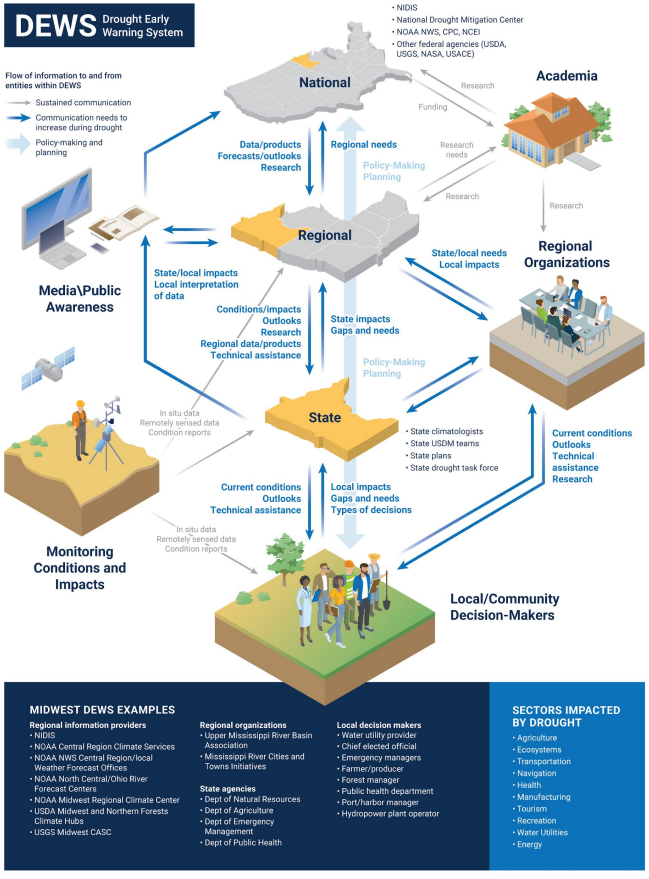
Flash Drought Impact Assessments

- Impacts depend on timing of rapid intensification and how long drought persists
- Flash drought may increase how long an area stays in drought and the likelihood that extreme drought conditions will develop
- Impacts may develop more quickly than can be effectively managed



- Focus has been on ag sector – need studies to assess ecological and hydrological impacts
- Need to understand how flash drought impacts may vary by region or season
- Ability to assess impacts relies on continuous monitoring and collection of drought impacts

Decision-Making and Policy



Credits: Modeled after the DEWS within the National Integrated Drought Information System (NIDIS). Graphic by Fiona Martin of Visualizing Science.

- Figure shows collaboration and communication channels within the Midwest DEWS
- Emphasizes subsystems of cooperation and communication that must increase during drought
- Policy and planning response is most effective when informed by knowledge from within system
- Flash drought emphasizes need for these channels to be functioning ahead of time
- Short time scale of rapid intensification requires even more efficient coordination and flow of info to anticipate and reduce negative impacts