Sensitivity of gross primary production of irrigation-permitted and non-permitted grassland and croplands to drought and pluvial conditions during 2010-2016

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Introduction

- Gross primary production (GPP) is a measure of vegetative productivity.
- Croplands cover roughly 29% of Oklahoma's landscape.
- As of 2015, Caddo County ranked 3rd in irrigated acreage with over 7% of Oklahoma's irrigated lands.
- How croplands respond to drought at the field, farm, and watershed scales in the study area is unknown.
- In addition to temperature and precipitation, other factors determine the response of croplands to drought:
  - Photosynthetic pathway (C3 or C4)
  - Growing season (summer or winter)
  - Anthropogenic water use (non-irrigated or irrigated)

Objectives

• To asses the response of non-irrigated and irrigated grasslands, winter wheat, other C3 croplands, and C4 croplands, to drought and pluvial conditions

Methods

- The Caddo County, Oklahoma, was chosen as the study site (Fig. 1).
- Lands permitted for irrigation were mapped annually using vector data available from the Oklahoma Water Resources Board (Fig. 2a).[1]
- Cropland Data Layers (CDLs) from USDA in 2010-2016 were used to map vegetative cover types at 30m spatial resolution (Fig. 2b, c).[2]
- Gross primary production was calculated using the Vegetation Photosynthesis Model (GPP_{VPM}) at 500m spatial resolution and 8-day temporal resolution. [3]
- Year 2011 was the eight warmest and eleventh driest year on record, inducing exceptional drought (Fig. 3).[4] Pluvial 2015 was the second wettest year on record for Caddo County (Fig. 4).

Figure 1. Study area: Caddo County, Oklahoma.

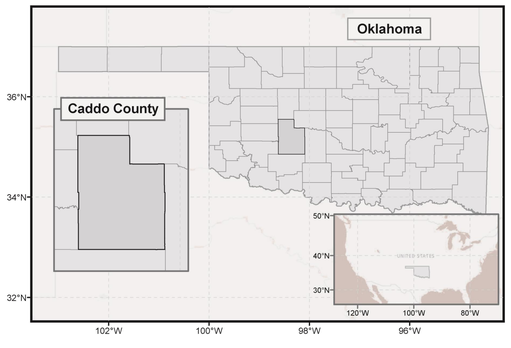


Figure 2. Spatial distribution of (a) grasslands and winter wheat, (b) other C3 croplands and C4 croplands, and (c) irrigation-permitted lands in Caddo County.

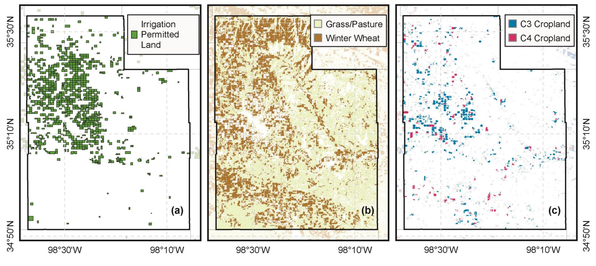


Figure 3. Drought severity for Caddo County 2010-2016.

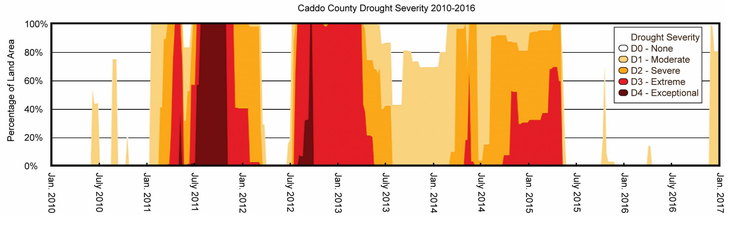
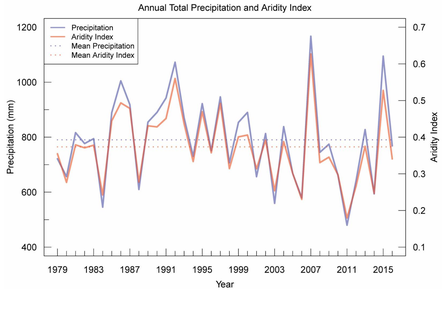


Figure 4. Annual precipitation and aridity index recorded at the Fort Cobb Mesonet station in Caddo County 1979-2016.



Results

Figure 5. Percentage departure of GPPVPM from the 5-year reference mean for irrigation-permitted and non-permitted grasslands and croplands during the 2011 drought and pluvial 2015 in Caddo County. *Not significant.

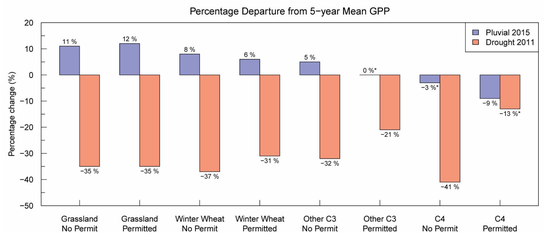


Figure 6. Mean annual GPP for (a) non-permitted and (b) irrigation-permitted grasslands and croplands in Caddo County 2010-2016.

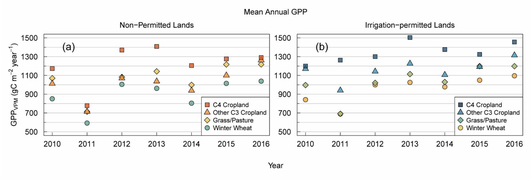
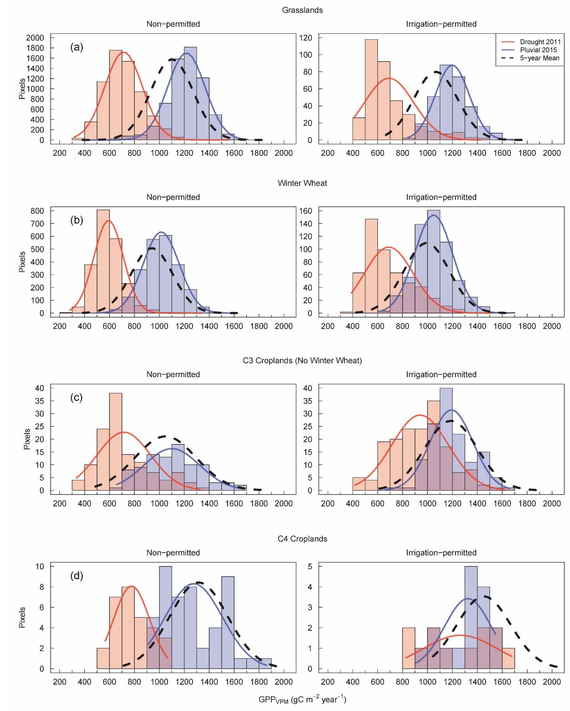


Figure 7. Histograms of annual GPP in 2011 drought and pluvial 2015 for Caddo County by vegetation type.



Conclusions

1) Mean GPP decreased significantly during the 2011 drought for all lands, with the exception of irrigation-permitted C4 croplands.
2) Mean GPP for irrigation-permitted lands was lower during pluvial 2015, except for grasslands.
3) Irrigation helps buffer croplands from the effects of drought, which is indicated by smaller standard deviations from mean GPP.
4) Irrigation may inhibit the productivity of croplands in a pluvial year.

References

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