Legacies of precipitation change alter ecosystem responses to extreme drought


Figure 1


Figure 2

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Purpose- improving understanding of climate change impacts

- Global climate change is causing more extreme droughts, as well as subtler chronic changes in precipitation patterns.
- Both extreme and chronic climate changes can alter ecosystem structure and function, and that may affect how systems respond to future extreme climate events.
- Understanding how legacies of past precipitation changes may alter the impacts of future extreme droughts is important for predicting ecosystem responses to climate change.

Procedure- measuring grassland production during extreme drought

We imposed an extreme drought (66% rainfall reduction for 2 years, via rainout shelters) in two experiments with different precipitation change legacies:

1. A long-term (15-year) experiment that chronically altered rainfall variability (longer dry intervals and larger rain events, but no change in total rainfall amount). Figure 1.
2. An experiment that imposed a previous short-term (2-year) extreme drought (66% rainfall reduction). Figure 2.

- We measured plant production both aboveground (via vegetation harvests) and belowground (via root ingrowth cores).
- Location: Konza Prairie Biological Station, Kansas.


Figure 3: Root ingrowth core procedure.

Results- significant impacts of past precipitation change, especially extreme change belowground

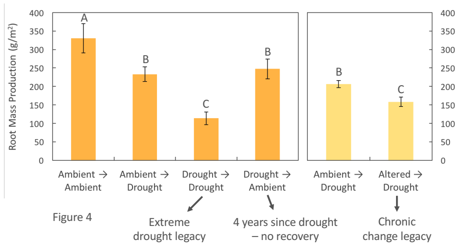

Figure 4

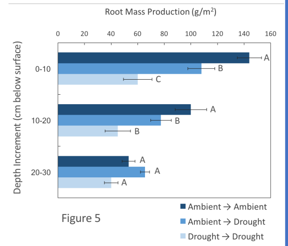

Figure 5

Fig. 4 – Root biomass production

- Extreme drought reduced root production (by ~30% compared to controls).
- Both chronic and extreme precipitation change legacies amplified the impact of extreme drought.
- The legacy of extreme drought was greater than the legacy of chronic precipitation change (65% vs. 23% reduction from control, respectively).
- Legacy effects of extreme drought are long-lasting (no recovery 4 years later).

Fig. 5 – Root biomass production by depth

- The greatest differences in root production were in the shallowest soil layers.

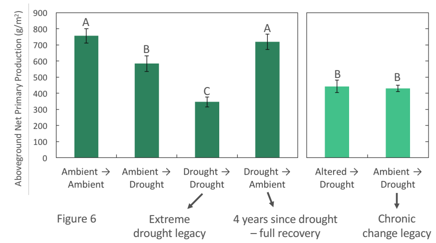

Figure 6


Figure 7 – grassland inside and outside of a rainout shelter, showing the impacts of extreme drought.

Figure 6 – Aboveground production

- Extreme drought reduced aboveground production (y ~38% from controls).
- Extreme drought legacy impacts were less pronounced than belowground (57% vs. 65% reduction from controls).
- We found no evidence of a chronic rainfall change legacy aboveground.
- Legacy effects of extreme drought were shorter-lasting aboveground than belowground (recovery was faster).

Implications- better forecasts of extreme drought impacts

- Failing to consider precipitation legacy effects and/or belowground production (both often understudied) significantly underestimates the impacts of extreme droughts.
- The disproportionate decrease in root production and lack of recovery suggest lower long-term sustainability than would be predicted from aboveground data only.

Future Directions- assessing recovery from extreme drought

- In the coming years, we will cease drought treatments and continue measuring aboveground and belowground production in both experiments as they recover from the drought under ambient precipitation conditions.
- Species-specific root production and traits will be assessed during and after extreme drought.

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