Sensitivity of Semiarid Rangeland Ecosystems to Hydroclimatic Variability

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Inner Mongolia Grasslands

Typical steppe ecosystem of bunch grasses and forbs, some shrubs

- MAP~ 350 mm, similar to Southern AZ, MAT ~ 3 C, much colder!

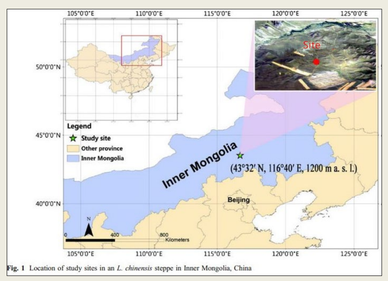
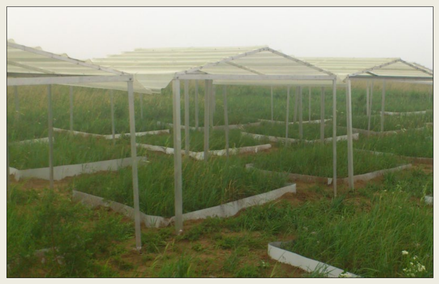


Fig. 1 Location of study sites in an *L. chinensis* steppe in Inner Mongolia, China



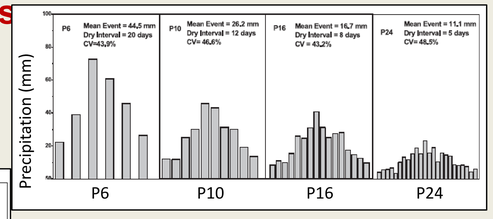
RainManSR – New Facility in SRER

RainManSR Constructed 2019

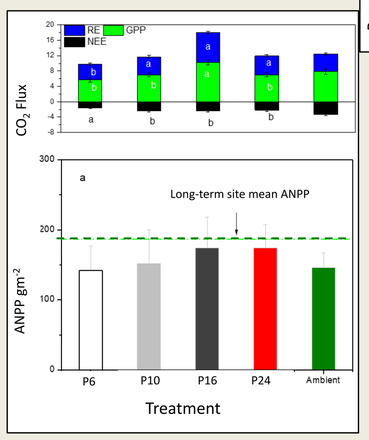
- 5-hectare exclosure with room to grow
- 60 plots under 5 rainfall shelters
- Soil water sensors at 1-10-25-75 cm
- Perennial/annual bunchgrass ecosystem, sandy loam deep soil

- Plots hydraulically isolated to 100 cm
- Shelters exclude 100% rainfall
- Rainfall treatments applied by hand

Mongolia 1: Repackaging precipitation into fewer, larger storms

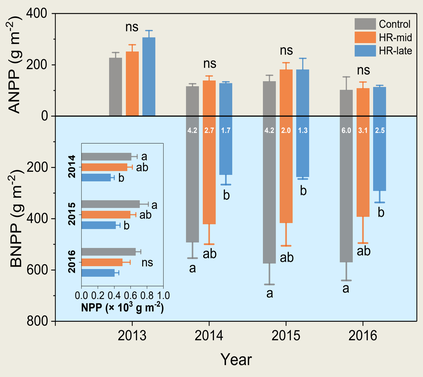


- 280 mm of rainfall was packaged into 6, 10, 16 or 24 events
- Historical average is ~16



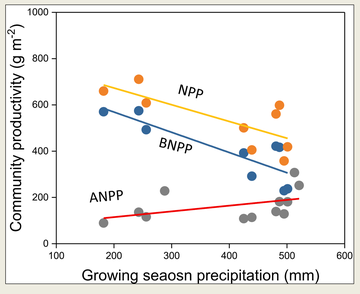
- Max GPP & ANPP at the climatic mean precipitation
- Repackaging into fewer, larger storms decreased productivity

Mongolia 2: Extreme rainfall of 250 mm over 2 weeks repeated for 4 years



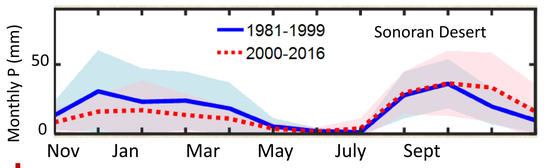
- Belowground net primary productivity reduced by ~50%
- No change in ANPP
- Plants allocated more carbon aboveground at cost of root production

When precipitation increase is an extreme event, net effect on productivity can be **negative**!



Why climate change experiments in semiarid rangelands?

- Drylands comprise~ 40% of Earth's land surface
- Water availability is the strongest driver in dryland ecosystems
- Rainfall manipulation to predict climate change impacts

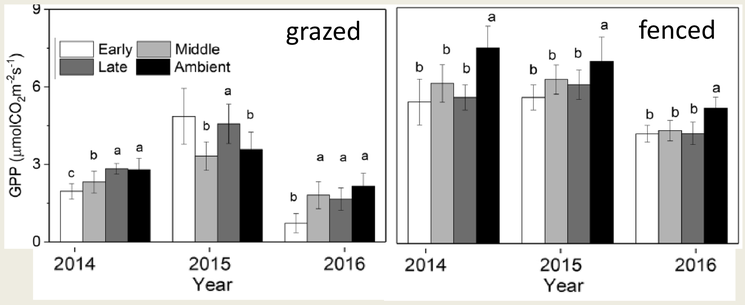


Study Goals

Quantify how ongoing and predicted changes in rainfall alter rangeland vegetation communities and the ecosystem services they provide:

- Productivity for grazing and forage
- Carbon uptake and storage in plants and soils

Mongolia 3: 30-day drought at different times



- Drought early in growing season reduced GPP most
- Relative effects are similar in grazed and fenced grassland
- High ambient rainfall at grazed site in 2015 affected results (disadvantage of using ambient as control)

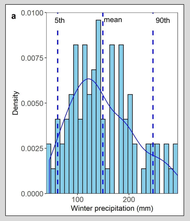
Mongolia Conclusions

- Timing matters:
  - early-season drought hurts more than late-season
  - Repackaging rainfall may reduce productivity
- Rainfall can reduce productivity if too much/heavy
- Impacts may occur mainly below ground

RainManSR Experiment 1 – 2020-24

Winter Rainfall Amount

- Does winter P affect summer bunchgrass structure & function?
- Cable (1975) suggests no, recent work suggests yes



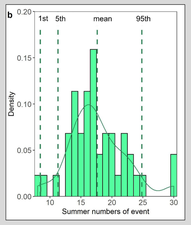
←Historical Winter P

Experimental Design→

Winter Percentile	Precipitation amount (mm)	Percent of historical mean (%)
1st	45.90	30.71
5th	61.65	41.24
10th	77.83	52.07
50th	137.67	92.10
90th	246.63	165.01
95th	267.72	179.11
99th	287.77	192.52

Summer Monsoon Temporal Repackaging

- Do fewer, larger storms favor deeper-rooted perennials?
- Is deeper soil moisture lost to drainage or accessible to grasses?



←Historical Summer Events

Experimental Design→

Levels	Percentile	Intervals (days)
S1	88th	15
S2	80th	10
S3	70th	7
S4	60th	5