Aboveground biomass in Inner Mongolian temperate grasslands decreases under climate warming

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Table S1. The environmental covariates used in this study.

| Covariates	Code	Description	Unit
Edaphic variables	CFRAG	Coarse fragments (>2mm)	%
	BULK	Bulk density	g cm^{-3}
	ORGC	Organic carbon	g kg^{-1}
	SDTO	Sand content	%
	CLPC	Clay content	%
	STPC	Silt content	%
	TAWC	Available water capacity	cm m^{-1}
	TOTN	Total nitrogen	g kg^{-1}
	CNrt	C:N ratio	-
	PHAQ	pH measured in H_2O	-
Climatic variables	T1	Annual mean temperature	°C
	T2	Mean diurnal range	°C
	T3	Isothermality (T2/T7×100)	%
	T4	Temperature seasonality (standard deviation×100)	°C
	T5	Max temperature of warmest month	°C
	T6	Min temperature of coldest month	°C
	T7	Temperature annual range (T5–T6)	°C
	T8	Mean temperature of wettest quarter	°C
	T9	Mean temperature of direst quarter	°C
	T10	Mean temperature of warmest quarter	°C
	T11	Mean temperature of coldest quarter	°C
	P1	Annual precipitation	mm
	P2	Precipitation of wettest month	mm
	P3	Precipitation of driest month	mm
	P4	Precipitation seasonality (coefficient of variation)	%
	P5	Precipitation of wettest quarter	mm
	P6	Precipitation of driest quarter	mm
	P7	Precipitation of warmest quarter	mm
	P8	Precipitation of coldest quarter	mm
	MATG	Mean annual temperature during growing season	°C
	MATNG	Mean annual temperature during non-growing season	°C
	MAPG	Mean annual precipitation during growing season	mm
	MAPNG	Mean annual precipitation during non-growing season	mm
Grassland type	-	Meadow, typical and desert steppe	-
Livestock	-	Cattle, sheep and goat	head km^{-2}
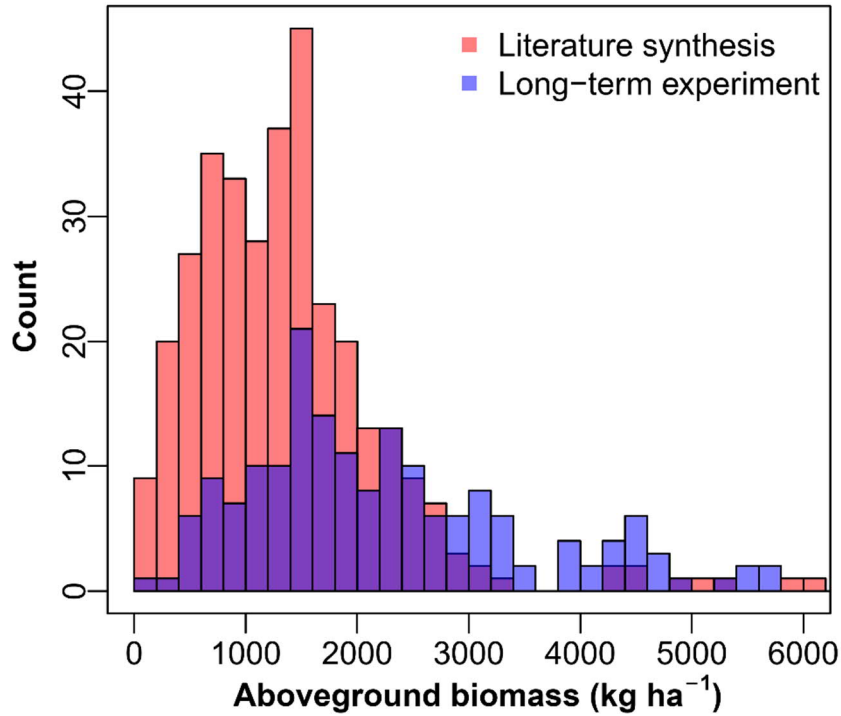
Figure S1. Histogram of aboveground biomass in Inner Mongolian grassland obtained from literature synthesis and the long-term field experiments. See Section 2.1 of the main MS for details.
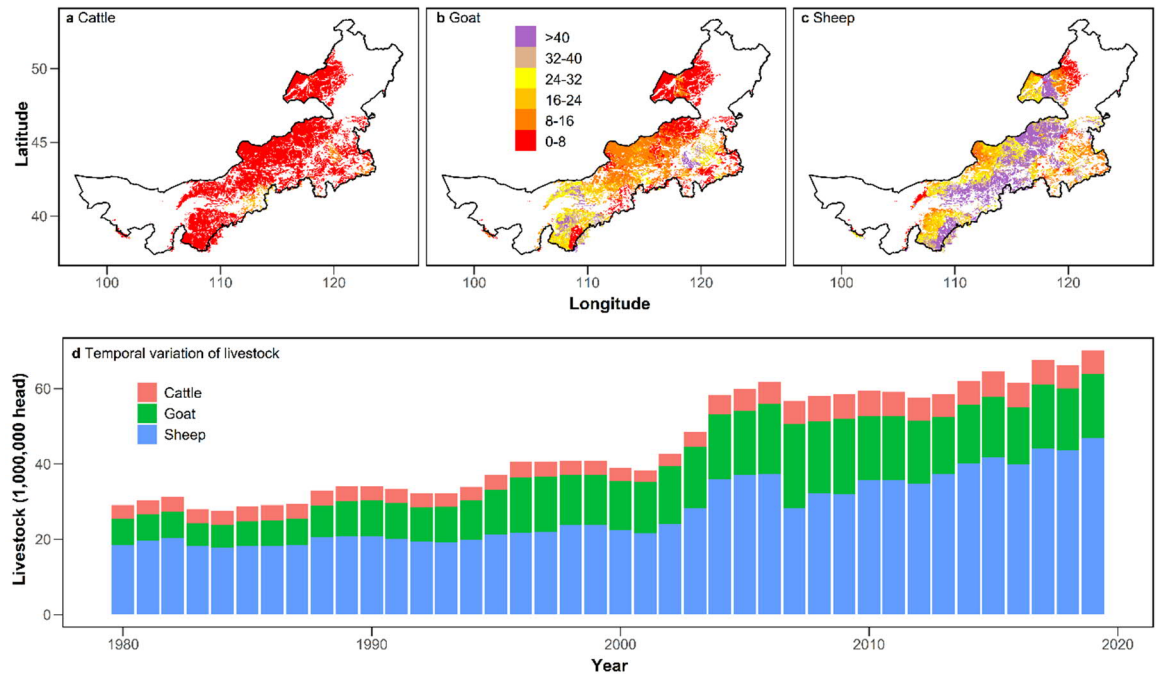
Figure S2. Spatiotemporal changes in livestock in Inner Mongolian grassland over the past four decades. The spatial patterns of cattle, goat and sheep (head km^{-2}) were derived from Gilbert et al. (2018), who reported the global spatial patterns of livestock during 2010. The annual livestock data in Inner Mongolia is obtained from National Bureau of Statistics of China (https://data.stats.gov.cn/).
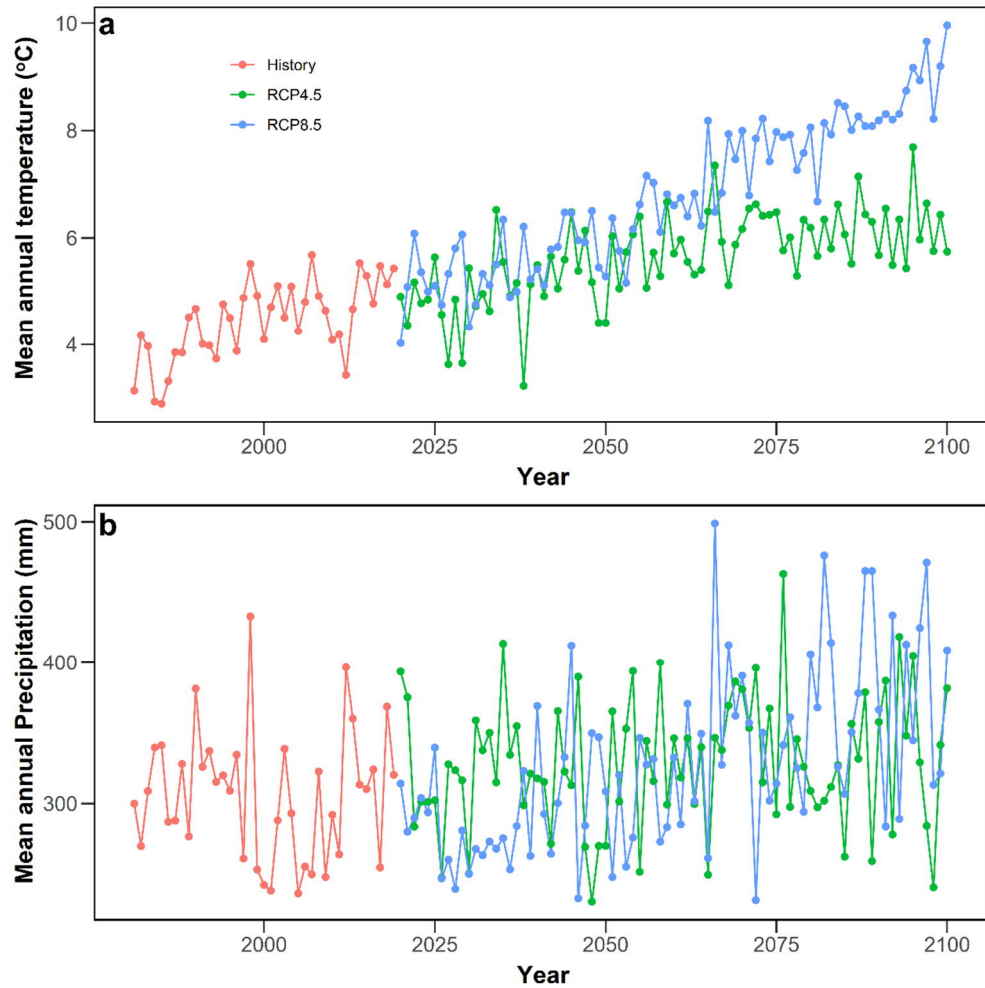
Figure S3. Mean annual temperature (a) and precipitation (b) in Inner Mongolian grasslands. The historical (1981-2019) temperature was determined from the daily climatic records obtained from the ground observations (Fig. 1b). Future (2020-2100) mean annual temperature were calculated from the projections by CESM1-BGC model using two representative concentration pathways (RCP4.5 and RCP8.5). The future climate data were derived from Karger et al. (2020).
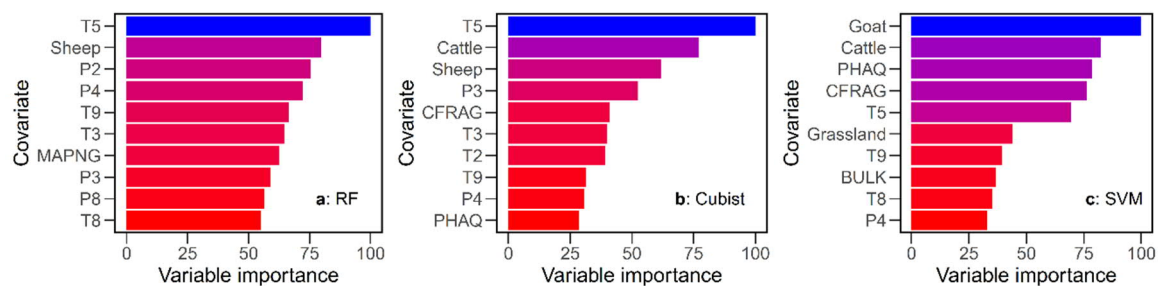
Figure S4. Variable importance indicated by the three individual machine learning models. a, random forest; b, Cubist; c, supporting vector machine.
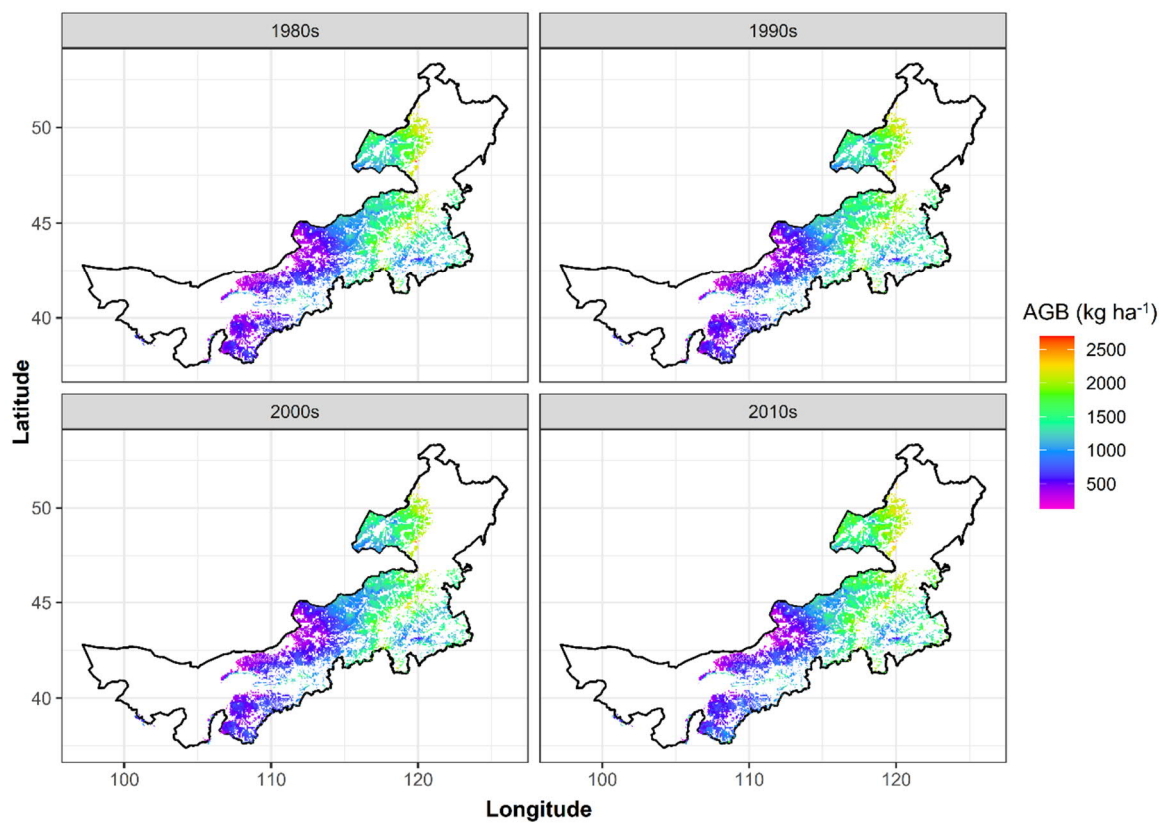
Figure S5. Spatial patterns of Inner Mongolian grassland aboveground biomass (AGB) estimated by the remote sensing derivations. The remote sensing based data are reproduced from the results published by Jiao et al. (2019).

Reference:

Gilbert, M., G. Nicolas, G. Cinardi, T. P. Van Boeckel, S. O. Vanwambeke, G. W. Wint, and T. P. Robinson. 2018. Global distribution data for cattle, buffaloes, horses, sheep, goats, pigs, chickens and ducks in 2010. Scientific data 5:1-11.

Jiao, C. C., G. R. YU, Z. Chen, and N. P. He. 2019. A dataset for aboveground biomass of the northern temperate and Tibetan Plateau alpine grasslands in China, based on field investigation and remote sensing inversion (1982–2015). China Scientific Data 4.

Karger, D. N., D. R. Schmatz, G. Dettling, and N. E. Zimmermann. 2020. High-resolution monthly precipitation and temperature time series from 2006 to 2100. Scientific data 7:248.