Paper ID: 31
Theme 5. Environmental issues related to grassland
Sub-theme 5.1. Climate change and grassland management

Response of dynamic change of vegetation index to precipitation fluctuations in Hulunbeier Typical Steppe

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Keywords: NDVI ,Precipitation Fluctuations, Typical Steppe

Introduction

In arid and semi-arid regions, precipitation is an important environmental limiting factor for ecosystems, where precipitation characteristic parameters at different time scales have great variability (Mohammad and Howard, 2006), and the small precipitation events (<5 mm) is the subject of precipitation events (Loik *et al*., 2004, Sala and Lauenroth, 1982). In this study, we used vegetation index extracted from TM or MODIS image to establish the regression models between vegetation index and precipitation, and then analyzed the response of typical steppe vegetation to precipitation fluctuations. Our result can supply reference for the productivity measurement model in typical steppe.

Materials and Methods

The study area is located in Hulunbeir high plains (Fig.1) with magnanimous vast terrain and an elevation of 500 to 900m. The climate belongs to semi-arid type, which has an average annual temperature of -3 ~ 0 ℃ and annual precipitation of 240 ~ 380mm.

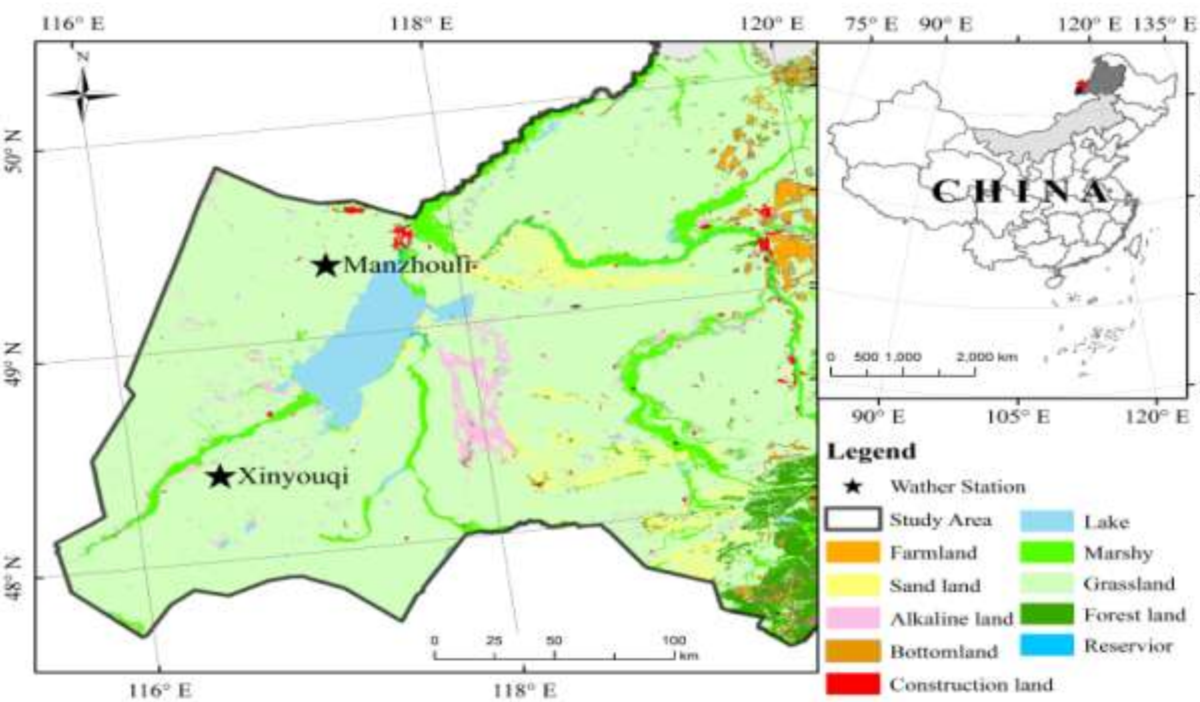

Fig. 1 Location of study area

Meteorological data was comes from China Meteorological Data Sharing Service System (http:// cdc. cma. gov.cn). First, we checked the daily observations, excluded outliers, and then established the sin- gle-day precipitation of more than 5mm as effective one. Meteorological data statistics was used piece- wise cumulative calculation to analyze the interannual precipitation fluctuation at different time scales. The NDVI was synthesized using MODIS/TERRA satellite from NASA in vegetation producti- on sea- son (late May to early September), and its image spatial resolution was 250m.

ENVI and ARC- MAP software were used to complete the extraction of the study area, Data synthesis, projection conv-ersion, etc. Study areas was made by 5 km range around the weather station.

Results and Discussion

The analysis of cumulative precipitation at different time scales showed (Table 1), with the accumulation of time scale, the variation coefficient tended to increase, and the variation coefficient of precipitation at different meteorological stations was less than effective precipitation over the same period. The precipitation at different time scales from different weather stations suggested that the average annual precipitation and annual effective precipitation increased from 1961 to 1990, while there was decreasing trend from 2000 to 2013.

Table 1: The characteristics of the precipitation pulse in different statistical cycles

	Time Frame		1961-1970	1961-1980	1961-1990	1961-2000	1961-2013
Manzhouli	Temperature（℃）	Average	-1.18	-1.20	-1.08	-0.78	-0.59
		Coefficient Variation	-0.72	-0.61	-0.71	-1.15	-1.66
	Precipitation (mm)	Average	257.87	261.58	286.85	287.60	274.90
		Coefficient Variation	0.23	0.24	0.28	0.31	0.33
	Effective Precipitation (>5mm)	Average	205.21	212.01	229.26	228.11	213.72
		Coefficient Variation	0.29	0.30	0.32	0.37	0.42
Xinyouqi	Temperature（℃）	Average	0.41	0.48	0.65	0.98	1.18
		Coefficient Variation	1.99	1.46	1.16	0.93	0.83
	Precipitation (mm)	Average	217.35	222.75	239.74	248.16	235.94
		Coefficient Variation	0.19	0.24	0.33	0.38	0.39
	Effective Precipitation (>5mm)	Average	170.39	178.63	189.52	195.94	180.31
		Coefficient Variation	0.23	0.30	0.38	0.46	0.50

From the response of typical grassland primary productivity to interannual precipitation fluctuations of view (Fig.2), interannual fluctuations of the average annual precipitation or the average annual effecttive precipitation had extremely significant positive linear regression relationship with productivity ($p < 0.001$). Correlation of annual effective precipitation and grassland primary productivity ($R2=0.6616$, $p<0.001$) was higher than that of annual average precipitation ($R2=0.6284$, $p<0.001$) (Table 2).

Table 2: Analysis on the regression equation

Type	Regression formulas	R^2
Average Annual Precipitation	y = 534.52*NDVI*- 60.165	0.6284
Average Annual Effective Precipitation	y = 540.44*NDVI* - 128.21	0.6616

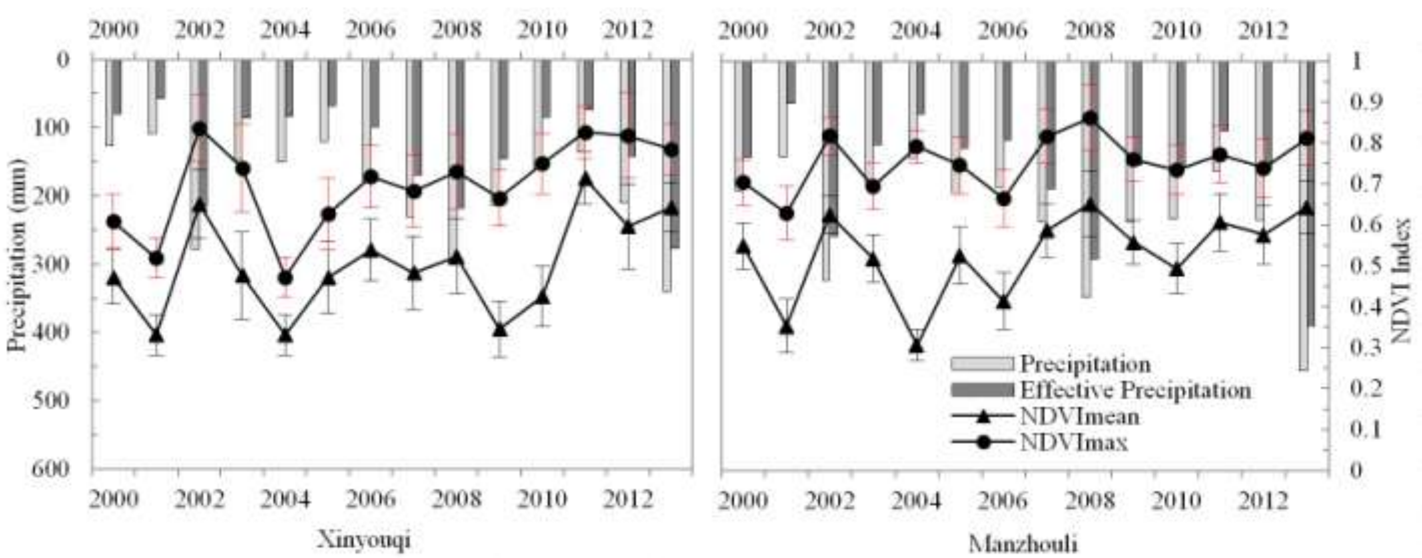

Fig. 2 The response of normalized vegetation index to annual precipitation fluctuation

Conclusion

Our results showed that the variation coefficient increased with the cumulative precipitation at different time scales, and that of different meteorological stations was less than effective precipitation over the same period. The interannual fluctuations of the average annual precipitation and annual effective average annual precipitation had the significant linear regression relationship with grassland primary productivity.

References

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Acknowledgement

This work was financially supported by environmental protection special public welfare research (No.201509040), and 2014 the basic scientific research business (No.2014-YKY-005)