Impact on Grassland Biomass from Climate Warming and Drying

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Introduction

It is becoming increasingly urgent to assess the impact of climate change on grassland biomass due to the important role these grasslands play in animal production. The typical steppe in Xilinhot of Inner Mongolia is the most representative vegetation types in the temperate grasslands of the northern China. One means to determine climate change is using the Aridity index (AI, also referred to as the dry degree of climate in this article) that is based on both temperature and precipitation (Arora 2002; Bannayan *et al.*. 2010; Nastos *et al.* 2012). The objective of this paper was to indicate how the biomass of a grassland ecosystem was affected by AI when determined by integrating regional temperature and precipitation.

Methods

In this study we employed Aridity Index (UNEP 1992) as a numerical indicator to quantify the drought occurrence at each study location. Aridity index (AI) was calculated as follows:

$$\mathrm{AI} = \frac{P}{\mathrm{PET}}$$

where PET is the average monthly or annual potential evapotranspiration (mm), and P (mm) is the average monthly or annual precipitation (UNEP 1992). In addition, anomalies in AI for each study location were also calculated as the difference between the annual AI and the long-term average.

Results

Using a combination of geostatistics, GIS and remote sensing, climatic data at 16 sites across the Xilinhot region were used to analyse the spatio-temporal trends of relative climatic factors during 1961-2005 (totally 44 years). The results showed over this time period annual precipitation gradually decreased, the bio-temperature (>0 and <30°C) increased, and AI increased by 0.624 based on a linear regression (Fig. 1). Hence, the climate of the region was significantly represented a warming and drying trend.

From the regional distribution of the average dryness of each decade, both the 1.6 and 1.8 contour of dryness displayed a "dry - wet - dry - wet" sequence during four decades (Fig. 2). To be specific, in 1961-1970 climate was dry due to the 1.8 contour in northwest in the study area; for the 1970s the contour extended to the north of Xilinhot; during 1981-1990, the drying curve rebounded to the central of study area; and since 1990s, the AI curve was back to being more northward than the its position of the 60s. In addition, it could be seen that the dry degree value increased from the southeast to the northwest, and thus the northwest area of Xilinhot was drier than the southeast.

Further research was undertaken to determine the reasons behind why these climate changes occurred in the study area. For instance, compared to other decades, annual precipitation was the lowest, and the biological temperature was also smaller during 1961-1970. In general, the drying degree within the research region was affected by annual precipitation and biological temperature.

From the scatter plot diagram (Fig. 3), the negative correlation was shown between AI and aboveground biomass on the plots in 2005 but similar results have been observed on 24-years of aboveground biomass measurements at other location with the typical steppe in China.

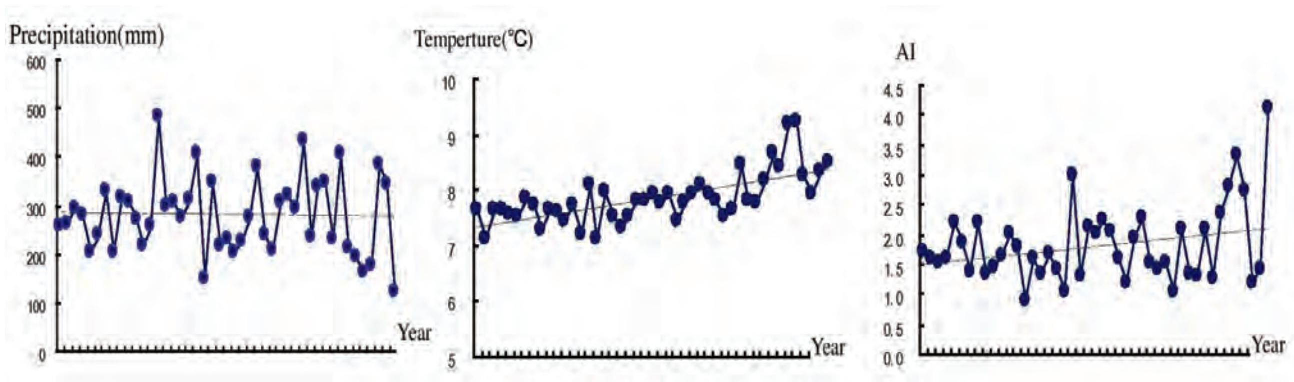

Figure 1. Annual precipitation, bio-temperature and Aridity Index.

AI 6170: average AI from 1961 to 1970
AI 7180: average AI from 1971 to 1980
AI 8190: average AI from 1981 to 1990
AI 9100: average AI from 1991 to 2000

Figure 2. Regio Suying Li nal distribution of Aridity Index in Xilinhot during 1961-2000.

Conclusions

Both temperature and precipitation jointly acted on having a significant and comprehensive effect on grassland biomass. In typical steppe region, a decreasing trend of biomass could be shown with the climate warming and drying.

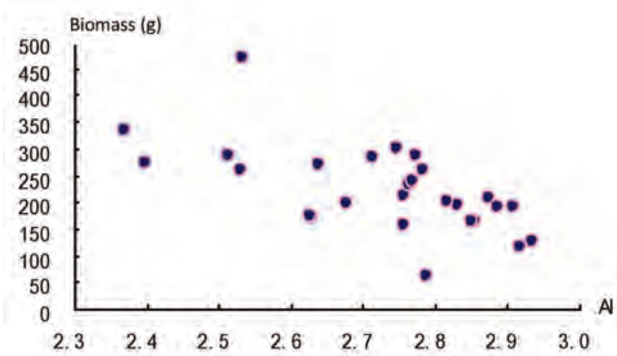

Figure 3. Relationship between Above Biomass and Aridity Index.

Acknowledgments

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