Precipitation pattern change influence on vegetation of Xilingol Grassland in Inner Mongolia, China

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Introduction

The Xilingol grassland covers the region bounded by 41'09"–45'31" N and 111'14"–118'25" E. It is representative of a typical steppe in northern China, with the major native grass species present being *Aneurolepidium chinense* and *Stipa* spp. However these grasslands have become increasingly degraded due to desertification and/or the impacts of human activities resulting in the previous climax plant community becoming substantially altered.

In the Xilingol League most weather station started observations around 1960 (earliest 1952), however, grassland phenology and biomass measurement only started in 1980. The growing season runs from the 1st May to the 30th September. Between 1961-2010, the Xilingol grassland annual mean temperature has increased by 2.2ºC, precipitation has decreased by18.65 mm, and sunlight decreased by 25.75 hours. Moreover, rainfall patterns have changed and extreme rainfall events and drought events have increased. In the 2000's, a policy to reduce the human population and grazing intensity in grassland areas was implemented and resulted in the removal of farmers from the Xilingol region. In addition, other measures were undertaken to reduce the impact of grazing including fencing vulnerable areas to exclude livestock, rotational grazing, and banning of grazing during spring to prevent further grassland degradation and promote recovery (Zhao and Zu 2000).

The aim of this paper is to determine how to best manage stocking density based on grass yield.

Methods

Grass yield

The growing season is from May to September, coinciding with the rainy season in the Xilingol grassland, but there is large degree of fluctuation around the rainfall periods during the growing season.

Climate

In order to understand the behaviour of grass growth, rainfall must be analysed over time (Hzaro *et al.* 2000; Hochstrasser *et al.* 2002). For this reason, statistical methods were applied to a rainfall time-series (1980–2010). Daily data, minimum, maximum and average temperature, precipitation, wind speed, humility, radiation and vapor pressure were used to calculate a monthly humidity index (Gathra *et al.* 2006), evapo-transpiration (Allen *et al.* 1998) rainfall volume and number of days without rain.

More than 18 combinations of climate from May to August were used to calculate a Correlation Matrix with grass yield (SAS Institute Inc. 1988). In addition, PCA was used to determine the key factors that influence the peak grass yield, and those key climate factors were chosen to build the relationship between grass yield and main climate factors (Table 1). All correlation factors were conducted using Fisher's least significant difference test with a significance level of 0 05.

Results

Maximum aboveground biomass usually occurs in August, however, due to the previously mentioned

Table 1. Partial Correlation Matrix of grass yield end of August with climate factors June to July in Xilingol grassland

Climate items	Humidity index	Precipitation (mm)	Potential evapo-transpiration (mm)	Mean temperature (ºC)	Days without rain (d)	Dry matter (kg/ha)
Humidity index	1	0.9632***	-0.8408***	-0.7865***	-0.8237***	0.8269***
Precipitation (mm)		1	-0.769***	-0.7035***	-0.7315***	0.7861***
Potential evapo-transpiration (mm)			1	0.8601***	0.7711***	-0.6341**
Mean temperature (ºC)				1	0.7358***	-0.6306**
Days without rain (d)					1	-0.6885**
Dry matter (kg/ha)						1

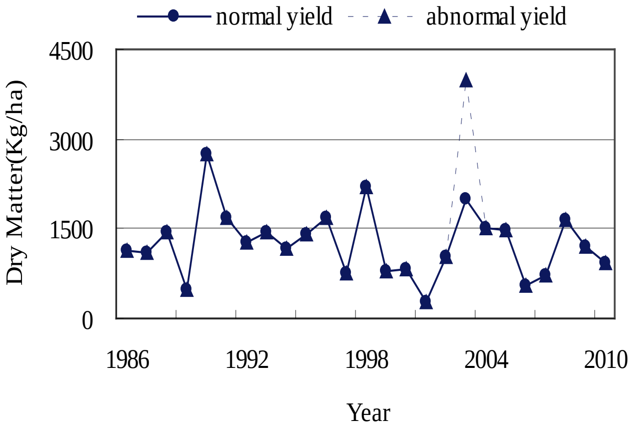

Figure 1. The grasses yield on August in Xilingol grassland

rainfall variability the intra-annual variability in biomass production can range anywhere between 36 to 200% of mean biomass production. In addition, rainfall pattern also influences plant community composition. For example, the rain season started late in 2003, and although overall grass was high, the annual grassy weed *Chenopodium album* accounting for 60% of the total aboveground biomass, however it is not consumed by livestock after it matures. Therefore, livestock carry capacity forecast will be wrong if based on this abnormal grass yield. It also affects the precision of grass yield forecast model. So, it should be taken off from the whole yield based on its proportion. The grass yield curve and abnormal yield cab be seen in Figure 1. Grass yield was most greatly influenced by humidity index and precipitation. While annual precipitation is important to the overall grass yield, it is not as important compared with June to July rainfall.

Conclusion

In Xilingol grasslands, if the precipitation appears in early or late Autumn, it has little impact on grass growth. In recent years, however, the occurrence of summer drought has increased, which impacts on total grassland biomass and thus on livestock weight gain weight during the growing season. This has consequences, as during the winter months livestock do not have not enough body fat to guard against the cold winter and thus old, weak and young animals have high mortality rates during low rainfall years.

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