Climate Changes and Trends in Phenology of Woody and Herb Plants in Inner Mongolia, 1981–2010

Yurong Wei
Inner Mongolia Ecological and Agricultural Meteorological Center, China

Yanfang Cao
Inner Mongolia Meteorological Information Center, China

Zhicun Wang
Chifen Meteorological Bureau, China

Xuebiao Pan
China Agricultural University, China

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Yurong Wei [A], *Yanfang Cao* [B], *Zhicun Wang* [C] *and Xuebiao Pan* [D]

[A] Inner Mongolia Ecological and Agricultural Meteorological Center, Hohhot 010051, Inner Mongolia, People's Republic of China
[B] Inner Mongolia Meteorological Information Center, Hohhot 010051, Inner Mongolia, People's Republic of China
[C] Chifen Meteorological Bureau, Chifeng 024000, Inner Mongolia, People's Republic of China
[D] Institutes of Resources and Environment, China Agriculture University, Beijing 100094, People's Republic of China
Contact email: yurong_w@126.com

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Introduction

The phenology of plants is a comprehensive reflection of seasonal climatological and ecological conditions and may be used as an indicator of climate change (Thomas *et al*. 2000; Volker and Annette 2004; Li *et al*. 2005). Analysis was made of the dates of sprouting, flowering and defoliating of woody and herb plants observed on 24 Agricultural Meteorological Stations in Inner Mongolia, China from 1980 to 2010. To assess the potential future change data was analysed for the 2011 to 2050 period using the England Hadley Climate Centre scenario (Wei *et al*. 2012).

Methods

Data Collection

Phenological data was collected from 24 meteorological stations that are located from east to west in Inner Mongolia that make up the Phenological Monitoring Network. Although, phenological data collection only started (for most stations) in 1980, recording of climate data across most stations started around 1952. Therefore, climate data series can be used to analyse longer climate trends. There is a great deal of climatic variation in Inner Mongolia as you move from east to west and thus for the purposes of this poster only data from the Xilingol league steppe grassland will be presented. It is however, broadly representative of northern china grasslands. The Xilingol league has fifteen meteorological stations that data were taken from and used to analyse climate trends.

Data analysis

Least square methods were used to calculate the change in climate relative to the rate of the annual mean temperature (Estrelle and Sparks 2007), along with precipitation of 15 meteorological stations from 1961 to 2010 in the Xilingol league. Linear regression analysis was used to analyse the impact of climate change on woody plant and herbs phenology.

Results

The change in climate since 1961 is shown in Table 1. Temperature increases per 30-year periods have shown in general much faster rates of increase in more recent times. This has apparently had an impact on the phenology of a large number of plant species. Compared to 1980 (when phenological observations started) by 2010, the sprouting dates of woody plants, including 71% of *Populus sp.*, 57% of *Ulmus sp.* and 59% of *Salix* sp. were occurring earlier. The abscission date of 71% of *Populus* spp., 67% of *Ulmus* spp. and 65% *Salix* spp. plants also occurred later. In herbaceous plants, germination dates of 55% of *Taraxacum mongolicum*, 41% of *Plantago asiatica* and 47% of *Iris ensata* plants occurred earlier than normal whereas the date at which plants senesced occurred later in the season; 77% of *Taraxacu mongolicum*, 68% of *Plantago asiatica* and 68% of *Iris ensata*.

As can be seen in Table 2, under the A1B scenario, temperature will increase 2.4ºC by 2050 and precipitation

Table 1. Climate trend index from 1961 to 1990 (baseline) and overlapping 30 years periods in Xilingol grassland Inner Mongolia, China.

Baseline periods	Annual mean temperature (0ºC)	Annual mean maximum temperature (0ºC)	Annual mean minimum temperature (0ºC)	Annual precipitation (mm)
1961-1990	0.24	0.03	0.54	-0.13
1971-2000	0.54	0.42	0.68	7.52
1981-2010	0.66	0.68	0.6	-14.13

Table 2. Climate scenario trend index from 2011 to 2050 in Xilingol grassland Inner Mongolia, China

Scenario	Annual mean temperature (0ºC)	Maximum temperature (0ºC)	Minimum temperature (0ºC)	Precipitation (mm)
A1B	0.06	0.05	0.06	-0.05
A2	0.05	0.04	0.06	1.08
B2	0.04	0.03	0.04	0.68

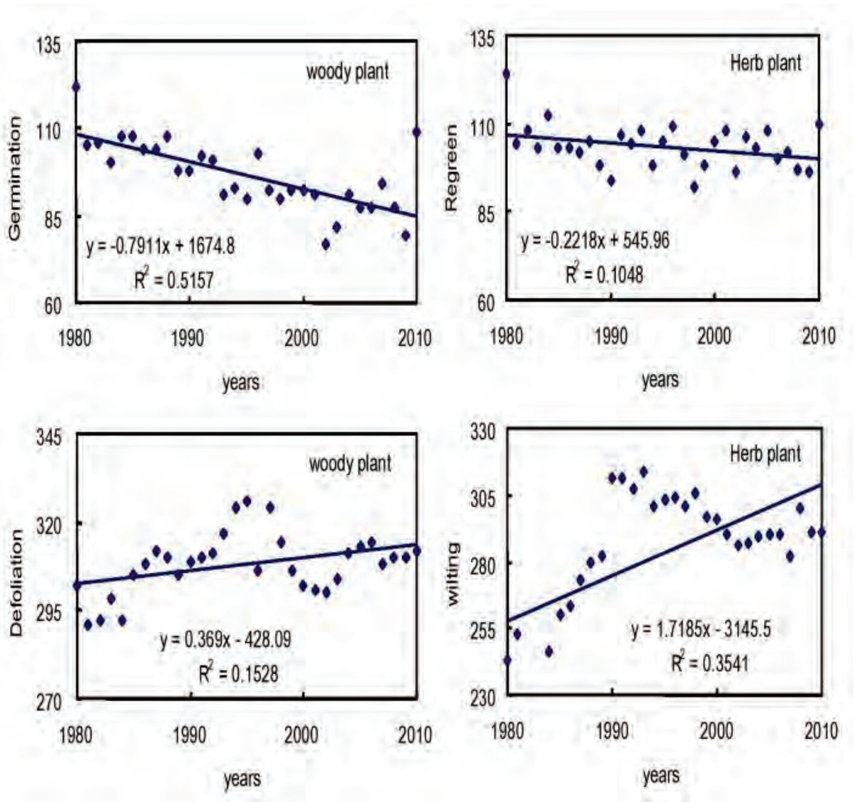

Figure 1. The relationship between germination and abscission (defoliation) in *Populus* spp. (woody plants) (left) and new growth (regreen) and senescence (wilting) in *Taraxacum mongolicum* (right) and year in Inner Mongolia.

As can be seen in Table 2, under the A1B scenario, temperature will increase 2.4ºC by 2050 and precipitation will decrease by only 2mm; A2 scenario, temperature will increase 2ºC, precipitation will increase by 43mm, and; B2 scenario, temperature will increase by 1.6ºC and precipitation will increase 27mm.

As a result of previous climate change (Table 1), there has already been apparent change to the phenology of both woody and herbaceous species (Fig. 1). This has resulted in the onset of springtime occurring earlier and prolonging autumn and thus making the whole growing season longer. That would potentially be of benefit to grassland and animal husbandry, however, with both temperature increases and changes in both the pattern and likely amount of rainfall forecast under a variety of climate change scenarios, it is likely to continue to have a major impact on the phenology of these important plant species. In addition, changes in rainfall pattern/amounts and increased likelihood of extreme rainfall events mean that droughts are increasingly likely to become more of an issue in the future. Therefore, how to adapt the climate change and to mitigate the influence of grassland drought is the important issue (Li *et al.* 2012).

Conclusion

Climate change is already a problem in northern China and predicted increase in both temperature and precipitation will continue to have potentially large impacts on plant production. In particular, the impact of drought is likely to become a more widespread issue in Inner Mongolia and thus degradation of grasslands will potentially become a serious problem for the region. The result is likely to be that management of animal husbandry will be have to change or be modified in order to cope with these forecast changes. We should adapt to climate change and develop more suitable species to growing in this land to increase grassland productivity.

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