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Research Article

Global Warming: The Instability of Desert Climate is Enhancing in the Northwest Area in China: A Case Study in the Desert Area in Northwestern China

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Abstract: To disclose the relation between the sandstorms change and the temperature changes, a case study in the desert area in northwestern china is investigated. The results showed that: the instability of climate in Minqin desert area is enhancing in the arid desert region in northwest China. Mainly as follows: Variation the annual extreme maximum temperature increasing. Variation of extreme minimum temperature also an increasing trend. Average visibility of sandstorms significantly reduced and the fluctuation trend increased significantly. In the past two years, there have been some unusual climate events in other regions in China. They reflect the fact that the deterioration of the stability of the climate change. The instability of the climate change impact on human life and production is increased more than global warming, more worthy of global concern.

Keywords: China, desert climate, global warming, instabilities

INTRODUCTION

Global warming is now a hot topic worldwide. The 3rd evaluation report by IPCC (Intergovernmental Panel on Climate Change) indicated that the world's average temperature in the 20th centaury rose by 0.6±0.2℃, with the warmest period of 1980s and 1990s (Houghton *et al*., 2001). The 4th evaluation report by IPCC showed that from 1906 to 2005, the average air temperature in the world rose by 0.74°C, and the average temperature in the latter half of the 20th century was the highest in the last 1300 years (IPCC, 2007). According to a model manipulation, by 2100, "the most possible scenario" of temperature rising globally will be 1.8～4°C, and the sea level will rise by 18～59 cm. Provided that the temperature rises by 1.5～2.5°C in the coming years (in contrast to that during 1980-1999), 20%～30% of the species will probably go extinct and the percentage will reach 40%～70% if the temperature rises by 3.5°C (Qin *et al*., 2007). The latest report drafted by UNIPCC's work team indicates that from 1860 to the present, the temperature in the northern hemisphere has risen by 0.4～0.8°C averagely. The temperature rose more dramatically in the 20th century than at any other time in the millennium and the average temperature from1990 to 1999 was the highest in the millennium (Mann *et al*., 1999; Qin *et al*., 2002).

In the 20th century, the temperature in China has raised by 0.4～0.5°C, slightly lower than 0.6°C, the world's average. In Shanxi, Gansu, Ningxia and Xinjiang provinces in northwest China, the temperature rising extent is greater than China's.

Average (Qin *et al*., 2002; Wang and Dong, 2002; Ding, 2002). Northeastern China is one of the regions with sensitive response to global warming. Its average temperature from 1981 to 1999 rose by 1°C, in contrast to the average from 1951 to 1980. In recent 50 years, the temperatures in the southern part of northeast China and in most parts of North China rose by 0.5～1.0°C (Sha *et al*., 2004). The average temperature in northern Xinjiang in recent 10 years was 0.7°C higher and that in Tianshan Mountain ranges was 0.4°C higher than the average in the past 30 years, respectively (Ding, 2002).

Kitoh *et al*. (1997) found that rainfall brought by summer monsoon from the Indian Ocean increased apparently with global warming. The study by Chinese scholars indicated that the increasing /decreasing of rainfalls in the arid areas in northwest China was, to some extent, related to the global temperature rising/dropping (Leng *et al*., 2007; Jin *et al*., 2005).

The responses of temperature rising to global warming differentiate in various regions with different land forms (Ding, 2002). Due to extremely high temperature, the pollen hypersensitivity in the middle- to high-latitudinal areas in the northern hemisphere

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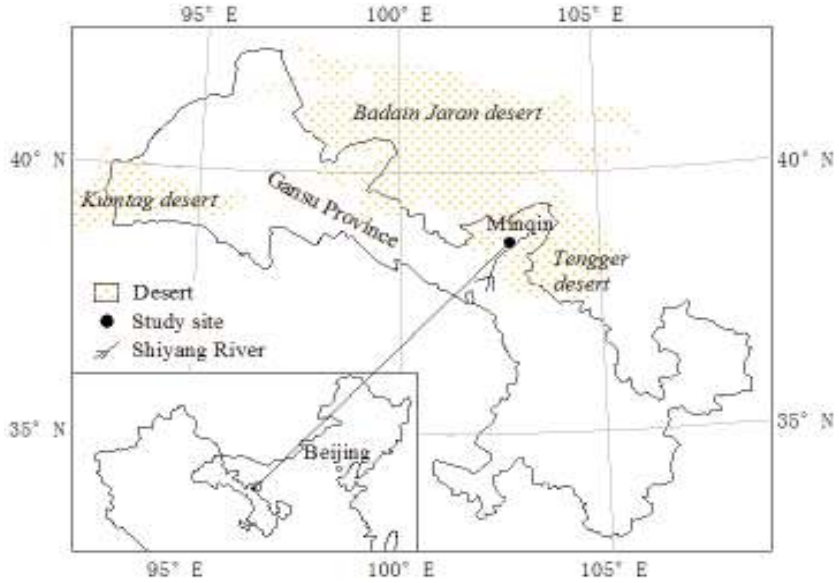

Fig.1: Location of study area

advanced and the population mortality in some European areas also increased (IPCC, 2007; Sun *et al*., 2002). Desert is one of the three natural landscapes on the continent. The climate in the desert area is quite different from that in other regions. The analysis results Zhu and Chang (2011) showed that: the increasing rate of the mean annual temperature in Minqin during 1961-2009 was greater than that of the global average and that of the hundred-year average in China; whereas lower than that in the arid area in northeastern China in the recent 20 years.

Desert is one of the three natural landscapes on the continent. The eco-environmental phenomena in arid and semi-arid areas are closely related to temperature rising (Hu *et al*., 2001). The desert is the most vulnerable ecosystems system. Well, how desert climate of stability in the process of global warming?

It is important to disclose the relation between the sandstorms change and the temperature changes to manage the Desert.

MINQIN DESERT AREA

Minqincounty (102°03′～104°03′E 38°05′～39°06′N), with an area of 16016 km^2, and an average elevation of 1300～1350 m, is located in the lower reaches of the Shiyang River in the northeastern Hexi corridor in Gansu province and at the western fringe of Tengger Desert in China (Fig. 1). The landscape in Minqin can be classified into three types: the natural landscapes formed before Han dynasty (2100 years ago), the degraded lands from Han dynasty to Minguo Age (from BC 206 to AD 25) and the artificial lands reclaimed since 1949.

The study area is typical desert in China. Desert, Gobi, alkali-saline land, low hills and sand dunes currently occupy 94.2% of the total area. Among which, desert is 8813.3 km^2 (55.03%), Gobi is 800.0 km^2 (5.00%) and desertified rangeland is 5466.67 km^2 (34.13%). Total population is 307,200, with a density of 19.18 persons/km^2.

The average annual precipitation in Minqin is 116.52 mm, while the evaporation is 2351.79 mm. There have been annually 28.2 days with≥17m/s/gales, 25.8d with sandstorm, 37.8d with sand-driven winds and 30.2d with dust. At present, water table inside and around the oasis has dropped to around 20 m due to the overuse of water resources. Large area of vegetation degraded with the death of plants and rangeland degraded simultaneously.

OBSERVATION INDEXES AND ANALYTICAL METHOD

Meteorological data collected from the Minqin Desert Control Experimental Station during 1961-2009 were used. Insolation duration, air temperature, air pressure, rainfall, humidity, ground temperature, wind speed and wind direction, days of gales and sandstorms, etc. were observed. In each index, more sub-indexes are included. For instance, in item of air temperature, monthly and annual average temperatures, the monthly maximum and minimum temperatures were included; in item of rainfall, monthly and annual rainfall and the diurnal rainfall intensity were included.

Linear regression was used to analyze the changing trends of average temperature, the maximum/minimum temperatures, precipitation and air humidity. Regression significance was tested with 95% confidence level. The changing trend of the variation was denoted by the absolute values of the difference between observations and the trend line corresponding point. In the relevant figures, the angle between the lines above and below the general trend line denotes the

changing trend of variation. The relationship between variants was denoted with Pearson coefficient and the relative significance was tested with 2-tailed method. All the data were analyzed with SPSS13.0 software.

INSTABILITY OF DESERT CLIMATE IS ENHANCING IN THE MINQIN

- **Luffing of maximum temperature is increasing:** The average maximum temperature in Minqin was 37.16°C, with the peak in 1997 (July 22nd), 41.0°C. The maximum temperature during 1961-2009 showed an insignificant rising trend ($p>0.05$) (Fig. 2a), with the rising rate of 0.10°C/ (10a). The inter-annual difference of the maximum temperature from 1961 to 2009 displayed a significant increasing trend ($p<0.05$), with the increasing rate of 0.261ºC/(10a) (Fig. 2b). In Fig. 2b, the values on the line above the general trend line display a significant rising trend ($p<0.05$ =, with the rising rate of 0.37°C/(10a); whereas the values on the line below the general trend line display an insignificant decreasing trend ($p>0.05$) (Fig. 2b).
- **Luffing of minimum temperature is increasing:** During 1961-2009, the average minimum temperature in Minqin was -24.99°C, with the lowest in 2008 (February 1st), -32.2°C. The minimum temperature during 1961-2009 showed a significant decreasing trend ($p>0.05$) (Fig. 3a) at the rate of -0.19°C/(10a). The inter-annual difference of minimum temperature during 1961-2009 displayed an insignificant increasing trend ($p>0.05$) (Fig. 3b). In Fig. 3b, the values on the line above the general trend line display an insignificant decreasing trend ($p>0.05$); whereas the values on the line below the general trend line display a significant decreasing trend ($p<0.05$), with the decreasing rate of -0.56°C/(10a).
- **The start date of sandstorms is advancing:** One hundred and thirty six days sandstorms during 1988-2009, the first sandstorm in a year advanced significantly ($p<0.05$) (Fig. 4a). The average visibility during sandstorm event significantly decreased and the fluctuation trend increased significantly ($p<0.05$) (Fig. 4b). During 1988-2009, the decreasing trend of the average duration and the maximum duration of sandstorms were insignificant ($p>0.05$).

The correlation between the advancing trend of the first sandstorm in a year, the average temperature in the previous successive month and the changing trends of the monthly average temperature were insignificant ($\alpha>0.05$). The average visibility during sandstorm events was negatively related to the temperature in May in a comparatively significant way ($\alpha<0.05$) and was

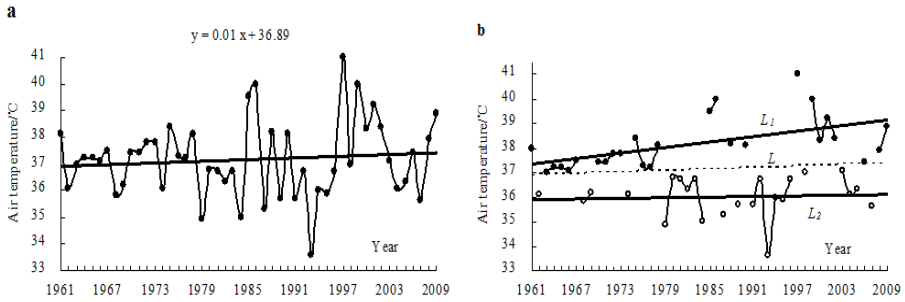

Fig. 2: (a) Variation of the maximum temperatures during 1961-2009, (b) The increased differences of the maximum temperatures during 1961-2009; L is the trend line in of all data points. L_1 is the trend line, located above the point of the L line. L_2 is the trend line, located below the point of the L line.

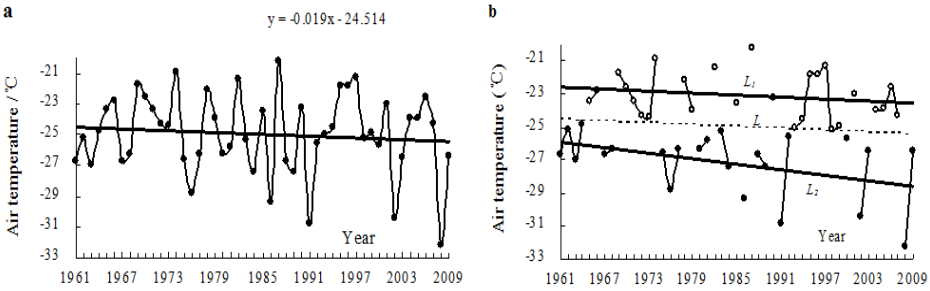

Fig. 3: (a) Variation of the minimum temperatures during 1961-2009, (b) The increasing trend of the differences of the minimum temperatures during 1961-2009

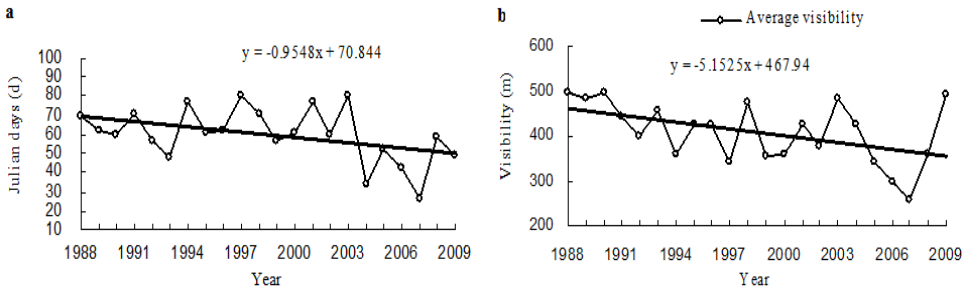

Fig. 4: (a) Variation of the starting dates of sandstorms during 1988-2009, (b) Variation of the visibility in sandstorm events during 1988-2009

positively significantly related to the temperature in September ($\alpha<0.05$). The monthly distribution of the 136d sandstorms during 1998-2009 was negatively significantly related to the relative air humidity in the corresponding months ($\alpha<0.01$) (Fig. 4b). Accordingly, the increasing of the relative air humidity was one of the important factors contributing to the decreasing of sandstorms. Study carried out in Xinjiang Province supported this result (Hu *et al*., 2001).

DISCUSSION

Currently, there are a lot of studies have reported about global warming. But the one hand, reported the facts about global warming. The other hand, the study reported that their response to global warming about animals, plants or precipitation, or sea level. There triggered diseases such as reported by global warming (IPCC, 2007a; Sun *et al*., 2002). But it seems that no studies have reported on the stability of the climate caused by global warming. However, it has a greater impact production and life of human by climate stability becomes worse than global warming and more worthy of global attention and response.

There have been some unusual climate events in the past two years in China:

- There encounter once-in-a-century drought in 2010 in Yunnan, China. And the wide range of the drought, the length of time, the loss of large, are rare in Yunnan Province history.
- Last seven months-long drought in the spring of 2011 in southern China. The also belonging to the once-in-a-century. The five provinces of Yunnan, Guizhou, Guangxi, Chongqing, Sichuan victims. Affected an area of $673.3\times10^4 hm^2$. 2088×10^4 population and 1368×10^4 livestock Water shortages.
- Rainstorm on July 21, 2012, it is the biggest years to 61 years in Beijing. Affected an area of $160\times10^4 hm^2$ and inundated area of $140\times10^4 hm^2$ and the city's population affected of 160.2×10^4. Resulting in economic losses of 116.4×10^8 Yuan.

They reflected the common feature is the instability of the climate change is increasing that these events of "unusual event" or "once-in-a-century event"

CONCLUSION

Annual maximum temperatures ranged from increased inter-annual level in process temperatures continue to increase in Minqin desert area. Although the downward trend of annual minimum temperature was not significant, but the point lower than the lowest temperature trend line below with the lowest temperature trend deteriorated significantly increased. the first sandstorm in a year advanced significantly. The average visibility during sandstorm event significantly decreased and the fluctuation trend increased significantly. The sandstorms change significantly correlated with temperature changes.

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