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Causes, Processes and Consequences of Sandstorms in Northern China*: A case study of sandstorms in 2000

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Abstract: Serious land degradation exists in the marginal areas of North China, the important ecological transition between semi-arid and sub-humid climate zones, which is a relatively narrow belt with 100~250 km in width and about 2 000 km in length. The annual rainfall varies between 300~400 mm. In the past hundred years (before 2000), most of the land in the region had been used for grazing and dryland cropping. As land-use is intensifying, particularly since 1970s and 1980s, desertification has accelerated. Our case studies in 2000 indicated that: (1) Sand-dust storms are the result of a combination of climate change, such as strong winds and dry weather, but their frequency and intensity are mainly related to precipitation variations. The El Nina/El Nino effect is strongly implicated. (2) Human economic activities result in sufficient sand-dust sources to create a hazard. Large-scale land conversion for cropping, deforestation, irrational use of water resources and over-exploitation of groundwater have all contributed to the problem. (3) There is a trend that the frequency of dust storms has been increasing since 1950s. (4) At regional scales, there are two main types of desertification landscapes where desertification is spreading quickly with serious hazards. One is a vast sandy land and the other is the developed oases along the rivers in the desert margins.

Key words: sandstorms, climatic factors, nationwide trend, regional trend, Northern China

1 INTRODUCTION

China is one of the most severely affected countries suffering from desertification. The total area of desertification affected land in China is approximately 2.674 million km^2, accounting for 27.9% of the total land, or 80.6% of the area of arid, semi-arid and dry sub-humid regions in China, compared to the global average percentage 69% (Liang Chao, 2002; Lu Qi, 2000). The affected lands are mainly distributed in Northwest China, North China and Northeast China. Along with the acceleration of drought, increasing population pressure and limited progress of rehabilitation, desertification is spreading with an annual rate of 10 400 km^2. In consequence, increasing desertification deteriorates ecological environments,

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accelerates poverty and encroaches the survival space of human beings. In some regions, under the impact of desertification, human living environment is severely threatened and villagers have to emigrate from their native places to other regions as environmental refugees. Desertification has caused huge losses to national economic and social development. It is a hidden trouble and major danger to China. It is estimated that 400 million people are threatened by desertification and the annual direct economic loss caused by desertification is about 7.1 billion US$ (Lu Qi, Wu Bo, 2002). Desertification gives rise to severe impacts and destruction to communication facilities, water conservancy projects, mining fields and defense installations, and then threatens to the development of industries and major cities. Desertification aggravates poverty in rural areas. One fourth of poor villagers and farmers from underdeveloped counties in China are found in the desertification regions. The per capita output value in the affected rural areas is only one third of the average in China.

2 ANALYSIS OF CLIMATIC FACTORS CAUSING SANDSTORMS

2.1 Climatic Causes of Sandstorms

Sand-dust storms are the resultant effect of strong winds, but their frequency and intensity are mostly related to precipitation variations. Analysis of fundamental data of millennium climatic variations indicates that the curves of frequent occurrences of sand-dust storms are closely associated with climatic background curves of drought periods (inclined line in Figure 1). The periods of frequent sandstorms that occurred from 1060~1270 and 1470~1920 coincide with prolonged droughts that happened during the same periods of time.

In addition, the frequency of strong sand-dust storms goes up quickly in recent years and this is possibly related to the frequent occurrence of El Nino events, strong La Nina events that occurred in the Eastern Pacific Ocean since June 1998, and global warming caused by the increase of man-induced greenhouse gasses.

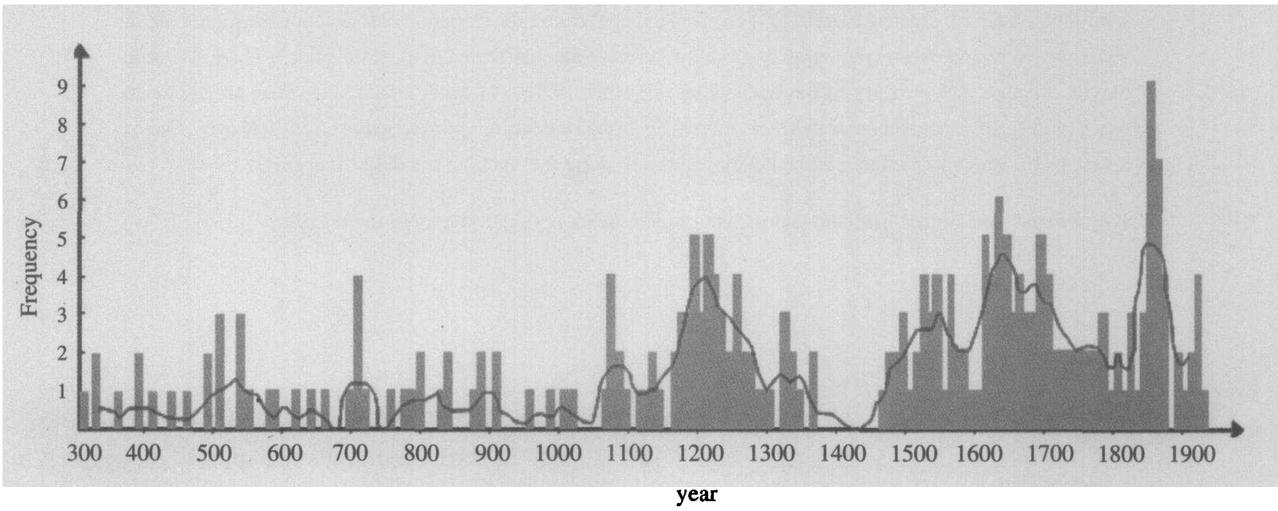

Figure 1. Frequency curve of dust fall since A.D. 300 and its 50-year running mean curve

2.2 Analysis of the Climatic Factors Causing Sandstorms in the Spring of 2000

During a period of 45 days from March 2, 2000, the sandy storm weather with 8 blown sands, suspension dusts and sand-dust took place on a large scale in Northern China (Table 1). The sandy storms occurred very early with a high frequency, wide scale and powerful strength, which are closely related to the climatic variations from 1999.

Table 1. Record of sand-dust storm weather in Beijing and adjacent regions in 2000

No.	Date	Impacted regions	*Sandstorm types*
1	Mar. 3	Inner Mongolia, Beijing and nearby regions	Suspension dust, sand drifts
2	Mar.17~18	Beijing and adjacent regions	Strong wind, suspension dust, and sand rifts
3	Mar.22~23	Inner Mongolia, Beijing and Nearby regions	Blowing sands
4	Mar. 27	Gansu, Ningxia, Inner Mongolia, Shaanxi, Shanxi, Beijing, Hebei, Henan, Shandong	Blowing sands and strong winds
5	Apr. 3	Beijing and nearby regions	Blowing sands and strong winds
6	Apr. 6	Inner Mongolia, Shanxi, Hebei, Beijing and Tianjin (photos 1~3)	Blowing sands, suspension dusts, sand-dust storm and strong winds
7	Apr.9	Beijing and nearby regions	Strong wind
8	Apr. 25	Beijing and adjacent regions	Suspension dusts

2.2.1 Prolonged scarcity of rainfall, high temperature and frequent drought in 1999

There was significant sparse rainfall in most regions in northern China in 1999. Particularly, the summer rainfall that accounts for 60%~80% of the total annual precipitation was the lowest in the last 50 years (Figure 2). Mean annual temperature was 1~2 times higher than that of normal years and the prolonged high-temperature weather in summer has not been seen since the early 1950s in many regions of Northern China. Limited rainfall and large evaporation loss caused severe drought on a large scale in Northern China in 2000.

2.2.2 The coldest winter since 1997

After thirteen continuous warm winters, the air temperature in the winter of 1999 was fairly common, particularly in the eastern part of Northwest China, most regions of Central Northern China and the west part of Northeast China. The regional mean air temperature in January of 2000 was the lowest since 1977 (Figure 3), which was 2 times lower than that in the same period of time in normal years, or even 4 times lower in some regions. Frigid frozen weather critically exposed land surfaces. The frozen soil layers were so thick that they could easily cause the formation of loose soil layers when the land surface defrosted.

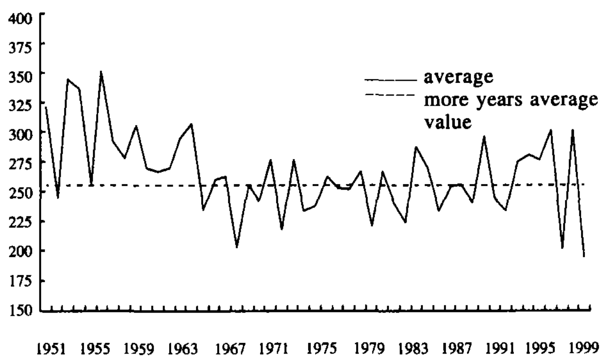

Figure 2. Precipitation (mm) variations during June-to-August

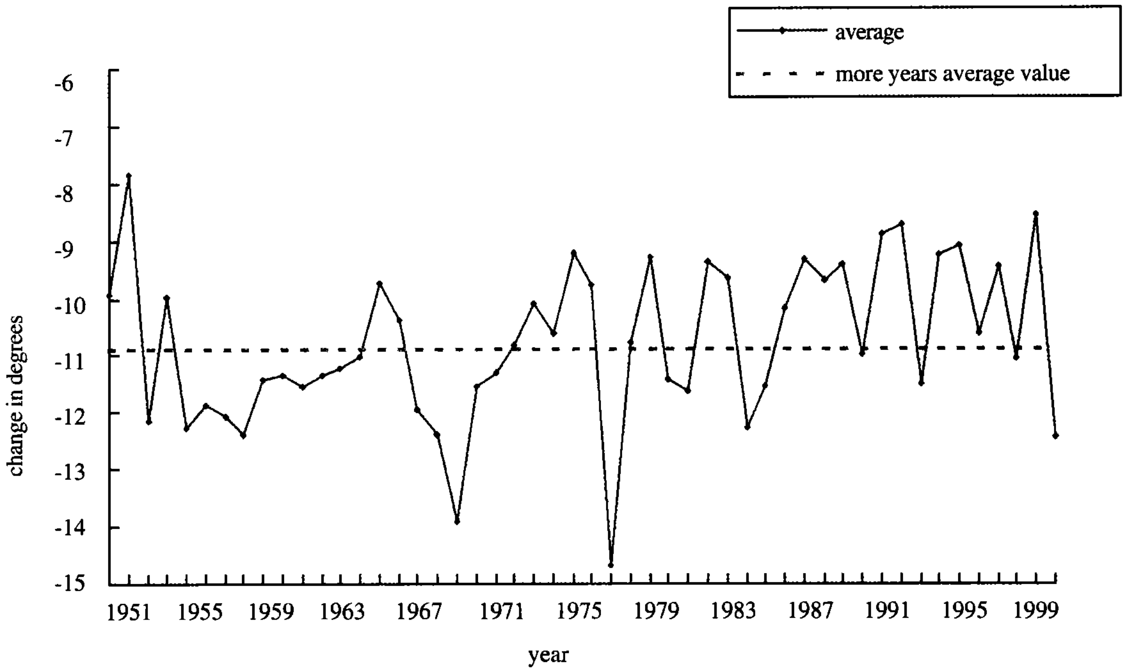

Figure 3. Variations of mean air-temperature in January in the western part of Northwest China, Central Northern China and the eastern part of Northeast China during 1951~1999

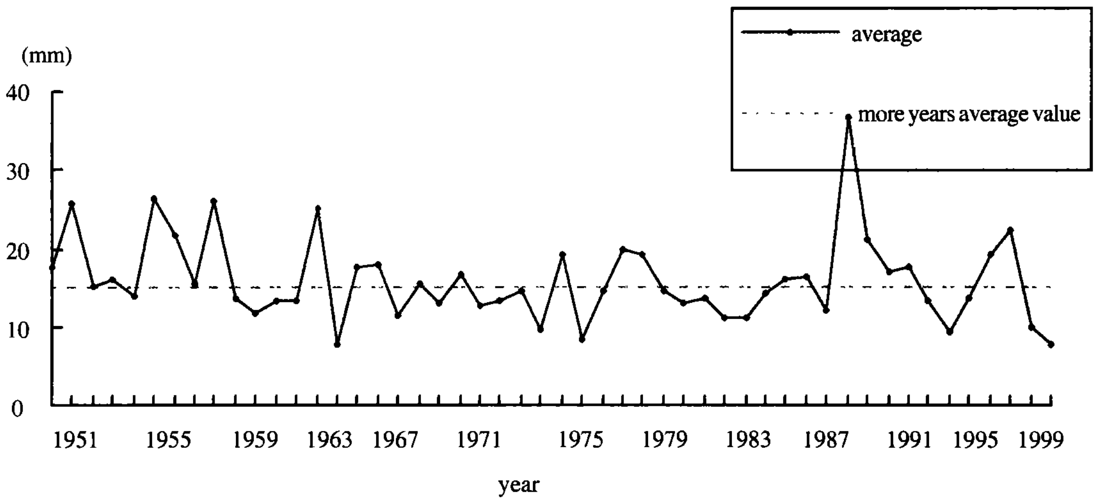

Figure 4. Variations of mean precipitation from February to Early April, 1951~2000 in Northern China

2.2.3 Limited rainfall and high temperatures at the end of winter and early spring

There were several snowfalls in January 2000, but the precipitation from February to early April in most regions of Northern China was relatively sparse in comparison with previous years; furthermore, precipitation in some regions was the lowest since the 1950s. Meanwhile, the air temperature was 1~2 degrees higher than that in the same period of the past 40 years. These climate conditions reduced water-holding capacity, and resulted in dry and loose topsoil. There was no obvious rainfall that could control the blowing up of fine sand and silt participles before the sweeping of prevailing winds (Figure 4~5).

Figure 5. Precipitation(%) from February to Early April, 1951~1999 in Northern China

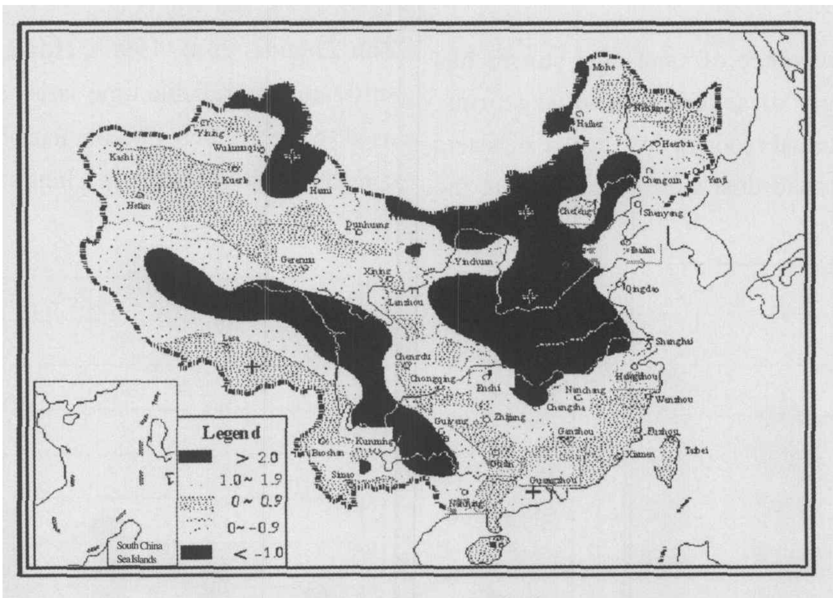

Figure 6. Anomaly of Mean Air Temperature (°C) from March 1 to April 9, 2000

2.2.4 High frequency of cold atmospheric air and vortex winds in early spring

Due to the strength of longitudinal circulation, cold air threatening China was frequent since the early spring. Along with the cold air, strong wind weather obviously increased. In addition, the vortexes of Temperate Zone were strongly developed in Inner Mongolia and Northeast China while cold air arrived. These vortexes did not reduce the temperature severely, but significantly increased the wind force (Figure 6).

2.2.5 Human activities resulting in sufficient sand-dust sources

In recent years, over-grazing, large-scale deforestation and opening-up of rangeland and irrational irrigation in many regions have evidently destroyed natural vegetation, where land surfaces were exposed to denudation and the water-holding capacity of soil decreased. Land degradation and desertification processes become more serious year by year. Urbanization has also caused reduction of vegetation and topsoil exposure that provide material sources for sandy storms under wind-sand weather.

3 NATIONWIDE TREND OF DESERTIFICATION

3.1 Increase of Sandstorm Frequency

The frequent occurrence of sand-dust storms has promoted disasters of severe sand-dust storms. According to historical records, five severe disasters caused by strong sand-dust storms occurred in the 1950s and the disasters have doubled since then (Figure 7). There were 36 sand-dust storm disasters in the 1990s. In 2000, Beijing and the adjacent regions experienced the most severe sand-dust storms in the past hundred years. Table 1 shows the intensity of disasters of sand-dust storms (Technical Programme for Combating Desertification and Controlling Sandstorm developed by the Ministry of Science and Technology, PRC in 2000).

It is a big challenge to evaluate the developmental trend of desertification in China. There is evidence that the desertification spread in some regions of China has been accelerated since the 1950s (Youhao, et al, 1997; Dong Guangrong, et al, 1998; Liu Xinmin, et al, 1996; Dong Guangrong, et al, 1993, 1999; Desertification/Land Degradation Research Group, 1998; Wang Gengxu, et al, 1999; Wang Tao, et al, 1998; Wu Bo, et al, 1997, 1998, 1999; Wu Wei et al., 1997; Zhu Zhenda, 1985; Zhu Zhenda, et al, 1990). However, there are not sufficient and reliable time series data, which can be used to clearly describe the nationwide trend of the spread of desertification in China.

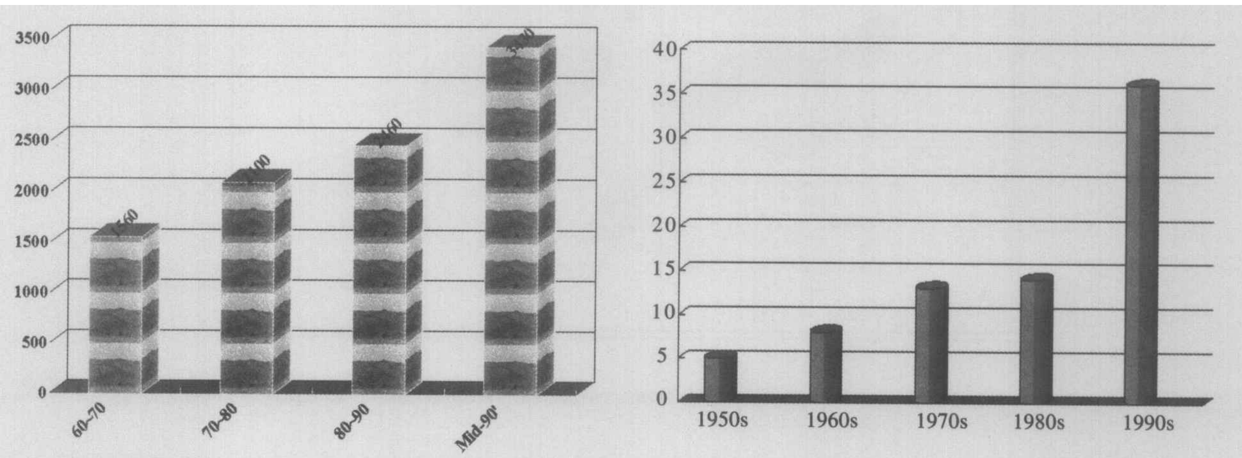

Figure 7. Extend speed of sandy desertification per year (left) and frequency of sand-dust storms (right) during the last 5 decades

3.2 Data Sets Comparison

There are two data sets regarding the nationwide developmental trends of desertification (some use the term sandification) from the 1950s to the mid-1980s. Zhu Zhenda et al. hold the view that the annual spread of desertification from the 1950s to the mid-1970s was 1 560 km² (Zhu Zhenda, 1985) and 2 100 km² from the mid-1970s to the mid-1980s (Zhu Zhenda, et al, 1990).These statistics were obtained on the basis of study of some specific areas through interpretation of black-white aerial photos in the 1950s, 1970s (1975~1976) and 1980s (1985~1987). Zhu and his group concluded that the total area of desertification in China was 137 000 km² in the 1950s, 176 000 km² in the 1970s and 197 000 km² in the 1980s. It should be noted that these data are very discrepant from the data (1.607 million km²) published officially by China National Committee for the Implementation of the United Nations Convention to Combat Desertification (CCICCD, 1997). Such differences were caused by the definition of desertification. According to Zhu's viewpoint, land desertification (sandification) refers only to desert-like land characterized by aeolian sand movement and is mainly caused by human activities during man's historical periods. All those sand deserts and Gobi formed naturally in pre-historical eras and geological periods are excluded from land desertification. According to Zhu's viewpoint, land desertification is mainly distributed on alluvial sand plains, alluvial and lacustrine plains and alluvial-deluvial plains in arid and semi-arid zones, including oasis peripheries and inland rivers downstream in arid zones, steppe areas in semi-arid zones and dryland farming areas and adjacent areas in semi-arid and dry sub-humid areas (Zhu Zhenda, 1985; Zhu Zhenda, et al, 1989, 1990; Desertification/Land degradation Research Group, 1998). As a result, Zhu and his group's studies show that the annual expansion rate of desertification in China from the 1950s to the mid-1970s was 1% and rose to 1.1% since the mid-1970s to the mid-1980s. The growth rate in some specific regions is higher than that of the entire country. Detailed discussion follows.

On the basis of a nationwide survey of deserts, Gobi and wind-sand impacted lands in China, conducted by the former Ministry of Forestry [1], PRC from 1994 to 1995 (CCICCD, 1997), the annual spread rate of desertification or sandification from the mid-1980s to the mid-1990s was 2 460 km². However, the survey report does not describe the spread of land desertification at the regional level with detailed information or data; namely, about 60%~70% of desertification (sandification) of 1.607 million km² are sand deserts and Gobi areas and those areas of newly desertified lands in the affected regions occupy a small percentage of total land desertification (sandification). Yet there is no further detailed evidence at present. In the nationwide survey mentioned above, the definition of land desertification and the criteria system for distinguishing land desertification adopted in the above-mentioned nationwide survey were completely different from what Zhu Zhenda used. Therefore, the data of 2 460 km² (CCICCD's figure) and the two data of 1 560 km² and 2 100 km² mentioned above (Zhu Zhenda's figures) cannot be used to compare each other for the time sequence from the 1950s to the mid-1990s. At present, the developmental trend of desertification since the 1980's can be discussed only at the regional level.

4 REGIONAL TRENDS OF DESERTIFICATION

There are two types of most severely impacted regions where desertification spreads quickly and hazards are serious. One type includes 4 sandy lands, namely, Horqin Sandy Land, Mu Us Sandy Land, Hulun Bir Sandy Land and Otindag Sandy Land. These 4 sandy lands are mainly distributed in Inner Mongolia. The other type comprises the oases located along inland rivers or downstream of inland rivers in arid zones in Northern China. They are mainly distributed in Xinjiang and Gansu, Northwest China (see Figure 8).

4.1 Marginal Area in Northern China

Land desertification in the marginal area in Northern China is serious. The marginal area in northern China is located in an important ecological transitional zone,

1 Renamed State Forestry Administration in 1998

from semi-arid to sub-humid zones. This transitional belt stretches from Daxing'an Ling in Eastern China to the northeastern part of Qinghai Province in Western China via the east and southeast parts of Inner Mongolia, the north part of Hebei Province, Shanxi Province, Shaanxi Province and the eastern part of Gansu Province. Administratively, this belt is mostly situated in Inner Mongolia and its neighbouring provinces. It is a narrow belt with a width of 100~250 km and a length of 2 000 km. The annual rainfall varies from 300~400 mm. Spatially, it is an inlay of arid croplands and steppes (rangeland). The belt was alternatively used for dryland farming and animal grazing before the 20th century, but rainfed farming and animal grazing coexist.

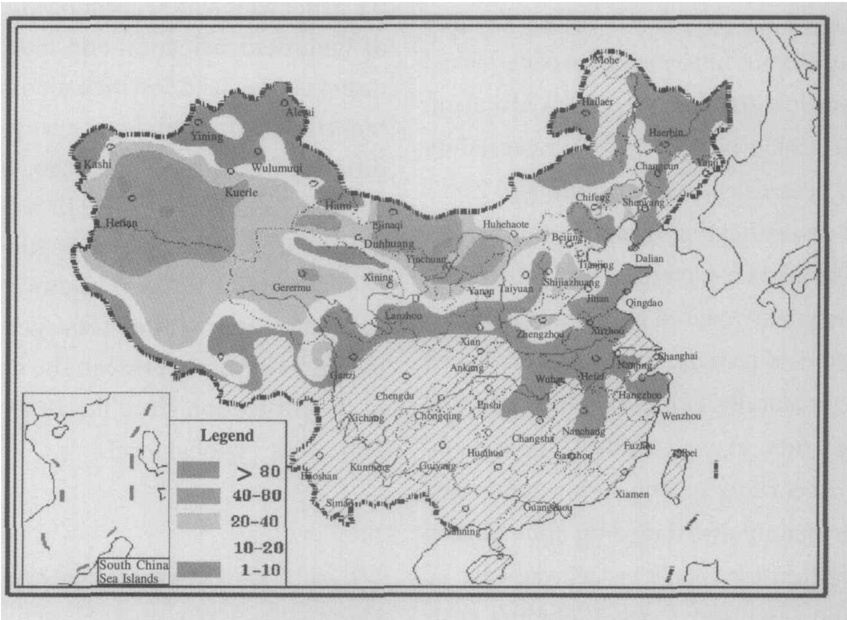

Figure 8. Spatial distribution of dust and sandstorms from 1959 to 1998 in days per year (d/a)

There are 3 major issues concerning this marginal area: (1) rangeland or steppe degradation caused by over-grazing, deforestation and undue collection of firewood and blind gathering of medicinal herbs, such as the re-activation of fixed dunes, decline of rangeland productivity and loss of biodiversity; (2) arable land degradation caused by rough and extensive cultivation systems; (3) inadequate protection of tree-networks surrounding settlements or villages, sand invasions and dune movement become disastrous. The first is the key issue that relates to social and economic development in the marginal area.

Research findings indicate that, from the 1970s to the 1980s, desertification (sandification) in marginal areas was accelerated. In some parts of Inner Mongolia, the annual growth rate of desertification (sandification) is 8%~9% (Table 2). In Horqin Sandy Land, the total area of desertified land has rapidly increased and the intensity of land desertification is increasing (Table 3).

Due to lack of sufficient data and case studies about desertification from the 1980s to the 1990s, it is difficult to analyze in detail the developmental situation. Some evidence shows that desertification in China is still developing (spreading) at a high rate. For instance, in the northern part of Duolun County of Inner Mongolia and Fengning County in the north of Hebei Province, the ratio of desertified land over the total land area increased to 74% in the mid-1990s from 42.9% in the mid-1980s. In Haolaiku, the eastern part of the Otindag Sandy Land in Inner Mongolia,

Table 2. Developmental trends of desertification in some typical districts in marginal area from the 1970s to the 1980s

Study Area and Type	Land desertification in the 1970s		Land desertification in the 1980s		Annual growth		Year
	Area (km^2)	% of desertified land in study area	Area (km^2)	% of desertified land in study area	Area (km^2)	Rate (%)	
Cereal cultivated area in Qahar Steppe, Inner Mongolia	2 848.3	31.5	5 992.9	66.1	262.1	9.20	1975~1987
Ulan Qab Prefecture in Inner Mongolia	2 031.4	4.4	4 055.2	8.7	168.7	8.30	1975~1987
Western part of cereal cultivated steppe in North Hebei	1 761.7	13.4	3 272	24.9	125.9	7.14	1975~1987
Eastern part of cereal cultivated steppe in North Hebei	762.3	22.3	1 336.6	39.1	47.6	6.28	1975~1987
Steppe of Yanchi, Southeast Ningxia	1 368.9	29.0	1 845.5	31.8	47.6	3.48	1977~1986
Northwest of Horqin Sandy Land and Xiliao River upstream	28 971	68.4	32 851	77.6	323.3	1.12	1976~1988
Ordos Steppe, Ih Ju of Inner Mongolia	43 407	88.3	45 973	93.6	256.6	0.59	1977~1986
Yulin Prefecture, North Shaanxi	7 808	43.3	8 166.9	45.3	35.9	0.46	1977~1986

Source: Wang Tao, 1998; Zhu Zhenda, et al, 1990

Table 3. Developmental trends of desertification in Horqin Sandy land from the 1970s to the 1980s

Intensity of desertification	Severe land desertification	Medium land desertification	Slight land desertification	Micro-degree land desertification	Total desertification
1970s (km^2)	2 908.25	7 969.22	24 986.84	22 114.05	57 978.37
1980s (km^2)	5 384.17	5 637.15	24 480.47	36 181.90	71 683.69
Growth rate (%)	85.13	-29.2	-2.03	63.61	23.64

Source: Liu Xinmin, et al, 1996

Table 4. Growth Rate (%/yr) of Land Desertification in different periods of time in Mu Us Sandy land

Code of study area	Area of study area (km^2)	Growth rate (1958~1977)	Growth rate (1977~1993)	Growth rate (1958~1993)
YC	92.2	8.2	1.3	5.9
TL	105.8	1.3	0.3	0.9
CC-1	98.9	3.4	-0.8	1.2
CC-2	63.0	0.7	-0.9	-0.1
KKG-1	58.3	0.6	0.3	0.5
KKG-2	28.6	-0.1	-0.8	-0.4

Source: Wu Bo, et al, 1999

desertified land increased to 28.3% in the mid-1990s from 19.8% in the mid-1980s (Desertification/land degradation research group, 1998).

Other studies undertaken in the Mu Us Sandy land by Wu Bo (1999) indicate that the spreading rate of desertification has slowed down from the end of the 1970s to the beginning of the 1990s (Box 1~2). Furthermore, desertification has been reversed in some parts of the affected areas.

Box 1. Case study: Mu Us Sandy Land

Mu Us Sandy Land is located at the boundary areas of Inner Mongolia, Shaanxi and Ningxia and covers an area of approximately 40 000 km², of which 65% is situated in Inner Mongolia. It is a marginal area (transitional area of dryland farming and animal grazing) in northern China. The steppe in the northwest part is grazing land which falls within the jurisdiction of Inner Mongolia. In the east and south part, some steppe was opened up for dryland farming and animal and cereal farming coexist.

On the basis of aerial photo interpretation, a land-use map with a scale of 1:500 000 of Mu Us Sandy Land was compiled in the 1950s (1958). By utilizing satellite imagery, a land-use map with a scale of 1:500 000 of Mu Us Sandy Land was compiled in the 1990s (1993). Research results show that desertification in Mu Us Sandy Land from the 1950s to the 1990s developed at a high rate, and the net increase of land desertification was 940 200 ha; the growth rate was 60.37% and the annual growth rate was 1.7%.

According to the interpretation analysis of black-white aerial photos of 3 stages (1958, 1977 and 1993), the spreading rate of land desertification from the end of the 1950s to the beginning of the 1990s is notably lower than that from the end of the 1950s to the end of the 1970s and an obvious negative increase of land desertification has occurred in some parts of the affected area.

Source: Lu Qi, 2000

Box 2. Case study: Yingbaza District

Taking Yingbaza District at the middle reaches of the Tarim River as an example, in comparison of the situation in the early 1980s and the early 1990s, severely desertified land increased to 14.6% from 13.1%, moderately desertified land accelerated to 15.1% from 14.7%, and the slightly desertified land has decreased to 33.6% from 40.7% (Desertification/Land Degradation Research Group, 1998).

Source: Research Group of "*Study on Combating Desertification/Land Degradation in China,*" 1998

4.2 Arid Oasis

In Northwest China, oases in the arid zones are located along inland rivers or distributed downstream of inland rivers. Administratively, these oases are mainly situated in Xinjiang and Gansu Provinces. Desertification in these oases were commonly caused by the following processes (see Box 3~4):

(1) Drying up of oases under the impact of mismanagement and irrational use of inland river water or over-exploration of underground water, including the decline and decrease of natural vegetation, descending of ground water tables and drying-up of lakes and catchments (Table 6).
(2) Salinization caused by irrational irrigation methods.
(3) Over-grazing caused by unwise opening-up of steppes or rangeland for cultivation purposes, undue collection of firewood and blind gathering of medicinal herbs and over-grazing.
(4) Sand encroachment and dune movement because of inadequate protection of tree-networks and shelterbelts around settlements and villages. The

former two are the core problems caused by mismanagement of water resources. The issues in oases are comparatively easier to solve, because they are closely related to water resources. In searching a better resolution to this issue, a set of sound policies and optimum mechanisms for managing water resources have to be developed. Of course, advanced technology for optimum irrigation is needed and investments for installation of water saving facilities are essential.

It is reported that desertification (sandification) in some sections of inland rivers in arid deserts is continuously accelerating (Table 5).

Table 5. Degradation of natural forests downstream of the Tarim River in Xinjiang from the 1970s to the 1980s

District	Area in 1973 (km^2)	Area in 1983 (km^2)	Reduced rate (%)
Tieganlike to Karguyi	317.5	224.7	29.2
Karguyi to Alagan	224.4	135.9	39.4
Alagan to Yiganbujima	92.6	34.2	63.1

Source: Zhu Zhenda, et al., 1990

Box 3. Case study: Ejina Oasis

Ejina Oasis downstream of the Heihe River is situated at the Alxa plateau in western Inner Mongolia. This is one of the driest regions in China. Annual precipitation is less than 50 mm and total human population is 15 000. Since the 1950s, the climate became drier and drier. But in comparison with the impact of climatic fluctuation, human economic activities brought about more serious impacts in the change of water flow from the Heihe River. Due to over-exploitation and irrational utilization of water resources at the middle reaches of the river, land degradation and environmental crises were validated at downstream: (1) on the basis of analysis of remote sensing data, desertified land increased to 6 000 km^2 in 1986 from 3 400 km^2 in 1975 and the annual growth rate was 6.5%. About 71% of the existing arable land along the river course was abandoned; (2) during the period from the 1950s to the 1990s, 54% of the area of *Populus euphratica* forest and *Eleagunus spp.* was reduced, and about 33% of *Tamarix spp.* was reduced, the area of *Hedysarium spp.* declined to 5 300 km^2 from the original 11 300 km^2. In the meantime, coverage of the plant community slowed down to 10%~30% from 30%~50% in the 1950s; (3) the productivity of desert steppes descended to 150 kg/ha in the 1990s from 225~300 kg/ha in the 1950s. Meanwhile, the carrying capacity of desert steppes was reduced to 0.27 sheep unit/ha from the previous 0.5 sheep unit/ha. During the same period of time, the average weight of sheep/goat and camel was reduced to 10 kg and 150 kg from 25 kg and 300 kg, respectively; (4) two natural lakes, namely, Gashun Nor, 267 km^2 in size in 1958 became dried up in 1961 and Sogol Nor, 35.5 km^2 in size in 1958 was periodically dried up in 1973, 1980 and 1986, and completely dried up in 1992. In addition, another 11 small lakes and 4 swamps were dried up during the same period of time.

Source: Luqi, 2000

Box 4. Case study: Minqin Oasis

Minqin Oasis is a natural oasis located at the Shiyang River downstream in western Gansu Province. Annual rainfall varies from 80~160 mm and approximately 300 000 inhabitants dwell in the oasis. Due to the quick development of irrigated agriculture and increased consumption of water in the middle reaches of the Shiyang River, serious ecological crises have taken place in Minqin Oasis. (1) Natural plants declined and withered in large amounts due to descending of underground water tables. About 70% of natural desert plants were degraded and deceased, and vegetative cover was reduced to 15% or less in the 1990s from 44.8% in the 1950s; (2) since the 1960s, 25 200 ha of farming land were abandoned covering 36% of the total arable land in the oasis; (3) over-exploration of underground water was caused by excessive pumping (Table 6; Youhao, et al, 1997). Mineralization of underground water is as high as 4~6g/L. More than 70 000 villagers and 120 000 animals are suffering from a lack of drinking water; (4) Minqin County receives 1.5 million kg of cereals and 180 000 RMB yuan from the central government as relief subsidy. Minqin is one of the counties where people live under the poverty line.

Source: Lu Qi, 2000

Table 6. Underground Water Table Changes in Minqin Oasis, Gansu

Years	Underground water table (m)	Rate of decline (m/yr)
1961~1967	2.24~2.93	0.12
1967~1978	2.93~5.20	0.21
1978~1988	5.20~9.00	0.38
1988~1994	9.00~12.99	0.67
Mean 1961~1994	2.24~12.99	0.33

Source: E Youhao, et al, 1997

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Photos 1 to 3: Sandstorm closed Beijing on 9:00 AM of 6 April 2000 (left), covered Beijing on 16:00 PM of 6 April 2000 (middle) and moved forward East China Sea on 9:00 AM of 7 April 2000 (right)

Source: Sandstorm Research Group of National Satellite Meteorological Center, China Meteorological Administration