

# DESERTIFICATION HAZARD AND FARMING- GRAZING SUSTAINABLE DEVELOPMENT IN LINGWU-YANCHI REGION OF NINGXIA<sup>①</sup>

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**ABSTRACT:** In the view of the desertification hazard process in Lingwu-Yanchi region of Ningxia Hui Autonomous Region, the paper analyzed the interaction between the physical environment and the human activities, and discussed the social problems of controlling sandy land by using the way of "decreasing farming for increasing grazing" and developing agriculture and animal husbandry. The results indicated that the changes of desertification in the Quaternary geological periods was a kind of climatic geomorphic processes, and a kind of climate-human processes in human history, which are mainly controlled by climatic conditions and partly interfered by human economic activities. Both of the physical environment and the human activities have double effects to aggravate or reverse the desertification.

**KEY WORDS:** desertification, climatic change, human activity, social sustainable development, Lingwu-Yanchi region

## 1 PROCESS OF DESERTIFICATION AND INFLUENCE OF PHYSICAL ENVIRONMENT AND HUMAN ACTIVITY IN LINGWU-YANCHI REGION

The desertification hazard in Lingwu-Yanchi region of Ningxia Hui Autonomous Region has been the most serious in the studied area to the east of the Huanghe(Yellow) River, including Wuzhong Town, and Taole, Lingwu, Yanchi and Tongxin counties, of which the sandy land is 20.1% of the total area (18 200 km<sup>2</sup>). In Lingwu County, it is mainly mobile dune, which is 44.6% of the sandy area of the county; and in Yanchi County semifixed and semimobile sand takes up 64.5%. The modern landscapes in Lingwu-Yanchi region are mostly sandy land of desert steppe and the transition from desert to steppe.

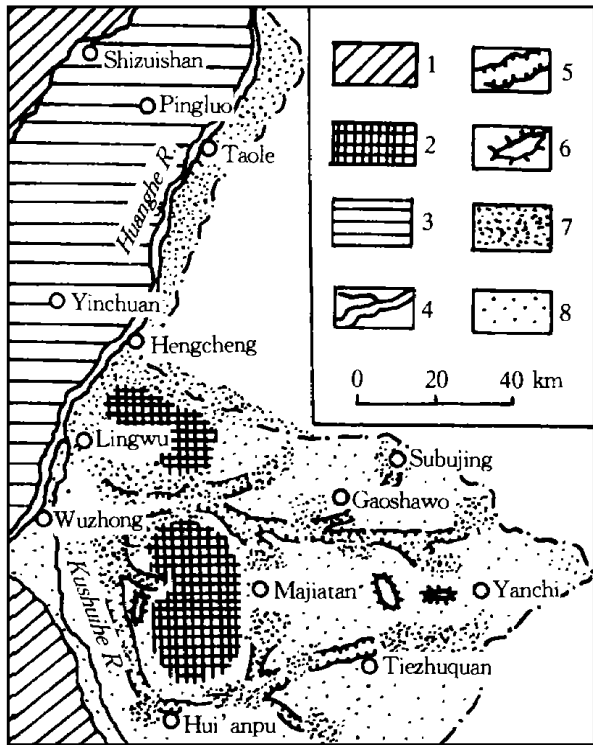
There, the elevation is 1100- 1600 m, the average annual temperature is 7.0- 8.9°C, and the average annual precipitation and evaporation are respectively 212- 296 mm and 2000- 2300 mm. There are also frequent windy and dusty activities. The desertification hazard is greatly controlled by the physical environment, that is, an interior factor. The human activities play a role of "the reinforce dose" in the desertification process on the basis of nature (Shan *et al.*, 1993).

### 1.1 The Natural Action of the Desertification Process

#### 1.1.1 Buried ancient channel and wind-drift sand from the local

By investigating the most serious desertification

of the studied area, it was discovered that mobile and semi-fixed dunes were continuously distributed in belt, which has a very close relation with the buried ancient channel (Fig. 1). The ancient channel of the Late Pleistocene in Baijiatan district was discovered



1. Mountain 2. Deducted low hill 3. Plain 4. River  
 5. Ancient channel 6. Deducted monadnock  
 7. Mobile and semi-fixed dunes 8. Fixed dunes and sandy land

Fig. 1 Distribution of ancient channel and dunes in Lingwu-Yanchi region of Ningxia

by the Lingwu Governing Sand Synthetic Test Station of the Chinese Academy of Sciences in 1959. According to the connection of the ancient channel with some characters such as the correspondence of the low land belt on the ground, hydrophilous plant growing, and the distribution of relict landscape by terrene dissection, the ancient channel in Fig. 1 were explained once again by the authors who integrated the predecessor's the landform study and the aeronautics surveying report. It was displayed that the fragmentary or zonal serious desertified land was mainly located at the ancient channel and its near by areas. These facts not only accorded with the conclusion of "wind-drift sand from the local" for studying source of sand

area (Xue, 1965), but also expressed a certain result of "the swaying movement" under the common influence both of the natural environment and the human activities.

1.1.2 Evolution of natural environment and developing or reverse processes of desertification

According to the analysis on the data of the drill holes within Baijiatan of Lingwu County and Gouchi of Yanchi County, it is found that the sediments had been piled up as the loess, sandy soil, alluvium and lacustrine sediment and that the ancient landform had already become undulate and gentle "yellow ocean of loess" in the middle period of the Late Pleistocene. On the basis of the analysis on the famous Shuidonggou section in Lingwu County, it can be seen that 11.8 m of silty clay stratum like loess caused by wind had been formed under dry and cool climatic condition in the maximum period of the Last Ice Age (Zhou *et al.*, 1988). The environmental analysis of the Holocene section indicated that the vegetation landscapes of the sparse forest steppe, the shrubby-arboreal steppe and the arid steppe had changed many times (Sun *et al.*, 1991). So we know that the expansion of the desertification and desert landscape in the studied district took place in the late period of the Late Pleistocene, and in the Last Ice Age the ancient channel had been dried up and covered under dry, cool and windy climate. The formation and development of the desert had changed simultaneously in direct or reverse connection with undulating of the global climate, which inflected that the desertification process was mainly controlled by natural environment. In other words, it was the drying of the climate that resulted in forming and developing the desert, and the human factor was just another aspect for aggravating the desertification at the later stage. These can be proved by the discovery of the ancient eolian sand of the Quaternary in the Erdos Plateau (Dong *et al.*, 1983), four development and reverse processes of desertification shown by the fossil sand and sandy blacksoil in the Holocene in the Sandaogou section of Yulin County (SSITCA, 1991), and the studies of the natural environment about Liushuwan section of the

southern Mu Us Desert in the Holocene (Huang, 1991).

## 1.2 The Artificial Action of the Desertification Process

Some geographers and desert researchers have considered that the human activities in historical period had brought about the desertification in Erdos region. According to the historical records of different eras and the traces of ancient man, they believed that the desertification in Erdos region was caused by a large-scale reclamation since the Qin and Han dynasties (Chen, 1986), and that the Mu Us Desert which is a main body of the Erdos was caused by human activities within about a thousand years after the Tang Dynasty (Zhu *et al.*, 1982), and that the desertification of Lingwu-Yanchi region located in the southwest of the Erdos resulted from the human cultivating and stationing troops, war, over firewood collecting, and so on during the Ming and Qing dynasties (Hou, 1964). Although our view is different from their opinions, it can not be ignored that the human activities there have played "the effect of accelerator" in the desertification on the basis of the major factor of the nature, and its direct result was making desertification haste and mutation development. For instance, in Yanchi County (Table 1), the developmental rate of desertified land had reached 143.95% in 22 years from 1961 to 1983, in the early 15 years its average growing rate was 114%, and 143% within 7 years afterward. These indicated that the area of desertified land enlarged rapidly.

It must be pointed out that human activities, just like environmental change, also have positive effect on desertification. For example, during the first period of construction of the "three north shelter belts" on the highway between Lingwu and Yuling from 1980 to 1985, the shelter forest of 500–1000 m wide and 135 km long on mobile sandy land and that of the 100–300 m wide on the desertified land were built on the two sides of the highway in Lingwu-Yanchi region, and it has efficiently safeguarded

the transportation of this high way (Zhang, 1991). Therefore, the artificial action has both aggravating and reversing effects on the process of the desertification.

Table 1 Land desertification in Yanchi County from 1961 to 1983

	1961	1976	1982	1983
Total of desertified land (km <sup>2</sup> )	1883.3	3593.3	4266.7	4594.3
Desertified land in whole county (%)	28	58	63	68
Accumulative increase of sandy land (km <sup>2</sup> )	/	1710.0	2383.4	2711.0
Accumulative increase rate of sandy land (%)	/	90.8	126.55	143.95
Net increase areas in different stages (km <sup>2</sup> )	/	1710.0	673.4	327.6
Average annual increase rate (%)		114		143

## 1.3 Interaction Between the Nature and the Human Beings in the Desertification Process

With regard to the desertification in the Erdos region, as mentioned above, it shows not only that the nature has the main effect on desertification, but also that its period corresponded to the dry and cool period of the climate fluctuation, based on the facts such as the discovery of fossil eolian sand earlier than human historical period, its limit of distribution furthermore larger than now a days, and the interbedded development of aeolian sand and black soil (indicating the warm and moist environment) in modern dune section. The desertification time in Lingwu-Yanchi region has much better synchronous and homologous relation with development epoch of the glacier (Last ice age), the periglacial landform and the loess in the Helanshan Mountain region near the western side of the region. This is in accordance with the model of environmental development in the monsoon area of the northern China (Li, 1990). On the basis of the correspondent study on the temperature undulating tendency and the drought occurring frequency in the northern China during the past 1700 years, droughts

and windstorms happening frequently in the studied district was influenced by the neoglaciation of the northern hemisphere, and it was about 1–2 °C lower than the present temperature, and the degree of dry and cool condition on the Late Holocene increased severely, especially in the past 400 years (Wu, 1991). In the Erdos region there had three large-scale reclamations in the Han, Tang and Qing dynasties in the history as well as in a few years after the liberalization, the early 1960s, and the early 1970s. The period of stationing troops to open up wasteland in the Ming and Qing dynasties in the Lingwu Yanchi region just corresponded to the maximum period (i. e. 1700–1900 A. D.) when droughts and windstorms happened frequently in the past 400 years, the two large-scale reclamation periods after 1949 were in line with the decrease of precipitation year by year, and

the tendency of ten-year sliding average reduced from the 1960s to the middle 1980s although the meteorological record of precipitation had undulating characters (Fig. 2). This fact was in accord with the comparing results of desertification expanding limits and the precipitation changes from 1959 to 1984 in 32 weather observatory stations (Fang, 1987), so it accounts for that the desertification in recent time was still controlled mainly by the tendency of climate getting dry. For this reason, in view of the relation of the nature and the human beings in the process of desertification in the area, the changes of desertification in geological periods are a kind of climatic-geomorphic processes, but the changes in human history belong to a kind of climate-human processes which are mainly controlled by climatic conditions and partly interfered by human activities.

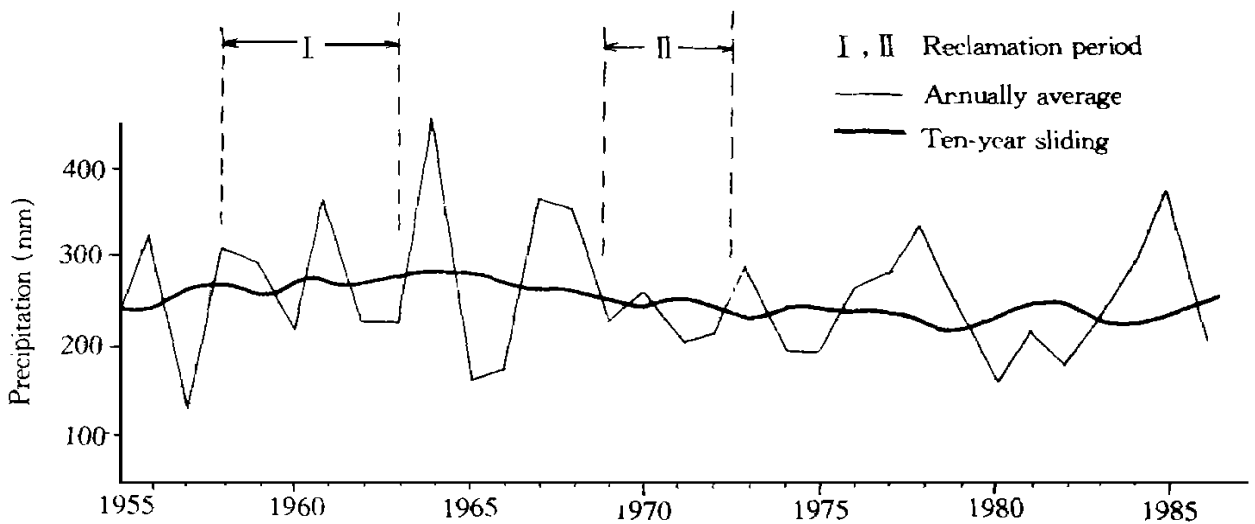


Fig. 2 Contrast of the annual precipitation changes and the tendency of ten-year sliding average in the period of human reclamation in Lingwu-Yanchi region of Ningxia

## 2 DESERTIFICATION HAZARDS AND SOCIAL SUSTAINABLE DEVELOPMENT

### 2.1 Desertification and the Development of Agriculture and Animal Husbandry under the Tendency of Climate Warming

The changes of glaciers and lakes indicate that the climate in the central part Asia had presented fur-

ther warming and drying tendency since the end of the Little Ice Age (Shi, 1990). Under the background of the global warming, the arid degree strengthens and the desertification intensifies in the western part of sandy area of the northern China, but the precipitation increases and desertification slows down or even reverses possibly in the eastern part of China (Dong *et al.*, 1990).

The eco-environment in Lingwu-Yanchi region

located at the boundary of the monsoon climate in the eastern China is extremely fragile, and the drought and desertification have aggravated. In Yanchi County, for instance, gales occurred averagely 23.4 times each year, and even reached 85 times in a year, and the sandy storms increased from 12.7 times each year in the 1960s to 25.9 times in the 1980s. The arid and windy climate is directly controlling the natural ecosystem and fiercely effecting agricultural pastoral activities as well.

The data of the fixed spot in Yanchi County surveyed by the husbandry department show that from May to July in 1961 the precipitation was 127.5 mm (normal year) and per square hectare land produced 2.25 tons of green grass, that in 1977, the precipitation was 87.9 mm (arid year) and 1.125 tons of grass was produced, and that in 1980, the precipitation was only 47.8 mm and grass, about 450 kg. These indicated that the fluctuation of temperature and precipitation had a direct impact on the ecosystem changes in steppe and desert steppe, and the quality and quantity of the forage grass production was directly correlated to precipitation, light and heat. Therefore, arid and desertification hazards are directly going to result in both of the livestock's death and the failure or annihilation of agriculture and animal husbandry production, thus hindered seriously to the sustainable development of the local social economy.

## 2.2 The Pressure of Fast Population Growth and the Way of "Decreasing Farming for Increasing Grazing" to Control Desertification

The way of "decreasing farming for increasing grazing", a basic principle which is obeyed in Chinese desert region, played a positive action in governing the desertification in the past. However, the particular eco-environment of the district limits the bearing capacity of land, and the warming trend of climate is going to restrict the natural reverse of desertification in the future. With the pressure of fast community population growth, the excessive activity of animal husbandry will lead to unreality for governing deserti-

fication in the end, if we just depend on the strategy of "decreasing farming for increasing grazing"; what is more, it is very difficult to satisfy the real demands of modern people for getting rid of the poverty with economic increasing at high speed. As an autonomous region of the Hui minority, the growing rate of Ningxia's population was much faster than average rate of the whole country, because it was ever protected by several policies of the nation and locality. The total population (316 578) of Lingwu-Yanchi region in 1985 was 323.2% of that in 1949 and its growth rate was 2.48 times faster than the nation. Under the condition of concerting developing economy, governing sand, warming and drying climate in future, it is not realizable that one try to reverse and to manage desertification upon nature. It is necessary to develop land resources by various ways and irrigate farmland artificially, which can decrease desertification hazard, can set up and regain a find local ecosystem, and can connect with economic development of the district. Governing the desertification land in Yanchi region between 1983 to 1989, the ecosystem there had improved to certain extent, by the countermeasures of drilling 1100 water holes and setting up 18 000 water cellars in meadow, developing 24 km<sup>2</sup> of irrigation land, afforesting 680 km<sup>2</sup> in the farming-grazing zones, and planting 173.3 km<sup>2</sup> of grassland. These made the commodity rate of the sheep production of whole county go up from 55% in 1980 to 80% in 1988, the slaughter rate raised to 40% from 22% in the same times. In 1989, the per capita rural net income (337 yuan) and per capita grain (259 kg) increased 2.5 times and 1.2 times respectively than that in 1983. Yanchi County had become the first in eight counties in the southern mountain region of Ningxia, of which the problem of poverty-stricken was solved essentially. And the Wulipo village in Lingwu County was a wildness and sandy land without grass in the past, but since digging out the east main ditch, the farmers and herdsman coming from other places in 1975 had diverted water to afforestation 420 000 trees each year. Up to 1989 the whole village had maintained 130 000 trees and achieved the

forest network on farmland. It not only stops wind and dust, but also sets up a new homeland with abundant crops, luxuriant forest and sheep crowds. The per capita grain surpassed 400 kg, and each home had about 0.07 hectare of fruits gardens. These facts account for the advantage action using the ways of human irrigation and reasonable developing land.

But it must be pointed out that the ground water with salt, bitter and high fluorine in the district and the surface water bodies in the studied are in the distribution areas of high-salt and high-fluorine water in Ningxia, and the evaporation is much larger than precipitation, which make both salinization hazard of land and F poisoning to human bodies (Shan, 1982). Therefore, if one wants to cure and coordinate the ecosystem in the district, it must count on foreign aid using the big facilities such as Yanchi-Huanxian-Dingbian water conservancy and Dalishu irrigation works, and must use scientific countermeasures that concert the desertification governing with economic development to exploit land. For example, planting grape and reforming desert with the irrigation to draw the Huanghe River water, had got success by the Sapotou Desert Science Station of the Chinese Academy of Science and the Japan Institute of Development Sand Land in the brink of Tenggelí desert during 1986 to 1990.

### 3 CONCLUDING REMARKS

The occurrence and development of land desertification is a climatic geomorphic process in the Quaternary and a climate-human process in human history, which are mainly controlled by climatic conditions and partly interfered by human economic activities. Both of physical environment and human activities have effects on direct or reverse desertification.

In the theoretical study of desertification and the specific practice of governing hazard, it is necessary to take notice to the producing and developing laws of the desertification under the regular changes of nature, and to predict study about the reason of climate drying, the regular patterns of long and short period

change and its results. To make a strategic decision bring the direct action of human activities into full play, the best benefits of the society, economy and ecosystem will be gained to solve the outstanding contradiction between human economic activities and environmental resources, which was caused by fast changes of economic development and the population growth for the sustainable development in the district.

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