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### Development of land desertification in Bashang area in the past 20 years

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Abstract: Natural conditions in Bashang area are characterized by zonal transitions which are liable to be impacted by natural disasters and intensified human activities. The extremely fragile eco-environment is also liable to have desertification formed and developed. In the 18 years from 1978 to 1996, the desertified land area of Bashang within the scope of the map nearly doubled, a total increase of 2199.11 km<sup>2</sup>, averaging an increase of 122.17 km<sup>2</sup> per year. Moreover, the seriously desertified area increases rapidly. Land desertification in Bashang is the combined result of natural factors and irrational human economic activities. Cultivated land expansion, population growth, and overgrazing aggravate desertification development.

Development of land desertification in Bashang area in the past 20 years CHEN Zhi-qing<sup>1</sup>, ZHU Zhen-da<sup>2</sup> (1. Institute of Geographic Sciences and Natural Resources Research, CAS, Beijing 100101, China; 2. Institute of Cold and Arid Regions and Environmental Engineering, CAS, Lanzhou 730000, China) 1 Physiographic characteristics of Bashang area In broad sense, Bashang area refers to the entire Zhangbei, Kangbao and Guyuan counties, northern part of Shangyi, northern parts of Fengning and Weichang counties of Chengde Prefecture, most part of Duolun county, entire Taipusi Banner (Taipusi County), southern part of Zhenglan and Zhengxiangbai banners (counties) and northeast of Huade in Inner Mongolia, altogether 12 counties or banners covering an area of more than 42,000 km<sup>2</sup> with a population of over 2 million. Concerning geographic location, Bashang area serves not only as a north gate of Beijing and Tianjin but also one of the source areas of water of the two cities, therefore, its eco-environmental quality directly relates to them. Bashang area possesses characteristics of a transitional zone, it is not only the transitional zone from North China Plain to Inner Mongolian Plateau but also the transitional zone from monsoon climate to continental climate, humid to semiarid zone, temperate broad-leaved forests to steppe, and farming to livestock grazing. Topographically speaking, terrain on Bashang is relatively high, with elevations being mostly 1500-1600 m, descending generally from south towards north. The northern part is the residual hill of Yinshan Mountains which is 1200-1500 m in elevation, appearing hills. The central part is the typical plateau landform with undulating terrain and the southern part is composed of mountain range of around 1500 m[1]. In terms of climate, the annual mean temperature of Bashang area ranges from -0.3-3.5 oC with frost free period of 80-110 days and accumulated temperature > 10 oC merely 1600-2200 oC. The annual precipitation is 340-450 mm with annual variation being 13-20%, about 60-70% of precipitation concentrating in June, July and August. Evaporation is four times that of precipitation, having an aridity of 1.5-2.2. The annual average strong windy days with a force over 6 degrees total 50-70 and gales with a velocity of 5-7 m/s frequently occur from March to May. The greatest velocity can reach 28 m/s, usually leading to the formation of sandstorms[1,2]. Concerning soils, the zonal soil in western part is chestnut soil and black soil is frequently seen in eastern part. Most of the rivers are interior ones with short course, shallow channel and insufficient amount of water, and they are mostly seasonal rivers. Chestnut soil with coarse texture and thin horizon is sandy loam, containing sand gravel components to different degrees. Its water holding capacity is poor, liable to be eroded by wind and form desertified land. Since relief of the area is relatively high without apparent natural barrier, the higher relief in southern part blocks the penetration of the summer warm and humid air current. Therefore, it is under the control of strong, dry and frigid northwest air current most of the time in a year, resulting in the formation of steppe dominated ecosystem in the area with simple hierarchical structure of the landscape, short food chains and poor self-regulating ability. It is thus an

extremely sensitive and fragile ecosystem area in northern China liable to be impacted by natural disasters or intense human activities and also an area liable to have desertification formed and developed.

## 2 Development of land desertification in Bashang area in the past 20 years

In order to study desertification development status of the Bashang area in the past 20 years, we compared satellite images of two scenes in different periods. One was obtained on September 20, 1978 and the other, September 26, 1996. The two images were interpreted with the same standards and desertification status maps of different periods (Figure 1). The measured desertified areas based on desertification degrees of the two maps are indicated in Table 1.

Category	1978 (km <sup>2</sup> )	1996 (km <sup>2</sup> )	Net Increase (km <sup>2</sup> )	Annual Average Increase (km <sup>2</sup> )
Existing desertified land	42,513	47,166.68	4,653.68	258.54
Newly added desertified land	0	2,199.11	2,199.11	122.17
Severely desertified area	494.00	1,149.56	655.56	36.42
Moderately desertified area	1,301.88	2,762.6	1,460.72	81.15
Slightly desertified area	13,017.88	14,608.68	1,590.8	88.38

Studies of the comparative results of the maps and the table demonstrated that of the 42,513 km<sup>2</sup> of the existing desertified land area within the scope of the study area, 47,166.68 km<sup>2</sup> of land had been desertified up to 1996, accounting for 11.09% of the total map area. In the 18 years time, desertified area increased by 2,199.11 km<sup>2</sup>, an annual average increase of 122.17 km<sup>2</sup>. In the newly added desertified land area, severely desertified area increased rapidly. It increased from 494.00 km<sup>2</sup> to 1,149.56 km<sup>2</sup> in 18 years, a net increase of 655.56 km<sup>2</sup>, an annual average increase of 36.42 km<sup>2</sup>. In 1996, severely desertified area was 2.33 times that of the 1978, or more than doubled in 18 years. Although moderately desertified land area also increased, yet the increment is insignificant, an increase of 82.87 km<sup>2</sup> in 18 years, an annual average increase of 4.60 km<sup>2</sup>. The reason accountable for this is some moderately desertified land has become severely desertified area due to aggravation of desertification degree. Hence, this portion of original moderately desertified land should be deducted, a phenomenon of dynamic balance and variations. Slightly desertified land is most extensively distributed in this area and increment is also quite fast. It increased from 13,017.88 km<sup>2</sup> to 14,608.6 km<sup>2</sup> in 18 years, a net increase of 1,590.72 km<sup>2</sup>, an annual average increase of 88.38 km<sup>2</sup>. What is worth noting is that the newly added slightly desertified area is originally non-desertified land which gradually became desertified land under joint effect of natural factors and irrational economic activities.

### Figure 1 Desertification process of Bashang area, 1978-1996

Viewing from the areal distribution of desertified land, the mountain region occupies 35.30%, hilly area and flatland, 64.70%. From Figure 1 one can clearly see that desertification is insignificantly developed in the past 20 years in mountain region where the limited desertified land area is in sporadic distribution. Desertified land mainly develops in hilly and flat land area, provided mountain area was excluded, the total desertified land area in 1996 had made up 17.15% of the hilly and flat land area. Severe desertification occurred in hilly area of Bashang where extensively desertified area with high intensity was observed. For example, originally non-desertified land in some places on banks of Shandian River in northeastern part of Duolun County became seriously desertified land after 18 years. Seriously desertified land area in Zhengxiangbai and Zhenglan banners also increased substantially. Another area located among Zhengxiangbai, Taipusi and Kangbao witnessed rapid development of desertification, the originally desertified land in sporadic and scattered distribution has connected in continuous distribution, some has developed into moderately desertified land. The presently desertified lacustrine flatland to the south of hilly area in western Zhangye County, though in dispersed distribution, the area has expanded obviously in contrast to that of 18 years ago, some places have developed into moderate degree. In Bashang, the area of desertified land is limited with insignificant changes in meadow steppe flat land, only on banks of Shandian River in northeastern part of Zhenglan Banner, two patches of slightly desertified land are found.

## 3 Relationship between land desertification and human activities in Bashang

Land desertification in Bashang was resulted by joint actions of natural factors and man's irrational economic activities. Natural conditions are poor with extremely fragile ecosystems in Bashang, once land resources were excessively used, desertification would develop rapidly.

County	Population (1970s)	Population (1980s)	Annual Growth Rate (%)
Duolun County	Low	High	19.37%
Zhenglan Banner	Low	Medium	11.17-13.53%
Zhengxiangbai Banner	Low	Medium	11.17-13.53%
Taipusi Banner	Low	Medium	11.17-13.53%

From Table 2 one can find that population in these banners or counties has increased generally from the 1970s to the 1980s, the increasing rate is the highest particularly in Duolun County. In the nine years time the population net increase is 14,100, annual average increase rate reaches 19.37% whereas in the other three banners or counties, the annual growth rate of population in the former nine years is 11.17-13.53%. Though the growth rate drops in the four counties in the latter nine years, the growth rate in Duolun County still reaches 8.89%. With growth of population, cultivated land area in Duolun also increases substantially, a net increase in the 18 years is  $2.2 \times 10^4$  ha, the newly added cultivated land making up about 40.04 % of the original cultivated land while it doesn't change much in the other three counties. The number of draught animals does not change much generally. Only an increase of 10,000 heads is found in 18 years in Taipusi. The number of sheep that causes relative great damage to grassland resources varies in different counties. It does not change much in Taipusi, but in Zhenglan Banner it increases fast in the former nine years and remains almost the same in the latter nine years. In Zhengxiangbai Banner, the sheep flocks develop fast and increase constantly in the 18 years. In Duolun County, the number of sheep flocks increases drastically in the latter nine years. Overgrazing induced

desertification also constitutes an important reason for desertification development of the area. Cultivated land area continues to drop as a result of development of land desertification. Comparative result of cultivated land area of the four counties in different years in Table 3 indicates that cultivated land in all the four counties decreases constantly. The drop is most apparent in Zhengxiangbai Banner, the cultivated land in 1985 is only 73.38% that of the 1978. Comparison of area of land suitable for farming and cultivated land area indicates that they are basically the same, this means that all land suitable for farming have been turned into cultivated land. In Duolun County, the latter even exceeds the former, that is to say, all land suitable for farming have been reclaimed into farmland, the latter even surpasses the former, or all that can be reclaimed have been reclaimed and all that cannot be reclaimed have also been reclaimed. In addition, the rapid population growth and constant increase plus dramatic increase in sheep flocks in the latter nine years all resulted in rapid development of desertification in Duolun County, the area of desertified land is not only large but desertification degree is high. Table 3 Comparison of cultivated land in the four banners (counties) of southern Xilin Gol League, Inner Mongolia (unit: ha) The result of land desertification has not only caused constant loss of cultivated land but sharp drop of land productivity due to loss of substantial surface fine particles, drop of organic matter and coarsening of surface soil. Observation data analysis indicated that in the 0-20 cm deep surface soil, organic matter generally decreases from original 2-4% to 0.7-0.8%, fine particles (grain size < 0.05 mm) decrease from 16.38-14.72% to 5.01-4.1%, coarse material (> 0.25 mm) increases from 31.12% to 52%, and the amount of land produced also decreases apparently, from 2250 kg/ha in the initial period of reclamation to present 600-750 kg/ha. It is thus clear that the impact of desertification development is far-reaching. References

**关键词:** Bashang area; desertification; impact of human activities