Evaluation on the Prevention and Remedies of Desertification
- A Case Study in Horqin Steppe Region, Inner Mongolia, China

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Abstract

The Horqin Steppe is one of the regions that has suffered seriously from desertification in North China. According to the fieldwork investigation and the remotely-sensed data processing of wide scope, of 146,700 km², the desertified land has expanded from 22,730 km² in late 1950s to 57,980 km² in 1976 and to 71,680 km² in 1988. Desertification caused the decline of land productivity and the degeneration of the ecological environment, which restricted the subsistence and sustainable development in the region. To combating it, many projects have been carried out for many years so that about 4,500 km² of desertified land has been remedied only in the south part of the Horqin Steppe Region by the late 1980s, and much more after that. The theory and practice of combating desertification have made good progress. In this paper, based on case study, we monitored and evaluated the effective measures to deal with desertification in the region and reach the conclusion that desertification is land degradation resulting mainly from adverse human impacts on the fragile ecosystem, such as over-cultivation, over-grazing and over-collection of fuelwood. This has been caused by the rapidly increasing population and a less developed production pattern, and it could be prevented and remedied through readjusting the economic activities, improving the land management, increasing the agricultural investment and implementing the controlling measures.

Key words: prevention and remedy, desertification, Horqin Steppe Region, China

1. Introduction

Horqin Steppe Region is located in the transitive territory from the Inner Mongolia Plain to the Northeast Plain in the west part of the Northeast China. Most of its area belongs to the Jirem League and the City of Chifeng, Inner Mongolia and small areas are within the boundaries of Tongyu County in the west part of Jilin Province and Zhangwu County in the northwest part of Liaoning Province. The total area is about 150,000 km², in which the rangeland area occupies about 115,000 km². It was one of the best prairies in the semi-arid zone of China. Since the Guangxu emperor period (1875-1908) of the Qing Dynasty, the region had been brought under cultivation on a large scale. Along with the rapid development of agriculture, especially during the last 50 years, the land use in the region has been transformed from nomadic grazing to both cropping and grazing, but the major one is the cropping. Because of the unfavorable natural conditions, such as inadequate precipitation, strong wind erosion, impoverished soil and so on, and mainly due to the excessive land use and other human impacts, the region has become the most serious areas of desertification in North China. Desertification has created many environmental and social-economic problems in the region. For the subsistence and sustainable development, many great efforts have been made by scientists and local people to prevent and remedy desertification for many years. Based on analysing the development and process of desertification and the combated practices, we try to evaluate the principle and measures which have been applied successfully to prevent and remedy desertification in the region.

2. Desertification in the Horqin Steppe Region

Horqin Steppe Region has a continental monsoonal climate with a large daily and annual range in temperature. In most parts of the region, the average annual temperature is 3-7 °C, the coldest month(January) is -12-17 °C and the warmest month(July) is 20 - 24 °C, and the ≥10 °C accumulated temperature is 2,200-3,200 °C. The average precipitation varies from 350 to 500 mm from west to east(Fig.1). It is the summer monsoon that brings rainfall, mainly between June and August, which contributes more than 70% of the annual precipitation. The yearly evapotranspiration ranges from 1,500 to 3,000 mm from north to south. The rainy season coincides with the hot season. The dry season lasts from September to next April with active wind erosion and sandstorms because of the strong winds and the loose surface having a deposition sandy composition.

The environmental background had formed a fragile ecosystem in the region. Throughout most of history, what humanity has used a nomadic system to cope, which has become the traditional pattern of land

use. Cropping on a large scale has development only over the last hundred years, which was forced mainly by the increased pressure of population. For example, in the Jirem League, the population increased from 124,000 in 1760s to 341,400 in 1910s, 792,400 in late 1930s, but decreased to 778,000 in 1947 because of many reasons such as social upheaval, wars, destitution and low-grade medical and health conditions. The population has increased rapidly since then and reached 945,000 in 1953, 1,558,000 in 1964 and 2,660,000 in 1987, and the density of population per unit area increased, too, as Fig 2. shows. The same story applies to animal husbandry during the same period (Fig.3). Such an increase of population and livestock certainly brought about more and more pressure on the fragile ecosystem. Under a weak social and economic system and a backward mode of production, it was impossible to avoid over-cultivation, over-grazing and over-collection of fuel wood in the region in order to the necessities of life. The negative result is very obvious: desertification.

Fig.1 Sketch map of studied area and its precipitation isogram

Fig.2. Changes of population and its density (persons/km²) in Jirem League, Inner Mongolia

Fig.3. Increase of livestock and rangeland occupation (ha/per sheep unit) in Jirem League, Inner Mongolia

According to our research results of a project on monitoring and assessing desertification in 146,000 km² of the region, which has been carried out based on the methods of combination on the multitemporal remotely-sensed data applied, the desertified land has spread from 22,730 km² in the late fifties to 57,980 km² in 1976 (average increased 9.69% annually during that period), and to 71,680 km² in 1986 (2.36% during 1975 and 1986). Most of the desertified land is distributed over alluvial plains in Naimanqi, Hozouhouqi, Jarudqi, Hureqi, Ongniudqi, and Ar Horqinqi.

3. Principles and Measures to Prevent and Remedy Desertification

To prevent and remedy desertification is a matter of prime importance in the Horqin Steppe Region, which has a direct bearing to the economic development and people's life. According to the natural conditions, economic characteristics, process of desertification and practice of combating it, we summarized some major principles as followings:

(1) To prevent and remedy simultaneously during exploitation of natural resources. At present, the first and more important objective is to protect the original farmland and rangeland from desertification. Meanwhile, to remedy the land should begin with the slightly desertified areas, which are easier than others, to the moderate, severe and then to the very severe areas.

(2) To unify the ecological, economic and social benefit together. In the region, a better way for

development is to rely mainly on animal husbandry and forestry while promoting a diversified economy. The economic objective should be "Commodity stock raising, Protective forestry and Self-supporting farming".

(3) Scientific and technical direction, administrative decree and effective implementation. To combine scientific institutions with administrative departments and broad masses of the local people and to conduct remedial experiments, to establish demonstration plots and to popularize successful experiences in a large area.

The following are suggested measures to remedy desertified lands in the region:

(1) To adjust the agricultural land use structure. Under the limited natural conditions, the land use structure is not reasonable since a large area of rangeland has been cultivated, although the land was not suitable for cropping and had to be abandoned about 3-4 years later, which mainly responsible for desertification. Take the land use in Jirem League in the eighties as an example. The farmland area was kept around 952,000 ha (17.55% of the total land use area), woodland 880,000 ha (16.23%) and rangeland 3,591,000 ha (66.22%). More than 60% of the farmland was low-yield land and degraded in different degrees from slight to very severe. Most of the rangeland suffered from over-grazing, and the woodland area was too small to protect the farmland and rangeland from serious wind erosion. So the farmland and rangeland should be reduced and the woodland increased in the region. A better structure, based on a case study, of farmland : woodland : rangeland is 15 : 30 : 55.

(2) To practice intensive farming. The traditional cropping agriculture, which depends on rainfed and extensive cultivation, should be changed into implementing intensive cultivation in those areas where water and manure conditions are favourable, so that the land with high and stable yields could be constructed which guarantees self-supporting farming. The rest of the land also can be intensively developed for forestry and animal husbandry.

(3) To determine reasonable grazing according to the carrying capacity of the rangeland. The rational rotation grazing and proper pasture use should be carried out along with reducing animal quantity and improving quality. An artificial grassland and forage farm should be built up to replenish the natural rangeland and decrease the livestock pressure on the region. An important project is to raise the commodity rate of animal husbandry.

(4) To reform the fuel structure and set up a stable fuel forest. According to an investigation in the countryside, over 90% of peasant households take crop straw, branch and other firewood as fuel for cooking and heating. But these firewood could meet 40% of the need only, and other part is supplied by cutting trees and shrubs, which destroyed the natural vegetation seriously. To solve the problem of fuel in the region, the main ways are to set up the stable fuel forest, to extend solar energy and methane-generating stoves and to use wind energy.

(5) To increase the agricultural input is the key to raise the productivity as well as to protect the environment. In the region, there were many works of building water conservancy projects, exploiting groundwater resources, spreading applied techniques and mechanization. All of these have improved the productive conditions and grain yield. For example, in the Jirem League, the per unit area grain yield has reached 3,500 kg/ha in the late eighties, which was 185% of 1970's and three times more than that during the 1950's. Alongside the steady growth of living standards, the local people reduced and even stopped conscientiously to overuse the land. At the same time, funds for expanding reproduction and combating desertification were accumulated, which combined effectively the agricultural production with environmental protection and put both into a fine circle.

4. Evaluation on Combating Desertification

As a huge ecological system, Horqin Steppe Region has varied conditions of eco-environment and complex relations between ecology, environment and human impact. Due to the unfavorable natural conditions, the eco-system is very fragile and it is much stable for grassland-livestock raising than dryland-farming. But along with the growth of population and development of cropping agriculture for the last 100 years, it is impossible to renew the original one again. Up to the present, the eco-system already has become a dry-land agricultural eco-system, which shares the cropping, animal husbandry and forestry as dominant composition and has much complex structure and function. Although the productivity is higher than before, the new eco-system is unstable. The process of desertification is the major result. So it needs great efforts to enable it reach a new stability for sustainable development.

Through studies and practices for many years, the prevention and remedy of desertification have made considerable headway. On the basis of the principles mentioned above, some measures have been carried out in the light of specific conditions so that about 4,500 km² of desertified land has been remedied to be productive land again during 1976 to 1988 (Table 1.), and more areas have been protected from desertification.

Table 1. Some examples of remedied desertified land in south part of Horqin Steppe Region(unit:km²)

	Monitored areas	Desertified land, 1976	Desertified land, 1988	Remedied areas	Per cent of monitored areas
Naimanqi	8,234	5,657	5,414	247	3.00
Hureqi	4,742	2,657	2,327	332	7.00
Baininyouqi	9,910	6,132	5,340	792	8.00
Ongniudqi	11,839	6,531	5,666	865	7.31
Aohanqi	5,744	1,649	1,547	102	1.78
Zhangwu	3,459	2,909	744	2,165	62.59
Total	43,928	25,537	21,034	4,503	10.25

The results show clearly that while spreading up the economy, the land desertification could be controlled when some necessary measures have been took. Based on the analyses of eco-environmental, economic and social benefits between before and after brought desertified land under control in Xinglongzhao district, Naimanqi, as a good example, we try to evaluate the desertification control in Horqin Steppe Region.

The area of Xinglongzhao district is about 53,000 ha, which was a fine pastureland until 1950s. But it was degraded because of over-cultivation, over-grazing and over-collection of fuelwood. The desertified land had expanded over 15,700 ha up to 1974, which resulted in the deterioration of ecological environment, decrease of grain production and reduction of livestock output. The process of desertification hindered seriously the development of local economy and improvement of living standards of the people. Since 1976 the local government and masses implemented a project on combating desertification for improving environment of production. This project has achieved success and the main targets are showed in Table 2.

Table 2. Effectiveness of combating desertification in Xinglongzhao District, Naimanqi(1974-1994)

	1974	%of total area	1994	%	Effectiveness	Changes
Desertified land	15,700ha	29.62	2,100ha(1993)	3.96	-13,600ha	-86.62%
Woodland	777ha	1.47	15,840ha	30.10	+15,063ha	+19 times
Farmland	4,960ha	9.36	6,900ha	13.02	+1,940ha	+39.11%
Grain yield	2,790t		13,110t		+1,0320t	+3.7 times
Unit grain yield	562.5kg/ha		1,900kg/ha		+1,337.5kg/ha	+2.4 times
Rangeland Capacity	124,200 sheep unit		152,200 sheep unit		+2,800 unit	+22.5%
Income per person	80 yuan		1,120 yuan		+1,040 yuan	+13 times

The project has prevented the desertified land to spread over more areas, which is very important since the preventing cost is much lower than controlling one, as well as a large area of desertified land has been rehabilitated. It brought about a coordinate advance in economy, society and environment, and made a considerable headway on the ecological, economic and social benefits.

(1) Ecological benefit: The reforested woodland and windbreak system play a key role on improving the agricultural environment, such as to decrease 300-400 mm of evapotranspiration and 40% of wind velocity, to increase 9% of relative humidity and 13 days of frost-free period and especially to reduce the modules of wind erosion from 210t/ha.y to 34.5t/ha.y.

(2) Economic benefit: There were increments in forestry 3.33 million yuan, farming 99.21 million yuan, animal husbandry 89.24 million yuan and fishery 14.00 million yuan, total was 206 million yuan(1976-1994). The total investment of the project was 82.76 million yuan during the same time, so input : output was 1:2.49.

(3) Social benefit: More than 140,000 workdays were increased ever year. The living standards of the people rose year by year. The people's sense of environment and sustainable development came into being.

5. Conclusion

Desertification is a complex process caused by human impacts and natural factors. For a sustainable development in the regions affected by the process, prevention and remedy of desertification is an arduous task which should and must be accomplished because of the human existence and can be accomplished since the effect of some theories and practice for combating desertification have been proved fully.