

Transformation of desertified land in the Grazing-farming interlaced belt of Northern China

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ABSTRACT

This rangeland-farmland interlaced belt with a fragile eco-system is mainly distributed along the Great Wall and the Xiliaohe River, occupying an estimated area of 200,000 km². Over-grazing and over expansion of dry farming, in conjunction with highly erodible sandy soils and a harsh windy and dry climate, have combined to cause extensive vegetation degradation and soil erosion. Since about 200 B.C., rain-fed agriculture has crept several times into dry areas and cropping has now taken place even in some regions of this belt receiving as little as 150 mm of mean annual precipitation, which is important historical reason for the fragility of the whole belt. The core of the fragility is thought to be the imbalance between the anthropogenic pressure and the limited renewable resource supporting capacity. Inappropriate strategies of desertification control have also delayed the transformation process of desertified land and resulted in large areas of dwarf trees, less palatable range vegetation and severely eroded farmland.

Heavy population pressure prevents light grazing levels and the restoration of the zonal steppe vegetation. By traditional plantation methods only, the theoretic approach to the eco-balance between anthropogenic pressure and resource capacity has to be to create a new pattern of pasture-agriculture combination with higher production and sustainable land use. In the regions with densely distributed sand dunes, an eco-model named "small biosphere" can increase the production in the inter-dune depressions so as to initiate the vegetation restoration on the surrounding sand dunes. Inserting the technique of water-saving rice cultivation which was plastic film for water seepage prevention in the core zone of the "small biosphere" has further perfected the eco-model. In the regions with larger area of rain-fed cropland intruded in the rangeland area, readjustment of land use structure is needed, by which a small part of the rain-fed cropland can be transformed into irrigated cropland. The rest of the land must then be reversed to rangeland in order to control soil erosion. In the regions with gently sloping sandy rangeland the combination of grazing controlling measures with establishment of shelterbelt networks can promote the vegetation restoration.

Key words: desertification reversion, land use readjustment, rangeland-cropland-interlaced belt, shelterbelts, "small biosphere".

INTRODUCTION

China is suffering from large scale and severe desertification. There are 593,000 km² of sandy deserts, 569,000 km² of Gobi deserts and 371,000 km² of apparently desertified land in China (Zhu Zhenda et al. 1994). More than 60% of the desertified land is located in the regions known as the rangeland-cropland-belt. China has a long history of combating desertification. Since the foundation of the People's Republic of China in 1949, particularly since 1978, much more attention has been paid to desertification control. Great achievements and progress in the aspects of revegetation, rangeland improvement and soil conservation have been made in the affected areas. Some acceptable and practical techniques, successful demonstrations, as well as extension models for combating desertification have been developed at grassroot, community, local and national levels. About 42,870 km² of land affected by desertification has been rehabilitated in the recent 5 years, out of that 29,500 km² have been re-afforested and revegetated. However, desertification has not been held back. Under the pressure of rapid population growth and the less developed economy, the general tendency of desertification in the whole country is still accelerating. More than 2,100 km² of pro-

ductive land is being lost annually to desertification in China, mainly in the rangeland-cropland interlaced regions.

Studies of desertification dynamics and experiments on its reversion in the typical rangeland-cropland-interlaced belt have been conducted in recent years at two field stations of the Institute of Desert Research, Chinese Academy of Sciences – Shapotou Experiment Station of Desert Research in the western part and the Naiman Experiment Station of Desertification in the eastern part of the belt. This paper is intended, based on the results from these stations, to analyze the features and causes of desertification in this belt and to suggest reversion strategies and techniques.

GENERAL FEATURES AND ANALYSIS OF THE CAUSES OF DESERTIFICATION

Distribution and general features of the desertified land

In China, vast areas of sandy deserts and Gobi deserts are mainly located in the arid zone, between 35–50°N and 74–107°E, where the annual precipitation is less than 250 mm. Desertification in this zone appears only in the oasis regions. Large scale desertification occurs mainly in the semi-arid and drier sub-humid zones, between 36–50°N and 107–125°E, where the annual precipitation is 200 to 450 mm. This area includes 200,000 km² of land affected by desertification along the Great Wall and the Xiliaohe River, forming a belt about 1,800 km long and 100 to 200 km wide. Its size and fragility is thought to be second only to the Sahel-Sudan belt in the world.

The general features of desertification in this belt are severe land degradation characterized by devegetation, ground surface sand reactivation, soil erosion, the formation of desert-like landscape, and accompanying process of rapid decline of production and poverty. It has been estimated that desertification in this belt is affecting about 7 million people and leading to a loss of several billion RMB yuan each year. A single sandstorm disaster on May 5, 1993 resulted in a tremendous economic loss, amounted to half a billion RMB yuan, and the death of 80 people.

Analysis of the causes of desertification

Although the land subjected to desertification is affected by unfavourable natural factors, the rangeland in most of the semi-arid zone had not suffered severe desertification nor lost its capability of recovering from light disturbances (Liu Xinmin et al. 1994). Originally, this belt-shaped zone with semi-arid climate and sandy land was mainly used as rainfed grazing land and dominated by herdsmen. Since around 200 B.C., with the population growth and agriculture development in the middle part of China, rain-fed cropping moved northwards to this zone and the conflict between herdsmen and farmers started. In order to keep the newly reclaimed farmland and avoid conflict or even war, the construction of the Great Wall started under the organization of the Qin Empire. The Great Wall is considered to have been of great importance, not only as a military demarcation line in the ancient time, but also as an apparent bio-climate dividing line between pasturage and agriculture areas. However, it did not permanently prevent the intrusion of cropping from the south. It played a better role of preventing herdsmen from migrating southwards than of stopping farmers from moving northwards. The rain-fed agriculture has since crept northwards several times into excessively dry areas and cropping is now taking place in regions receiving

as little as 200 mm of annual precipitation. This floundering land use structure resulted in a long lasting mismanagement of this big zone.

At the beginning of cultivation, farming activities can usually provide livelihood to more people than can animal husbandry activities in the sandy land. The local people thought that farming was a revolutionary action. It was then followed by desertification and land abandonment. Some 4 or 5 years later, when the vegetation had recovered to some extent, the local people would repeat their action and create an even worse degradation of the land. This situation was often accelerated by climatic fluctuations. Finally, this big zone became an ecological fragile one with a farming-grazing mixed structure and lower capacity for producing food, fodder and fuelwood. This historical impact on this fragile ecosystem will last for a long period of time.

Regarding the present reasons for desertification in this zone, it should first be considered that under the harsh natural conditions such as frequent drought, strong wind, vast area of sandy ground and short frost-free period, the limited renewable resource supporting capacity in this fragile eco-system can not bear today's intensified land use and the increased population pressure. This kind of a passive situation and the ecological disturbance is thought to be the result of the long lasting floundered pattern of land management in the whole zone.

Rapid population growth is an important driving force to increase the pressure on the land resource, because a larger population must induce more activities for needs of life. In the last 50 years, the population in this zone has doubled. The available cropland per capita and rangeland per sheep unit has decreased by a factor of three. A series of unwise activities, such as overgrazing, over expansion of cropland, abuse of water resource, removal of shrubs and trees for fuelwood gathering, etc., has caused wide spreading of desertification. Urbanization, traffic infrastructure construction, mine exploitation, as well as recreation, have also disturbed the land and the vegetation.

In summary, the core of the fragility of the eco-system in this belt is thought to be the imbalance between the anthropogenic pressure and the limited renewable resource supporting capacity. In addition, some inappropriate strategies of desertification control have delayed the process of desertification reversion and even stimulated the development of desertification in this zone. In the recent 50 years, with the political impact of the Great Leap Forwards (1957–1960) and the Great Proletarian Culture Revolution (1966–1976), large-scale changes in land use from grazing to cropping occurred several times. With the destruction of perennial vegetation the good structure and the nutrition of the soil was quickly lost. In addition, many inappropriate efforts for desertification control by conventional revegetation resulted in large areas of old dwarf trees, unpalatable range vegetation and less productive and erodible farmland.

APPROACHES TO DESERTIFICATION REVERSION IN THE RANGELAND-CROPLAND INTERLACED BELT

Strategies for desertification reversion

Through the above analysis of the causes of desertification it may be concluded that under the heavy population pressure and the floundered land use structure it is impossible to restore the steppe vegetation and the light grazing pasturage to its original situation, and that conventional plantation alone is not sufficient in order to control the

desertification. Therefore, the theoretic approach to the eco-balance between anthropogenic pressure and resource capacity in this zone should include dividing, transferring and reducing the anthropogenic pressure on the whole region. That is to say, the grazing pressure on the large area of sandy rangeland should be decreased and at the same time the cropping pressure should be increased on the wet land in the inter-dune depressions. For realizing this theoretic approach, some new patterns of pasture-agriculture interlacing system with higher production and higher population supporting capacity must be created.

New patterns of pasturage-agriculture interlacing models for transformation of desertified land

Desertification reversion process must be realized by a series of land use readjusting measures and new patterns of pasturage-agriculture interlacing models. In this rangeland-farmland interlaced belt, there are generally three major types of severely desertified land. Each different type has its own cause of desertification and characteristic fragilities, and needs a specific model for transformation.

In the regions where sand dunes are densely distributed, desertification reversion is very difficult to achieve. Through several years of experiments and demonstration services, the Naiman Experiment Station of Desertification Research, Chinese Academy of Sciences, jointly with the people in the demonstration village, has developed an eco-model named 'small biosphere', which can promote the above mentioned theoretic approach to be realized (Liu Xinmin et al. 1995).

This small biosphere model basically consists of three small circular zones. The 'core zone' is arranged in the center part, occupying about 1 to 4 ha of wet land, equipped with one or two wells and pumps for irrigation in drought season and cultivated with productive crops such as wheat, maize, rice and fodder crops. It is used for food and fodder production. The out-fringe of the core zone is a 'protective zone', covering about 10 to 20 ha of sandy land or sand dunes, where shelterbelts and windbreaks are planted, and some psammophytic shrubs planted for fuel materials as well as for sand control. The houses and the animal yard are also arranged in the protective zone. Outside of it is a circular shaped 'buffer zone', occupying about 100 to 200 ha of sandy land or dunes. As a transitional belt between the protected zone and the bare drifting dunes, this buffer zone is used for light grazing, allowing 0.2 to 0.3 sheep units in one ha, or even forbidding grazing in the beginning of the small biosphere construction for vegetation establishment and to reduce the movement of sand. With the increase in crop and fodder production in the core zone the stocking rate on the surrounding sandy rangeland can be decreased gradually. This model can both reduce poverty and protect vegetation. Each small biosphere is managed by one family, which consists of 4 to 6 people. This way the income of the family has increased from less than 5,000 RMB yuan to more than 40,000 yuan in 5 years; the rangeland resource has been restored and the environment improved.

In the regions with larger areas of rain-fed cropland, which has intruded in the rangeland area, the heavy population is generally concentrated in big villages surrounded by larger areas of rain-fed farmland with lower production and severe soil erosion. An inappropriate, even erroneous strategy, which the local farmers adopted for dealing with the fragile conditions, was the over-expansion of cropland area. The

Naiman Experiment Station has completed a demonstration experiment in the Yaole-dianzi Village and reversed desertification by readjustment of land use structure, inter-plantation of erosion-resistant grass and crops, and maintenance of stubbles and residues. Before the demonstration experiment, the village had more than 220 ha of cropland and 500 ha of rangeland. Most of the cropland was rain-fed. The newly cultivated rain-fed cropland has suffered from severe soil erosion, with a maximum loss of fertile top soil of about 3,900 tons per hectare in a year (Xu Bin et al. 1996). At the same time, wind erosion caused changes in relief of ground surface which in turn further changed the erosion patterns. The vicious circle of more expansion of rain-fed cropland, more destruction of vegetation and soil structure and poorer production leads to extremely severe desertification. Through readjustment of land use structure, the 100 ha of the cropland in depressions has been transformed to irrigated land with higher production, equipped with 12 wells and pumps. About 20 ha of rain-fed cropland have been inter-planted with grass, and stubbles and residues are maintained in winter and spring. About 100 ha of rain-fed cropland has been abandoned and transferred to natural rangeland by revegetation. As a result, under the same condition of population (about 105 people), the total production of agriculture and animal husbandry has doubled and the vegetation coverage increased from less than 15% to more than 25%.

In the regions with large areas of rangeland on gently sloping sandy ground the desertification is mainly caused by over-grazing and over-gathering of fuelwood. It is, however, a very difficult task to release the rangeland from over-grazing pressure directly by decreasing the number of domestic animals, because that could temporarily decrease the production of animal husbandry and have a great impact on the population. A part of the population has been organized and migrated to the above-mentioned sand dune area to construct 'small biosphere' and a part of them organized to manage leather and wool factories or to build reservoirs. This organization makes lighter grazing system possible. From a long-term point of view, a fundamental measure for wind erosion controlling in sandy rangeland is the establishment of shelterbelt networks. In the study region, the distance between the main protective forest belts was taken as 200–300 m. The main belts are composed of four rows of trees and two rows of shrubs. The auxiliary belts, with about 400 m of interbelt distance, are composed of 2–3 rows of trees and 2 rows of shrubs. As a result, the rangeland has been restored to sustainable use and the shelterbelts have supplied enough fuelwood for the herdsmen.

In conclusion, the desertification in the ecologically fragile belt with rangeland-cropland interlocked pattern can be reversed. To do so, anthropogenic pressures need to be redistributed. Appropriate models need to be selected and the proper technical measures adopted to increase the capacity of the land to sustain people and to improve the environment and renewable resources in the whole region.

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