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Restoration and Stability of Ecosystem in Arid and Semi-arid Areas

Edited by Gao Jiarong
Maik Veste
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Preface

Desertification is major environmental crisis in various countries of the world resulting in land degradation and ecological problems. Sand dune movement and dust storms are threats to settlements, infrastructures and to sustainable development. Therefore, scientific progress are urgently needed to understand the complex environmental situation in sandy areas and to promote the application of the this knowledge to combat desertification.

The basic condition of human existence and development is the ecological environment and it is also the basics for the economic and social development. Protection and reconstruction of the environment is fundamental for policy, which must be consideration in the modernization process of China.

In 21st century, the improvement of the ecological environment and human settlements is the most important goal in Beijing and other areas. But the desertification in Beijing and its surrounding areas is one of the most serious problems that influence the conservation of ecological environment. Therefore, the purpose of the cooperation between Chinese, German and Israeli scientists is to establish the scientific knowledge for the restoration of natural vegetation, maintaining water quality and quantity, increasing biodiversity, controlling soil erosion, and optimizing the land utilization. These will put forward the economical and practical strategy on the protection of natural resources and the environment. At the same time it will promote the exchange and cooperation between the scientists and will contribute to the implementation of the UN Convention to Combat Desertification. The research will also provide a reference and technological supports for other affected areas in the world.

In China, several research institutes supports a wide range of environment activities ranging form restoration of vegetation to combating desertification. This workshop is also a result of fruitful discussions and joint projects between the involved scientists in the recent years and is an important milestone for the establishment of new research activities.

To achieve the goal of combating desertification and development of stable

ecosystem in arid and semi-arid regions a joint Chinese-German Dryland Research Center will be established at Beijing Forestry University. The center will host a joint cooperation group, research projects and scientific exchange between the scientists as well joined academic education.

Beijing, October 2005

Gao Jiarong, Maik Veste

Dryland Research Center Beijing

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General Situation, Integrated Harnessing Technique and Future Research Trend of Desertification in China

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Abstract Desertification is one of the most serious eco-environment problems in China nowadays, there are 1 740 000 km^2 desertified land, accounts for 18% of the total territory, and it is expanding at the rate of 2460 km^2 per year, wind-blown sand puts the livelihood of 100 million population and 240 million villages in jeopardy and causes an economical loss of 54 billion yuan (RMB) per year. The vulnerable eco-environment in north China and irrational human activities are the most dominant reasons that cause the expansion of land desertification. In order to impede the jeopardy and influence caused by desertification, in the past 50 years as long of combating desertification practice, integrated technology for combating desertification has been spread and applied creatively, and demonstration models of combating desertification are established in different regions, then the eco-environment in sand area has been obviously improved and the socio-economy has been greatly developed. With the accelerating and thorough global desertification combating, the research of key theory and technology, which includes ecology and biology process of desertification, comprehensive balance pattern of vegetation-atmosphere-soil-moisture and vegetative rehabilitation, resistant vegetation breeding and bio-diversity conservation, draught and sand storm monitoring, pre-alarming and forecasting system, integrated desertification combating strategy and social economy sustainable development, is becoming an important assurance that will impede wind-blown sand disasters basically and realize the sustainable development of ecology, economy and society in sand area.

Keywords desertification, combating technique, harnessing pattern, research trend

1. Introduction

The expansion of land desertification not only jeopardizes living environment, economical and social development, but also jeopardizes the Chinese subsistence space. In China, sandy land mainly distributes in arid-semiarid zones and some sub-humid zones in the

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north, especially farming-pastoral zigzag zones, pasture zones and the fringes of deserts, and at present the area of sandy land where the movements of sand and wind are active accounts for 300 thousands km^2. In recent years, quite a few sand storms occurs in north China, and the serious situation arouses broad attention from every corner of society, then preventing sand , enforcing the construction of eco-environment have been considered as a serious but urgent task that will renovate local territory and develop local economy.

2. The Present Situation, Causes and Future Situation

2.1 Area and distribution of desertified land

As the latest national desertification monitoring data from "Report of Desertification in China"shows, the area of desertified land in China is 26 740 thousands km^2, accounts for 27.3% of the total territory, in which the area of sandy land is 1740 thousands km^2, and it accounts for 18% of the total territory, wind-blown sand puts the livelihood of 100 million population and 240 million villages in jeopardy and causes an economical loss of 54 billion yuan (RMB) per year. The areas of desertified land in different provinces are shown in Table 1.

Table 1 Areas of desertified land in different provinces

Province	Area /hm^2	Percentage of national desertified land /%	Province	Area /hm^2	Percentage of national desertified land /%
Beijing	5390	0.003	Sichuan	13 413	0.008
Tianjin	1446	0.001	Yunnan	1 628	0.001
Hebei	905 742	0.56	Xizang	11 296 009	7.03
Shanxi	98 091	0.06	Shaanxi	822 366	0.51
Inner Mongolia	55 019 080	34.23	Gansu	15 287 415	9.51
Liaoning	26 214	0.02	Qinghai	8 267 045	5.14
Jilin	41 447	0.03	Ningxia	1 339 433	0.83
Shandong	130 970	0.08	Xinjiang	67 465 946	41.97
Henan	4 245	0.003			
Hainan	15 820	0.01	Total	160 741 698	100

The area percentage of desertified land in desertified region is usually considered as an important indicator that measures the desertification developing degree of a country or a region. In China, desertified land accounts for 79% of arid land, but the percentage of severely desertified land is 39.3%, both of the two are far higher than the average level in the world (shown in Table 2).

Table 2 The percentage desertified land takes up desertified region land both in China and the world

Region	China	World	Africa	Asia	North America	South America	Australia
Percentage/%	79.0	69.0	73.0	69.7	74.1	72.7	53.6

2.2 Causes of desertification

2.2.1 Vulnerable eco-environment

(1)The climate is getting drier and drier, it's an environmental condition for desertification to expand.

Desertified land in China mainly distributes in arid, semiarid zones, the dry climate is an important environmental condition of desertification. In recent 50 years, influenced by the fact that the global climate is getting warmer and warmer, in most part of north China, the atmosphere temperature has obviously risen and precipitation has decreased obviously, therefore the phenomenon of warm-dry occurred. The climate is getting drier and drier, it's an environmental condition for desertification to expand.

(2) Frequent gale is an important motive power for desertification.

Gales are frequent in north China, it plays an important role in the formation of sand storms. The critical velocity of drifting sand grain varies on different surface morphology, usually the larger sand grain is the higher critical velocity is. The critical velocity. of flown dunes is 5 m/s, and that of half-fixed sand is 7~10 m/s, and that of Gobi sand is 11~17 m/s, the amount of shifting sand is in direct proportion to wind velocity. Besides, the suspending and bounding height of sand is relative to wind velocity. When the wind velocity reaches 30 m/s, the bounding height of tiny sand can reach 2 m, but the powdered-sand then can suspend throughout the troposphere.Gales is common in spring in north China, and it is also a motive force for forming large area sand storms.

(3)Large barren surface, loose component and abundant sand resources offers material basis for desertification expansion.

In north China, the economy lagged behind, then people excessively digs wild plants, such as *Casuarina equisetifolia* and *Glycyrrhiza uralensis Fisch*, and chopped down shrubs for firewood, therefore, large area vegetation was destroyed, vegetation coverage decreased rapidly. As there are lots of loose sand sediment, so once the vegetation is destroyed, the fixed dunes will certainly be active again and the surface will suffer wind erosion again, then the desertified land will expanses easily. In winter and spring, large barren cultivated farmland and other desertified land are the source of

sand storms. However, the top tiny soil is the main dust source.

(4)Ecology water is in severe shortage, vegetation gradually looses the ability of controlling desertification.

As the population increases rapidly and more land being cultivated, many rivers dried up due to excessive water use, and wind up seasonal rivers. For example, the discharge of Heihe River in Inner Mongolia Oases decreased from 900 million km^3 nowadays, thus 930 000 hm^2 haloxylon died out in Ejina; 270 km course along lower reaches of Tarim River dried up, then 3530 thousands *Populus exphrqticq* forest died out. The examples shows that large area plants died out because of shortage of ecology water, and then lost the ability of fixing sand, therefore, the pace of land desertification was quickened.

2.2.2 The increasing population presses the eco-environment

In China, the rapid population increase is an important factor in desertification formation and development. In farming-pastoral zigzag zones of north China, population density increased from 10~15 persons per 100 hm^2 in 1950s to 40~60 persons per 100 hm^2 in 1990s, the average population growth rate is 30.8‰. To graze, extract mines, dig wild plants and cultivate excessively and to irrationally use water resources, all these human activities are the basic reasons causes desertification expansion. According to statistics, in sand areas, the stock-holding rate is as high as 50%~120%, in Inner Mongolia, the forage yield decreased from 1635 kg/hm^2 in 1960s to 645 kg/hm^2 in 1980 s; In Chaidamu Basin, there are 2 million hm^2 sand-fixation forest at first, then 1/3 of them were destroyed because of chopping, 3800 hm^2 *Pobulus eubhratica* were destroyed for firewood in Xinjiang Hetian Region, 17 300 hm^2 vegetation was destroyed in Shaanxi Yulin Region due to mine excavation in Gansu, digging *Glycyrrhiza uralensis Fisch* destroyed 334 000 hm^2 pasture in only 5 years.

2.2.3 Backward production technology and extensive management

Due to its interior location, the desertified region is far from coastal developed region, it develops the economy mainly by consuming the natural resources. As agriculture and stocking are the main economical activities, people here totally rely on land to get income. In addition, the quality of population here is low; most regions maintain a traditional production technology and extensive management, all the above conditions result in large area grassland turning into desertified land. Since 1950s, there has been 667 000 hm^2 farmland, 2 350 000 hm^2 grassland and 6 390 000hm^2 forest turned into shifting sand.

2.3 The future situation of desertification

In China, desertification expanses mostly but it's getting well only locally.

2.3.1 Sand storms occur more frequently

Sand storms occur frequently, and the jeopardy of severe sand storms aggravates. According to record, severe sand storms that had caused serious disasters occurred 8 times in 1960s, 13 times in 1970s, 14 times in 1980s and 23 times in 1990s.

2.3.2 Wind erosion and desertified land expansion speeds up

According to CCICCD in 1996, in mid 1970s, Chinese desertified land expanded at the speed of 1560 km^2 annually, in 1980s, its speed was 2100 km^2 annually, in 1990s, 2460 km^2 and at the beginning of 21 century it was already 3436 km^2.

Table 3 Desertification development in typical farming-pastoral zigzag zones from 1970s to 1980s

Region	Area of desertified land in 1970s		Area of desertified land in 1980s		Annual increase		Period
	Area /km^2	Percentage of desertified land in study region	Area /km^2	Percentage of desertified land in study region	Area /km^2	Percentage /%	
Farmland in Chahaer Steppe Inner Mongolia	2848.3	31.5	5992.9	66.1	262.1	9.20	1975~1987
Houshan region of Inner Mongolia	2031.4	4.4	4055.2	8.7	168.7	8.30	1975~1987
Western farmland in Hebei Bashang meadow steppe	1761.7	13.4	3272	24.9	125.9	7.14	1975~1987
Eastern farmland in Hebei Bashang meadow steppe	762.3	22.3	1336.6	39.1	47.6	6.28	1975~1987
Steppe in Yanchi of southeaster Ningxia	1368.9	29	1845.5	31.8	47.6	3.48	1977~1986
Up reaches of west Liao River and northeastern Kerqin sandland	28 971	68.4	32 851	77.6	323.3	1.12	1976~1988
Ordos steppe of Yikezhao League Inner Mongolia	43 407	88.3	45 973	93.6	256.6	0.59	1977~1986
Yulin District in northern Shaanxi Province	7808	43.3	8166.9	45.3	35.9	0.46	1977~1986