## G-1.5 Evaluation of the Activities and Technologies to Combat Desertification in China

**Contact person** Kazuo Tobe
Senior Researcher
Environmental Biology Division
National Institute for Environmental Studies
Ministry of the Environment
16-2 Onogawa, Tsukuba, Ibaraki 305-8506, Japan
Tel: +81-298-50-2486 Fax: +81-298-50-2586
E-mail: tobe@nies.go.jp

**Total Budget for FY1999-2000** 3,000,000 Yen **(FY2000**; 1,800,000 Yen)

**Abstract** The activities to combat desertification in China have been conducted since 1950s. After several decades' efforts, extensive projects have been carried out and huge amount of data have been accumulated, which are extremely valuable for control the expansion of desertification over the world. However, because the evaluations of these projects and technologies are not fully done and relationships among them are not fully analyzed, the application of these technologies is very limited. Therefore, this project focuses on data collection, literature review, and analysis. Based on it, the technologies which are effective to control desertification have been analyzed and evaluated. These technologies include straw-checkerboard technology to fix sand dune, vegetation establishment technology to rehabilitate the environment, sowing seeds by airplane, and desertification-monitoring technology. The possible application condition and the effect for control desertification of each of them are analyzed and discussed.

**Key Words** Canopy Coverage, Desertification, Plant Diversity, Remote Sensing, Straw Checkerboard

1. Introduction

China is one of the countries facing most serious desertification problem in the world[1,2]. The total area affected by desertification is 262.2 $km^2$, covering 27.3% of the total territory of China[3]. Most of the desertification-affected lands are located in northern China. Since 1950's, Chinese government has taken various actions to combat desertification. After several decades' efforts, extensive projects have been carried out and huge amount of data have been accumulated. These results and experiences are extremely valuable for control the expansion of desertification over the world. By these efforts, large degraded areas have been improved and a lot of technologies have been developed. However, because the evaluations of these projects and technologies are not fully done and relationships among them are not fully analyzed, the application of these technologies is seriously limited.

Despite of these achievements, the current situations are that desertification has been controlled at particular sites, but expanded in the entire area.

2. Research Objective

The project focuses on data collection, literature review, field investigation, and analysis. Based on it, the technologies that are effect to control desertification will be analyzed and evaluated. These technologies include straw-checkerboard technology to fix sand dune, vegetation establishment technology to rehabilitate the environment, sowing seeds by airplane, and desertification-monitoring technology. The possible application condition and the effect for control desertification of each of them are discussed detail.

3. Research Methods

We have collected and reviewed 56 books, 149 journals, and 224 papers related to the activities and technologies to combat desertification in China. Based on these results, we establish a database of "activities and technologies to combat desertification in China". And, the evaluation of the technologies for controlling desertification was analyzed and discussed.

4. Results and Discussion

4.1 The fundamental strategies of Chinese government for the implementation of the United Nations Convention to Combat Desertification (UNCCD)

To combat desertification more successfully, based on the actual situations of the country and corresponding with the UNCCD, Chinese government re-evaluated the activities to combat desertification. As a result of re-evaluation, Chinese government has proposed the following 5 fundamental strategies[3].

(1) Awareness rising of publicity and reinforcement of education. By these measures, making the entire societies to participate the activities for combating desertification.

(2) Consolidation of legal knowledge and reinforcement of execution of laws

(3) Enhancement of the effects to combat desertification by applying advanced science and technology and training professional personnel

(4) Promotion of sustainable development through rational utilization of resources

(5) Preparation of preferential policies and increase of fund input

4.2 The effectiveness of straw checkerboard on the sand dune fixation and its application in China

Straw checkerboard (straw-mat network) is a sand dune fixation technique, which is built in the shape of checkerboard by using the straws of wheat, rice, and reed. Half of the straw is buried into the sand dune and another half was exposed in the air (usually 10-30 cm in height). The scientists at Shapotou Desert Research Station started to apply this technique in 1957[4]. Because of its considerable effect of dune fixation, it has been widely applied in the desert regions in China. However, compared with its application, the related research is very few. Many details related with its mechanisms of dune fixation and

windbreak and its effects on environment are still not clear. The objectives of this study are to investigate the principles of windbreak and dune fixation and its effects on environment. Results show that straw checkerboard has the following characteristics[5].

(1) The reasonable height of straw checkerboard is 10-30 cm, which provides not only a significant effect of dune fixation, but also a low cost.

(2) The practicable size of straw checkerboard is 1m × 1m (Checkerboard area = $1m^2$), which not only has a remarkable wind break and dune fixation effects, but also is easy to built.

(3) The establishment of straw checkerboard can increase the roughness length of dune surface as much as 330 times, while the intensity of sand flux can be decreased as much as 220 times.

(4) In the fixed dune area by straw checkerboard, a process of soil formation can occur. Fine particles are accumulated and a hard soil crust is formed on the dune surface, which improved not only the microenvironment, but also the stability of dune surface.

(5) The establishment of straw checkerboard can significantly increase the content of organic matter of surface soil.

In general, the advantages of straw checkerboard technique can be summarized as: remarkable effect of dune fixation; easy to build; getting result rapidly; good for environment. The disadvantages of this technique are that materials (straw) and labors cost and replacement after 3-5 years. On the whole, straw checkerboard can be regarded as a very effective technique, which will be widely applied for sand dune fixation not only in China, but also in the world.

### 4.3 The changes of plant diversity in the established communities for rehabilitation of desertificated land

In arid and semi-arid regions, the best and inexpensive way to combat desertification is to establish vegetation without irrigation. After the establishment, the planted communities themselves will survive and further set up (succession). This process can be regarded as an opposite process of desertification. The objectives of this study are to investigate the change of plant diversity after the establishment of plant community and to analyze their relationships with some environmental parameters. In Tengeri Desert, the fourth largest sand desert in China, vegetation has been continuously established in this area since 1956[6]. Results showed that: (1) After more than 40 year's succession, the established shrub vegetation had evolved into shrub + herb + sporophyte community. Number of plant species increased from 3 to 6. These changes were determined by available water in the soil; (2) After the establishment, the coverage of plant canopy increased and gradually approached to the maximum value (about 30%) at the age of 7. Then the coverage decreased gradually. Finally, the coverage was stably around 15-20%; (3) Diversity index (Shannon-Wiener) increased from 0.3 to 0.7 and then decreased to 0.5, which was similar to the diversity index of natural vegetation in the same area. Meanwhile, dominant index decreased from 0.6 to 0.4 and then increased to 0.7. These results can provide knowledge not only for understanding the succession mechanism of established

community in desertificated area, but also for the rehabilitation of desertificated land.

4.4 Vegetation indicators for desertification and its applicability in remote sensing

As the development of remote sensing technologies, a sensitive, simple, and direct indicator for assessing the degree of desertification, which has the potential to be applied in remote sensing technology, is required. Vegetation is a factor that can satisfy this requirement because the changes of soil, water, and other micro-environmental factors can be sensitively reflected by vegetation changes. The objectives of this study are to analyze the characteristics of vegetation at different stages of desertification and to discuss the possibility to apply these characteristics as indictors of desertification by remote technology. Results showed that, as the progress of desertification, plant association changed greatly. In the point of view of vegetation, type of association, minimum area, canopy coverage, diversity, and evenness changed significantly and could be used as indicators of desertification. Among these five parameters, minimum area, diversity, and evenness could not be acquired from remotely sensed data. Coverage and type of association have the potential to be detected by remote sensing technology. However, desertification degree could not be determined only by coverage because it was not linearly related with the degree of desertification. Coverage + association type could provide a satisfied result to determine desertification. Recent progress showed that, even though further improvement and field verification are required, it is possible to estimate vegetation coverage by remote sensing technology. However, to estimate association type by remotely sensed data is still an unsolved issue. With the improvement of sensor resolution and data analysis technologies, it is expected to find answer for this problem in the near future.

**References**


1) Zha Y. and Gao J. (1997) Characteristics of desertification and its rehabilitation in China. Journal of Arid Environments, 37, 419-432.
2) Zhou Z., Liu S., Z. Wu and Di X. (1986) *Deserts in China*. Institute of Desert Research, Lanzhou, 132p.
3) China National Committee for the Implementation of the United Nations Conservation to Combat Desertification (1996) *China Country Paper to Combat Desertification*. China Forestry Publishing House, Beijing, 40p.
4) Liu Y. (1987) The establishment and effect of protecting system along the Bautou-Lanzhou railway in Shapotou sandy area. Journal of Desert Research, 7, 1-11.
5) Qiu G.Y., Tobe K., Shimizu H. and Omasa K. (2001) The effect of straw checkerboard on the sand dune fixation and its application in China. Journal of Arid Land Studies, 11, 45-52.
6) Qiu G.Y., Gao Y., Shimizu H., Tobe K. and Omasa K. (2001) Study on the changes of plant diversity in the established communities for rehabilitation of desertified land. Journal of Arid Land Studies, 11, 45-52.