Asia-Pacific Network for Global Change Research

The Degraded Ecosystem Restoration in the Arid and Semi-Arid Northern China-Mongolia Region

Final report for APN project 2005-23-NSY-Wang

The following collaborators worked on this project:

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The Degraded Ecosystem Restoration in the Arid and Semi-arid Northern China-Mongolia Region

2005-23-NSY-Wang
Final Report submitted to APN

Overview of project work and outcomes

Project work

Through intensive international communication, the project organized an international network of scientists within APN countries to exchange information regarding the best practice concerning desertification control and degraded ecosystem restoration. In the 3-day (June 20-23, 2006) in-situ international workshop held in Yinchuan, China, 43 scientists representing Australia, China Mongolia APN, GEF and Wetland International (WI) attended the workshop and 15 presentations were presented. A carefully compiled CD ROM recorded the workshop presentations and the post-workshop professional tour to the field experimental sites where the most effective techniques for desertification control and degraded ecosystem restoration being implemented by Chinese Scientists.

With 17 contributive articles and several vivid photographs the workshop proceedings was published by China Forestry Publishing House, which integrates the latest development of climate change study, the practicable techniques of degenerated ecosystem restoration, and the schemes of sustainable resource management. The relevant ecosystems include degraded grassland, agroforest and windbreaks, abandoned wetland, and the vegetation-free fugitive or semi-fugitive dunes etc.

The workshop participants agreed on a common notion that global change study should integrate and coordinate climate change, ecosystem restoration, natural resource management, human adaptation, as well as social-economical development and policymaking, from both social and scientific perspectives.

Objectives

1) to organize a network of scientists among APN countries to exchange information regarding best practice concerning desertification control and degraded ecosystem restoration related to climate change and human dimensions;
2) to visit experimental field sites where the most effective techniques are being implemented by Chinese scientists;
3) to provide a forum for international cooperation and multidisciplinary information exchange; present the latest knowledge for understanding fundamental regulations and mechanisms of environment degradation in arid and semi-arid area;
4) to propose an integrate technical package that is practicable for policy-makers and local residents for sustainable ecosystem restorations in the arid and semiarid areas.

Amount received for each year supported and number of years supported

One-year support of US$28,000 in 2006

Participating Countries

China, Mongolia, Australia

Work undertaken

1) Disseminate the workshop message, communicate among scientists who are interested in the desertification control, degraded ecosystem restoration and other global change research concerned topics, collect, edit and select abstracts, papers and presentations for the workshop;
2) Pre-workshop field trip to Yinchuan, Ningxia Hui Autonomous Region, China to prepare the visit sites and collect data for the workshop;
3) Hold the 3-day (June 20-23, 2006) workshop in Yinchuan, Ningxia Hui Autonomous Region, China;
4) Post-workshop professional tour to visit the field experimental sites;
5) Edit and publish the workshop proceedings, compile the CD ROM;
6) Manuscript and submit technique and financial repots.

Results

1) The workshop proceedings with 17 contributive papers named "The degraded ecosystem restoration in the arid and semi-arid Northern China-Mongolia Region" was published by China Forestry Publishing House. (with electronic version on CD ROM)
2) A CD ROM recording the workshop presentations, the electronic version of the workshop proceedings, and the post-workshop professional tour around Yinchuan, China.

Relevance to APN scientific research framework and objectives

The main objective of the project is to study the degradation mechanism and the restoration techniques of the terrestrial ecosystem within the arid and semi arid regions; the proposed technique package for degraded ecosystem restoration will benefit to the biodiversity conservation and eco-environmental improvement, which is closely related to APN's research framework of climate changes in terrestrial ecosystems and biodiversity. The workshop gathered scientists, policy makers as well as the land resource

stakeholders together; which integrates and coordinates the activities within the APN's research framework of human dimensions of global change.

Self evaluation

It is a fruitful workshop; we fulfilled the proposed objectives on time.

Potential for further work

1) Enlarge and manage intensively the present field experiment areas that show new technique and methodology of degraded ecosystem restoration to more national and international visitors
2) Hold an in-situ training course for young scientists from APN countries, the main objectives include: a) show them the most effective techniques for degraded ecosystem restoration implemented in arid and semi-arid; b) provide them with new knowledge for understanding fundamental regulation and mechanisms of environment degradation in such area; c) educate them with new understandings to interrelate human activities, global climate change, policy making, rural poverty mitigation, as well as the social sustainability.

Publications

1) Wang Hanjie (ed) 2006, The degraded ecosystem restoration in the arid and semi-arid Norther China-Mongolia Region, Proceeding of APN workshop （17 papers）, June 20-23,2006, Yinchuan, China, China Forestry Publishing House.
2) Wang Hanjie et al, 2007, A preliminary report on the field experiment of dune fixation and virescence using lignin sand stabilization material, Submitted to Acta Ecological Sinica
3) A CD ROM records: a) electronic version of the workshop proceeding, b) workshop presentations (both ppt files and video file), c) the post-workshop professional tour map.

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Acknowledgments

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Technical Report

Preface

Desertification / land degradation caused by global climate warming and intensive human activity has become the most serious problem in the modern society, particularly in the ecological sensitive arid and semi-arid areas. This report collected the most effective techniques that Chinese and Mongolian scientists implemented on degraded ecosystem restoration and desertification control in recent years. The most successful techniques listed in this reports are: 1) An innovative method of producing sand stabilization material using lignin extracted from the black liquor of straw paper mills; 2) A desertification control using clay, stone and vinyl net barriers; 3) An optimum tree-grass intercropping configuration for restoring the degenerated steppes and provide more fodder for domestic animals that supports grazing-ban and fence-closure stockbreeding policy; 4) A practicable scheme to replace over-cultivating with forest and/or grass in hilly area; and 5) A sustainable precept for wetland conservation and eco-tourism development.

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1.0 Introduction

Because of the global climate change and the intensive human activity, desertification / land degradation has become the most serious problem in the modern society, particularly in the ecological sensitive arid and semi-arid areas. Within the scope of the APN, key problem areas include Northern China, Mongolia and Western Australia. The degraded ecosystems include degenerating pasture, farmland, windbreaks, shrinking and drying wetlands and other terrestrial ecosystem. In recent years, Chinese scientists have paid special attentions to degraded ecosystem restoration and desertification control in Northwest China since the government proposed the West Development policy. Besides the climate warming and aridification, irrational human activities, such as the over-cultivation and irrational reclamation of steppe/rangeland, over-grazing, irrational exploitation of fuel wood and herb medicines, deforestation and shifting cultivation, terrace cropping and so on, are also important reasons that cause ecosystem degradation and environment deterioration.

Under the support of several national and international projects, some new techniques have been developed that are proving effective in China and are worth gaining international perspectives on, and are worth communicating to the wider APN community where desertification/land degradation are recognized as major consequences of global change. The most successful techniques are:

1) An innovative method of producing sand stabilization material using lignin extracted from the black liquor of straw paper mills; the new material was named sand stabilizing lignin (SSL) and is proving effective, economic, environmental- and plant-friendly in fugitive dune fixation; it can be used with forest and/or grass planting simultaneously. This technique not only creates a new method for desertification control but also prevent the straw paper mill from issuing lignin to contaminate the valuable water resources;
2) A desertification control using clay, stone and vinyl net barriers;
3) An optimum tree-grass intercropping configuration for restoring the degenerated steppes, this technique includes drought-resistant species selection of tree and grass, intercropping configuration, and is particularly effective in recovering the over-grazing pasture;
4) A practicable scheme to retreat farming for forest and/or grass growing, which is particularly for the over-cultivated farmland on slopes in hilly area;
5) A sustainable precept for wetland conservation and eco-tourism development.

These achievements have laid a scientific foundation for sustainable development of population, resources, and environment in the arid and semi-arid regions. The main objectives and the relevant activities of the project are:

1) Organize a network of scientists within APN countries to exchange information regarding best practice concerning desertification control and the degraded ecosystem restoration;
2) Hold a 3-day (two days for scientific meeting and one day for field site visiting) in-situ workshop in Yinchuan, the provincial capital of China's Northwest Ningxia Hui Autonomous Region where the most effective techniques are implemented, raise awareness of a social scientific theme of integrating and coordinating the climate change, ecosystem adaptation and restoration, eco-environment improvement, natural resource management, human dimensions, social-economical development as well as the authorized policy making.
3) Through international cooperation and multi-disciplinary information exchange, provide new knowledge for understanding the fundamental regulation and key mechanisms of environment degradation in arid and semi-arid area, and develop new scientific frameworks to interrelate human activities and global climate change.
4) Integrate the knowledge obtained from our experience as a technical package to help both policy makers and land resource stakeholders to implement sustainable development in ecosystem restoration practices.

2.0 Methodology

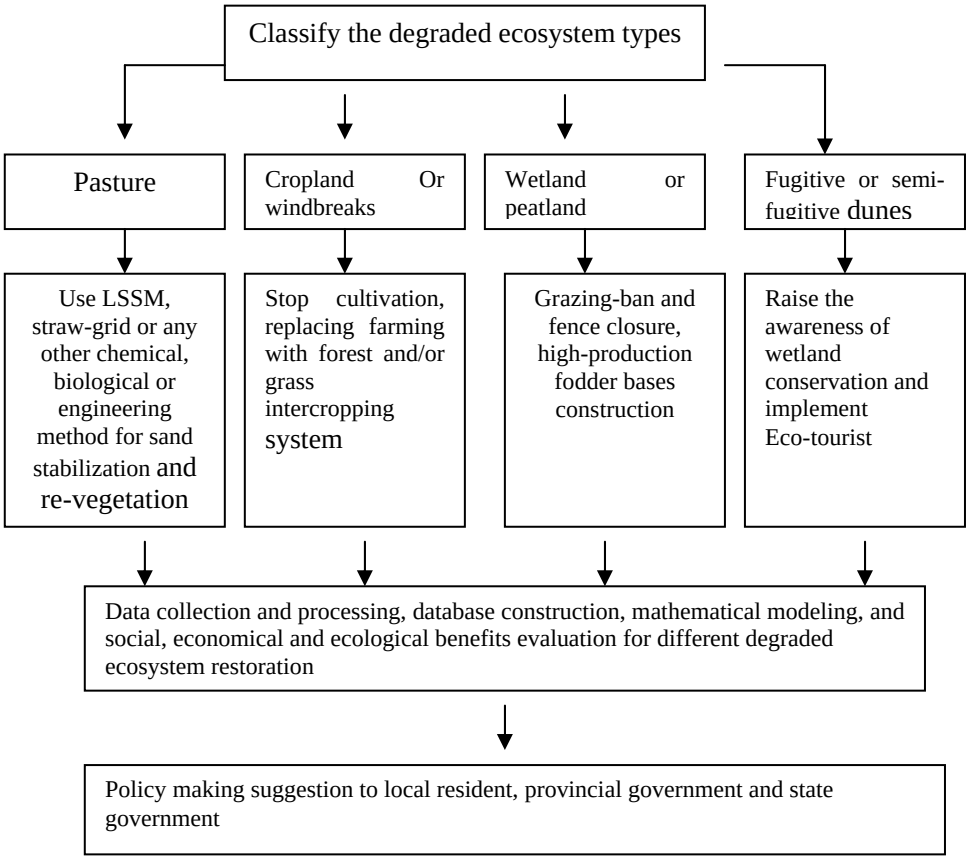


Fig. 1. Flowing-chart of the methodology for different degraded ecosystem

Focused on the main objectives of desertification control and degraded ecosystem restoration, the proposed technique package includes four deferent types depending on ecosystem classifications: 1) vegetation free fugitive dunes; 2) degraded pasture due to over-grazing; 3) degraded crop land due to over-cultivation, and 4) deteriorated wetland caused by aridification and damming. The methodology for different type of ecosystems is outlined in Chart 1. With respect to different ecosystem, the methodology is mentioned below correspondingly.

2.1 Method to green the vegetation free fugitive or semi-fugitive dunes

2.1.1 Lignin Sand Stabilization Material used in China

Besides the traditional method of “straw grid” dune fixation technique Chinese scientists used for decades, this project presents a new technique for fugitive or semi-fugitive dune fixation and re-vegetation. The new material called Lignin Sand Stabilizing Material (LSSM). LSSM is a reconstructed organic compound with lignin as

the most dominant component from the extracts of black-liquor issued by straw pulp paper mills. Unlike the polyvinyl acetate or foamed asphalt commonly used for dune stabilization, the new material is plant-friendly and can be used with virescence actions simultaneously. The field experimental study was conducted since 2001 in China's Northwest Ningxia Hui Autonomous Region and has been proved effective in stabilizing the fugitive dunes, making the arenaceous plants survive and the bare dune vegetative. A comprehensive field investigation was conducted to evaluate the effect of sand fixation.

The total phosphorous and Kalium show less variation than does organic matter and total nitrogen, the soil nutrients varied differently in layers of different depths. The technique is worthwhile to be popularized because it is provide not only a new method for desertification control but also an outlet for cleaning contaminations issued from the straw paper mills.

Pulping spent liquor from straw soda pulping can be modified to prepare biodegradable adhesive material through certain chemical reactions. The simplified process of LSSM preparation is outlined in **Fig. 2**.

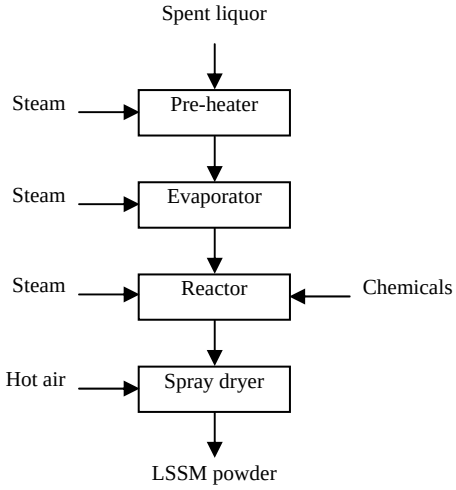


Fig. 2. Technical process of LSSM preparation

Fig. 2 shows that spent liquor from washing stage was condensed to 30-40% through evaporation. The concentrated liquor was then pumped into a reactor and react with some chemicals under certain conditions. Chemically modified liquor was sent into a spray dryer and the powder product of LSSM was obtained.

Light brown LSSM from wheat straw soda pulping spent liquor is an innoxious, harmless and naturally degradable powder. The LSSM sprayed on the windward slope of a fugitive dune (Fig. 3). The field experimental design focused on the following

objectives, 1) to find out the optimum concentration and dosage of LSSM solution with proper strength that can stabilize the fugitive dune and let the seed of arenaceous plant sprout, and 2) to confirm the promotion effect of LSSM on plant growth, and biomass accumulation.

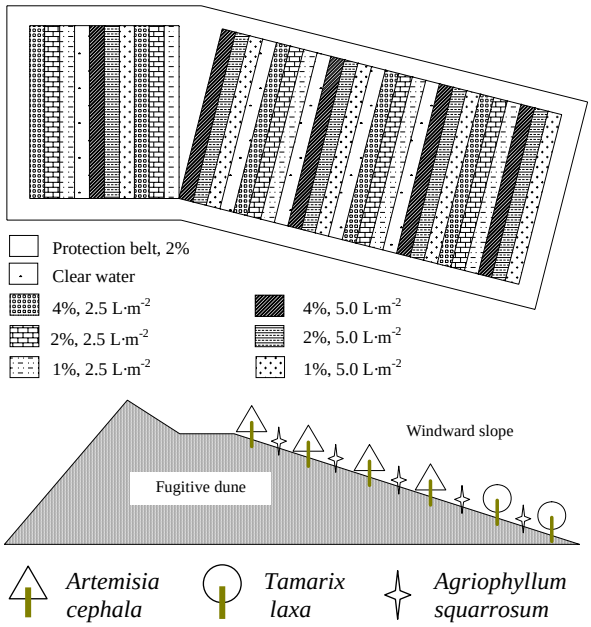


Fig. 3. Field experiment design for sand stabilization and vegetation restoration.

After seeding and planting, the LSSM solution with different concentration and dosage was sprayed on the dune surface. The selected desert plant species were Agriophyllum squarrosum, Artemisia cephala, and Tamarix laxa, which combined the annual herbs with perennial shrubs.

2.1.2 Mechanical barriers used in Mongolia

Mongolian scientists prefer use mechanical barriers for fugitive dune fixation. Three different types of mechanical barriers were trialed, namely clay, net and stone barriers. Each method is summarized below.

Clay barrier

This method was also developed by Chinese scientists and was trialed in an area of transverse sand dunes in the Tenggeri desert in the 1990's. The scientists created triangle walls, approximately 30-40cm in height, among the sand ripples. This parallel barrier system prevents sand flux along the general wind direction, thus stabilizing sand dunes (Sand Fixation, Handbook, 2004). Refer to schematic figure below (Fig. 3) for illustration.

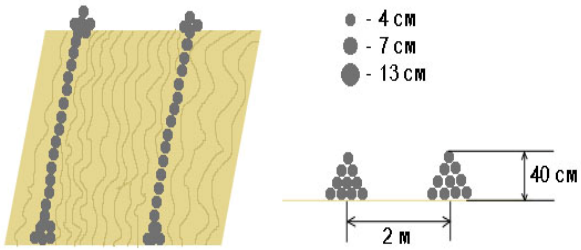


Fig. 4 Configurations for the clay barriers used in desertification control

- Vinyl net

Modern stabilizing technologies using synthetic materials, such as vinyl, have been trialed in large areas in the sandy deserts in China and other countries. The types of synthetic materials vary from wooden panels to chemical materials. For this experiment, we proposed to use vinyl and iron nets for establishing a low-density barrier. (Fig. 5)

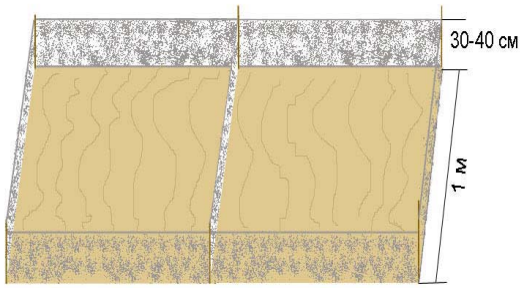
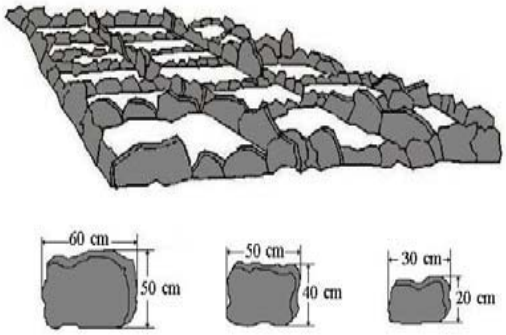


Fig. 5 Vinyl net used in desertification control

- Stone barrier

Another ‘dense’ barrier is stone fencing, which is a similar concept to straw checkerboards, where a checkerboard-style pattern is established in lengths of 1 x 1 m. According to aerodynamic research results conducted by several scientists, in order to create a dense barrier using stone we have to estimate the average sand flux amount and the physical process of the wind that is considered to be the main factor in sand movement. For this reason, the dense barriers have to be placed on a slope inclined at less than 10 degrees. Refer to **Fig.6** below for illustration.



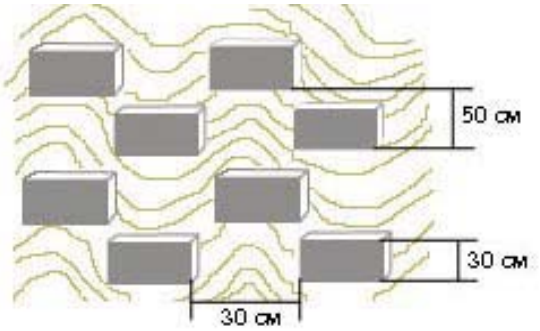


Fig. 6 Stone barriers used in desertification control

It had been fund that all types of barrier were effective to some degree in fixing sand. According to the results, it can be concluded that the efficiency of the stone barrier is more dependent on the position on the sand dune and less influence on the height, which in some cases showed negative influence by increasing the blow out rate.

2.2 The restoration method of degraded grass land

2.2.1 Grazing-ban with fence closure stockbreeding

The present project collected several papers that study the pasture capacities; dynamics of pasture biomass with climate change, grazing intensity, and the effect of grazing-ban with fence closure stockbreeding etc. The general methods include: pasture biomass determination; pasture capacity estimation, grazing intensity quantification etc. The field experiment was conducted in the following way: On the grazing land and enclosed area of every piece of experimental field, 5 sample strips were established and the distance between the sample strips is 100m. On every sample strip quadrats of 1m×1m were established at an interval of 100m between the quadrats. 5quadrats were set for each sample strip. 25 quadrats were set at each site of survey. The abundance, height, cover degree of various populations within the quadrat were recorded and the fresh weight was weighed.

2.2.2 High-production fodder base construction

In order to provide enough fodder to domestic animas and keep the gazing-ban policy effective, high-production fodder producing bases must be constructed to provide enough fodder for fenced animals. The project showed scientist some high-production fodder bases around Yinchuan, those include alfalfas, fodder-Mulberry tree and other common fodder grasses or shrubs.

2.3 The restoration method of over-cultivated crop land

Chinese government proposed a measure of “stop cultivation for forest and grass” in the end of 90s, which is recognized as the main method to restore the ecoenvironment in the rural area where the environment deteriorated seriously due to the over-cultivation. Whether the farmland is replaced with forest or with grass depends on the cover fraction of vegetation type being identified by the satellite database with a high resolution of 250m (EOS/MODIS data). If the forest covers a larger fraction than grass within a defined mesh area of 60×60 km, it implies that the eco-environmental condition in this area is suitable for forest to grow; therefore, the farmland in this area is replaced with forest. Similarly, if the grass covers a larger fraction than forest, the farmland is replaced with grass.

The forest and/or grass always inter-planted for further desertification control and higher production in unit area. There are plenty configuration types for inter-planting forest and grass depends on selected tree and grass species, soil and climate conditions, management purpose, products market, and available capital and labor investment. The most successful tree-grass inter-planting field after the cultivation being retreated is shows as Fig.7,) Chinese Ash (*Fraxinus chiensis*) with *Medicago sativa*.

2.4 Restoration method of degrade wetland and drained peatlands

2.4.1 Wetland conservation and sustainable development

During past several decades, wetland/peatland around China was shrunk quickly either because of the climate aridification or the intensive human activity such as the up-reach reclamation or damming the wetland for farming. Conservation and sustainable development at the same time is recognized as the most effective way in China to conserve and restore the shrunk wetland. The sustainable development includes fresh water cultivation and eco-tourism around the wetland.

2.4.2 Drained peatland restoration

We used Construction-small sandbag Dam and then Plank Dam (Stoneman & Stuart Brooks 1997) to restore the degraded peatlands since June 2003 (**Fig.7**). It is recognized that it is crucial to raise water table as the first step to avoid accessible to livestock after survey and consultation with local stakeholders. An obvious dam-building material is sandbag easily accessible and low cost. The details described as below: Step 1 Site the dams correctly based on slope and other factors; Step 2 Remove the peat from the sides

and base of the ditch (up to 40 cm), leaving a clean, wet peat face. Step 3 Fill in across ditch with wet peat, compacting to reduce permeability of the peat. Step 4 The peat turf should be laid back on top of the newly constructed dam. This will help prevent erosion of the bare peat face at the top of the dam. The following monitoring has also been conducted. Water levels are measured by PVC pipes and vegetation via regular site observation.

Except for sand bags, wooden plank dam was also applied to make a comparative study. But the result showed that plank dam is more proper and effective than sand bags. However it is noticed the construction of solid plank dams is labour-intensive and the volume of timber required can be considerable. Further investigation is needed to the effects of using untreated wood as such wood is prone to rotting, especially at the air/water interface. Other methods or techniques have also been used to stop the degradation of peatlands. The drained peatland restoration includes the following technological methods:

- Restoring the levels of lakes and other water bodies around the drained peatland
- Controlling intensity of grazing in peatlands
- Controlling desertification

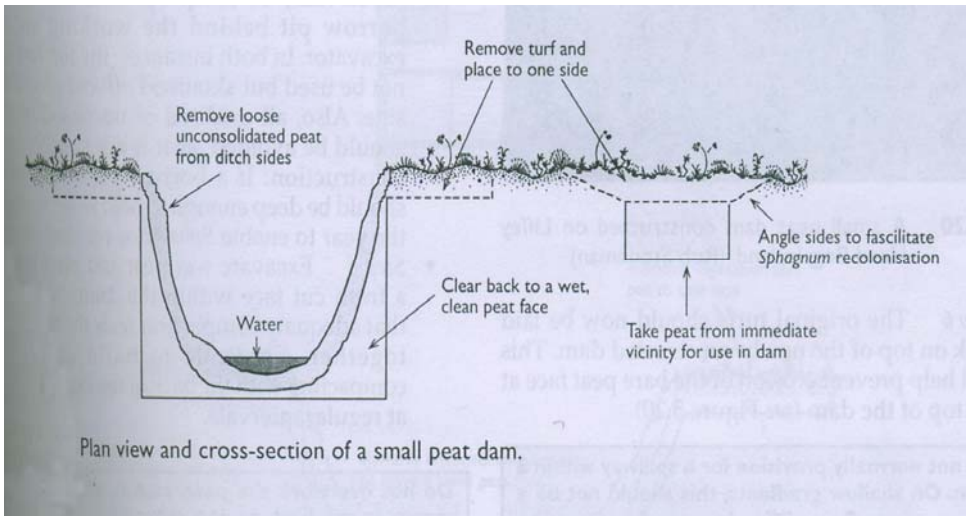


Fig.7 Method applied for restoring the drained peatland following R. Stoneman & S. Brooks (1997)

3.0 Results & Discussion

1) With the help of LSSM, vegetation-free fugitive dune could be greed in 2-3years (see Fig. 8), and the newly formed plant community is stable and sustainable shown by its species configuration, adaptation capability to extreme drought climate, and the capability of self-development and regeneration (Table 1). The measurement of soil water content within the

community shows that fugitive dune can keep soil water effectively and the selected drought-tolerant arenaceous plants, *Agriophyllum squarrosum* (L.) Moq., *Artemisia desertorum* Spreng., *Tamarix chinensis* Lour. can survive under extreme drought conditions. As the community being constructed, soil nutrients, such as organic matter and total nitrogen are increased significantly as compared with the control (Table 2), which is helpful to the growth of arenaceous plants.

Table 1 the measured data of *Artemisia desertorum Spreng*.community,

(Total measured plants 333, Area of the sampling plot 10×80 m^2)

Items	Base coverage (cm)	Crown diameter(cm)	Plant height(cm)
Average	3.0	81.3	74.8
Variance	2.8	43.2	32.1
Minimum	0.3	3.0	12.0
Maximum	21.0	214.0	161.0

Table 2 Comparison of soil nutrition

Surface soil

Sam.	Organic matter (g/kg)	Variation (%)	Total nitrogen (mg/kg)	Variation (%)	Total Phosphorus (g/kg)	Variation (%)	Total kalium (g/kg)	Variation (%)
3-yr	2.81	150.9	106.0	121.3	0.226	5.6	13.4	0.1
2-yr	1.43	27.7	59.9	25.1	0.215	0.1	13.6	2.2
Cont.	1.12	--	47.9	--	0.214	--	13.3	--

0-10 cm

Sam.	Organic matter (g/kg)	Variation (%)	Total nitrogen (mg/kg)	Variation (%)	Total phosphorus (g/kg)	Variation (%)	Total kalium (g/kg)	Variation (%)
3-yr	1.73	76.5	73.6	76.5	0.208	-2.3	13.4	0.0
2-yr	1.53	56.1	68.5	64.3	0.221	3.7	13.8	3.0
Cont.	0.98	--	41.7	--	0.213	--	13.4	--

10-30cm

Sam.	Organic matter (g/kg)	Variation (%)	Total nitrogen (mg/kg)	Variation (%)	Total phosphorus (g/kg)	Variation (%)	Total kalium (g/kg)	Variation (%)
3-yr	1.33	41.5	53.6	38.5	0.198	-6.6	13.2	-1.4
2-yr	1.19	26.6	58.1	50.1	0.209	-1.4	12.5	-6.7
Cont.	0.94	--	38.7	--	0.212	--	13.4	--

Fig. 8 A fugitive dune (left) is greened (right) in three years by using LSSM

2) Through the intensive field experimental studies on study pasture capacities; dynamics of pasture biomass with climate change, grazing intensity, and the effect of grazing-ban with fence closure techniques, the main results are: a) the pasture capacity of some natural pasture in Mongolia varied with the climate condition correspondingly, b) the tree-grass inter-planting system is the most effective ecosystem to restore the degenerated steppes, replace the over-cultivated crop land and produce necessary fodder for fence-closure stockbreeding; c) grazing ban plays a remarkable role in upgrading production capacity of nature sandy grassland, and d) precipitation and its seasonal distribution pattern affect stock capacity of sandy grassland directly and the corresponding grazing intensity should be adjusted. The high-production fodder producing bases for domestic animals looks like Fig. 9.

Fig. 9 High-production fodder producing base, fodder Mulberry tree (left) and tree (*Fraxinus chiensis)* and grass (*Medicago sativa*) inter-planting system (right)

3) The no-touch policy for wetland conservation does not work in the overpopulated area such as China. A practicable scheme is to conserves the wetland by a sustainable development scheme that considers wetland conservation and utilization simultaneously. Both fresh-water cultivation and ecotourism development around the wetland are practicable. Fig. 10 shows the original abandoned wetland (left） and the beautiful eco-tourist site (right) built on an abandoned wetland (right) .

Fig. 10. The original abandoned wetland (left） and the beautiful eco-tourist site built on an abandoned wetland

4.0 Conclusions

1) It is not only the climate warming and aridification but also the intensive human activities that causes desertification and ecosystem degradation in arid and semi-arid area. Within the Northern China-Mongolia region and other ecological sensitive zones, the later is more important than the former one.
2) There are several different types of degenerated ecosystems in the arid and semi-arid area, which includes the fugitive and semi-fugitive vegetation-free dunes, the degenerating pasture, farmland, windbreaks, shrinking and drying wetlands etc., the restoration technique respecting to different types of ecosystem are diverse correspondingly.
3) The further global change studies should integrate and coordinate climate change, ecosystem restoration, eco-environment improvement, natural resource management, human adaptation, as well as social-economical development and policy-making, from both social and scientific perspectives.

5.0 Future Directions

1) Enlarge and manage intensively the present field experiment areas showing the new technique and methodology of desertification control and degraded ecosystem restoration to more national and/or international visitors.
2) Hold an in-situ training course for young scientists from APN countries, the main objectives include: a) show them the most effective techniques for desertification control and degraded

ecosystem restoration implemented in arid and semi-arid; b) provide them with new knowledge for understanding fundamental regulation and mechanisms of environment degradation in such area; c) educate them with new understandings to interrelate human activities, global climate change, policy making, rural poverty mitigation, as well as the social sustainability.

3) Propose to CNC- IGBP the latest notion if integrating and coordinating climate change, ecosystem restoration, eco-environment improvement, natural resource management, human adaptation, as well as social-economical development and policy-making, from both social and scientific perspectives.

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Appendix 1. Workshop Agenda

Workshop name: "The degraded ecosystem restoration in the arid and semi-arid Northern China-Mongolia Region"

June 20-22, 2006, Yinchuan, Ningxia, China

APN Project (2005-23-NSY)

June 19 (Monday)

8:00-16:00 Registration desk, Lobby of the International Hotel

12:00 Lunch at Xianyu Wangzi Hotel, Room319

18:00 Reception dinner, Xianyu Wangzi Hotel, Room318

June 20 (Tuesday)

09:00-10:00 Opening Remarks

- ※ Speech by secretary general of Ningxia Autonomous Regions
- ※ Speech by representative of Academician Fu Zongbin
- ※ Speech By reprehensive of participant, Mr. B. Dashzeveg
- ※ Speech by local workshop organizer Director Dong Feng
- ※ Approval of agenda
- ※ Photographing together

10:00-12:00 presentation (Chair by Director Chen Kelin)

10:00-10:20 Speaker: Wang Hanjie
Title: Introduction of the workshop

10:20-10:50 Speaker: Ma Qun
Title: Agricultural Comprehensive Development and ecological restoration in China's Northwest Ningxiahui Autonomous Region, invited speech

10:50-11:10 coffee break

11:10-11:40 Speaker: Bayarbat Dashzeveg
Title: Present Situation of Desertification and Combat to Desertification in Mongolia

11:40-12:10 Speaker: Guangsheng Zhou
Title: Degraded Ecosystem Restoration and Sustainability in China"

12:10-14:00 Lunch at Xianyu Wangzi Hotel, Room319

14:00-17:00 Continuation of presentation (Chair by Prof. Hanjie Wang)

14:00-14:30 N. Mandakh "Results On Sand Fixation Experiments In Mongolia"

14:30-15:00 Liu Maosong "The influences of arboraceous layer on spatial patterns and morphological characters of herbs in an arid plant community"

15:00-15:30 Yongcan Jin "Modification of Straw Pulping Spent Liquor for Desert Sand Stabilization and Vegetation Restoration"

15:30-15:50 coffee break

15:50-16:10 Lu Jianguo Ecological slope protection for the new-constructed highways

16:10-16:30 Xu Chi or Liu Maosong, "Simulating NPP variation in Heihe River Basin at resolution of 90 m using a process model"

16:30-17:00 D. Erdenetsetseg "Dynamics Of Pasture Biomass And Pasture Capacity In Particular Year"

17:30 dinner at Delonglou Restaurant

June 21 (Wednesday)

09:00-12:00 Presentations and group Discussion (Chair by Dr. Bayarbat Dashzeveg**)**

09:00-09:30 Speaker: Hanjie Wang

Title: The degraded ecosystem restoration in the arid and semi-arid Northern China-Mongolia Region

09:30-:10:00 Speaker: Chen Kelin

Title: Ruoergai Peatlands Conservation And Restoration

10:00-10:20 Coffee Break

10:20-10:40 Speaker: Jin Yoncan

Title: Water recycling and pithead gardening technique in drought desertification area, designing and construction of ecotypeic garden at Yanchangwan coal mine

10:40-12:00 Group Discussions, Summary of the Workshop (Chair by Prof. Dr. Hanjie Wang)

Free talking about the following topics:

1) New techniques about degraded ecosystem restoration that was **NOT** mentioned in this workshop.
2) The possibility and difficulty of popularizing present techniques to APN counties? Which country should and can be extended? How?
3) Further steps for cooperation within APN countries
4) Any other common interests
5) Announce the field site visiting tour course.

12:00-13:30 Lunch at Guoqian Restaurant

13:30-18:30 Ecosystem Restoration Sites visiting tour around Yinchuan,

19:00 Dinner at Jinshawan Farm

June 22 (Thuresday)

7:00-12:00 field tour to Shahu (Sand Lake)

Lunch at Qingxin restaurant

13:00-17:00 visit Jinfeng district experimental sites

18:00 dinner Buffet at Ningxia International Hotel

June 23 (Friday)

Check out, participants leaving

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More than 20 graduate students of Ninxia University audited the workshop presentation. *(comprising*

Appendix 3 Funding sources outside the APN

1) National Natural Science Foundation of China (NSFC), Free visit to experimental sites, supported 5,000RMB by NSFC project 90302015,
2) Ningxia Agricultural Comprehensive Development Office, local transportation vehicles for airport and railway station reception, seeing-off, and post-workshop field tour, accounting for 3,000RMB

Appendix 4 Glossary of Terms

LSSM	lignin Sand Stabilization Material
NPP	net primary productivity
RS	remote sensing
GIS	geographic information system
LUCC	land use and cover change

NSFC	National Science Foundation of China
CNC-IGBP	Chinese National Committee for International Geosphere-Biosphere Programme

Appendix 5 Table of Papers in the workshop proceedings

1 Welcome remarks

2 The degraded ecosystem restoration in the arid and semi-arid Northern China-Mongolia Region

3 Combating Desertification in Mongolia

4 Preliminary Exploration of Natural *Form. Prunus mongolica* Community in Ningxia Hui Autonomous Region, China

5 Dynamics of Pasture Biomass and Pasture Capacity in Particular Year

6 Effect of Grazing-ban on Succession of Sandy Grassland Vegetation in Yanchi County in Ningxia Hui Autonomous Region, China

7 Results of the Sand Fixation Experiments in Mongolia

8 Modification of Straw Pulping Spent Liquor for Sand Stabilization and Vegetation Restoration

9 Degraded Ecosystem Restoration and Sustainability in China

10 Ruoergai Peatlands Conservation and Restoration

11 Water Recycle and Pithead Gardening Technique in Drought Desertification Area

12 Simulating NPP variation in the Heihe River Basin at a resolution of 90 m using a process model

13 Analysis of Vegetative Community of *Form. Achnatherum splendens* in Ningxia

14 Grassland Ecological Replacement in Xinjiang and Its Popularization in Yanchi County of Ningxia Hui Autonomous Region, China

15 Researches on Effect of Different Intensities of Grazing on Biomass of Rhizome Grass Vegetation on Sandy Land95

16 Land Use and Cover Changes in Zhangye Oasis, Northwest China

17 RS and GIS Based LUCC Study of Yanchi County of Ningxia Hui Autonomous Region, China