Volume No. 1

Regional Master Plan for the Prevention and Control of Dust and Sandstorms in Northeast Asia

UNCCD

UNEP

UNESCAP

ADB

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The regional master plan report is composed of three volumes, namely: Volume 1: A Master Plan for Regional Cooperation for the Prevention and Control of Dust and Sandstorms; Volume 2: Establishment of a Regional Monitoring and Early Warning Network for Dust and Sandstorms in Northeast Asia; and Volume 3: An Investment Strategy for Dust and Sandstorms Prevention and Control through Demonstration Projects.

This report has been prepared by a team of consultants engaged by ADB in cooperation with the national experts from Japan and the Republic of Korea under the guidance and supervision of technical committees formed for the two components of the regional master plan. The first component, on a phased program to establish a regional monitoring and early warning network for DSS, was conducted under the guidance of a technical committee chaired by the UNEP. The second component, on an investment strategy to strengthen mitigation measures to address root causes of DSS in source areas, was undertaken under a technical committee chaired by the UNESCAP. Finally, this report was reviewed and cleared by members of the Steering Committee. Appendix 1 presents the terms of reference for this regional technical assistance project (RETA 6068) while Appendix 2 lists the participating parties, consultants, and national experts.

ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
aimag	Province (Mongolia)
AWS	Automatic Weather Station
DSS	dust and sandstorms
GEF	Global Environment Facility
ha	hectares
LIDAR	Light Detection & Ranging (a scientific device)
MNE	Ministry of Nature and Environment of Mongolia
NAP	National Action Programs
PM_{10}	Particulate Matter of $< 10\mu$
PRC	People's Republic of China
RETA	Regional Technical Assistance
RMB/CNY	Chinese currency; yuan
soum	County (Mongolia)
TA	Technical Assistance
TSP	Total Suspended Particles
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Programme
UNESCAP	United Nations Economic and Social Commission for Asia and Pacific
US$	U.S. Dollar
WMO	World Meteorological Organization

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1. BACKGROUND

1.1 Objective of the Project

Dust and sandstorm (DSS) is the generic term for a serious environmental phenomenon in Northeast Asia. It causes considerable hardship and loss of income, disrupts communications, affects peoples' health, and, in extreme cases, leads to death of people and destruction of livestock and crops over large areas in the affected countries.

At the request of the governments of the People's Republic of China (PRC) and Mongolia, the Asian Development Bank (ADB), the United Nations Convention to Combat Desertification Secretariat (UNCCD), the United Nations Economic and Social Commission for Asia and Pacific (UNESCAP), and the United Nations Environment Programme (UNEP), initiated their own projects for the prevention and control of DSS in Northeast Asia. The ADB prepared the project concept for a regional technical assistance (RETA or TA) in early May 2002 and the three agencies of the United Nations made a project proposal to seek support from the Global Environment Facility (GEF) to address the same environmental problem in the region.

During a meeting among the environment ministries of the PRC, Japan, the Republic of Korea, and Mongolia in June 2002, it was proposed by the governments of the four countries that the ADB, the UNCCD, the UNESCAP, and the UNEP jointly develop an expanded TA to integrate the support from the international community, maximize the effects of the undertaking, and promote regional cooperation on DSS to be co-financed by the ADB and the GEF. A joint fact-finding and consultation mission comprising representatives from the four international organizations led by the ADB visited the PRC and Mongolia from 26 August to 2 September 2002. The mission reached an understanding with the governments of the PRC and Mongolia on all aspects of the Terms of Reference for the TA. The joint project on "Prevention and Control of Dust and Sandstorms in Northeast Asia (RETA 6068)" was then approved by the ADB and the GEF in December 2002 and its implementation commenced in March 2003. Appendix 1 presents the Terms of Reference of RETA 6068 Project while Appendix 2 lists the participating parties involved in undertaking the project.

The TA project was implemented together by the ADB, the UNESCAP, the UNCCD, and the UNEP in collaboration with the governments of the PRC, Japan, the Republic of Korea, and Mongolia. A Steering Committee and three Technical Committees were organized for the implementation of the project with the ADB as the executing agency responsible for the overall management and administration of the TA.

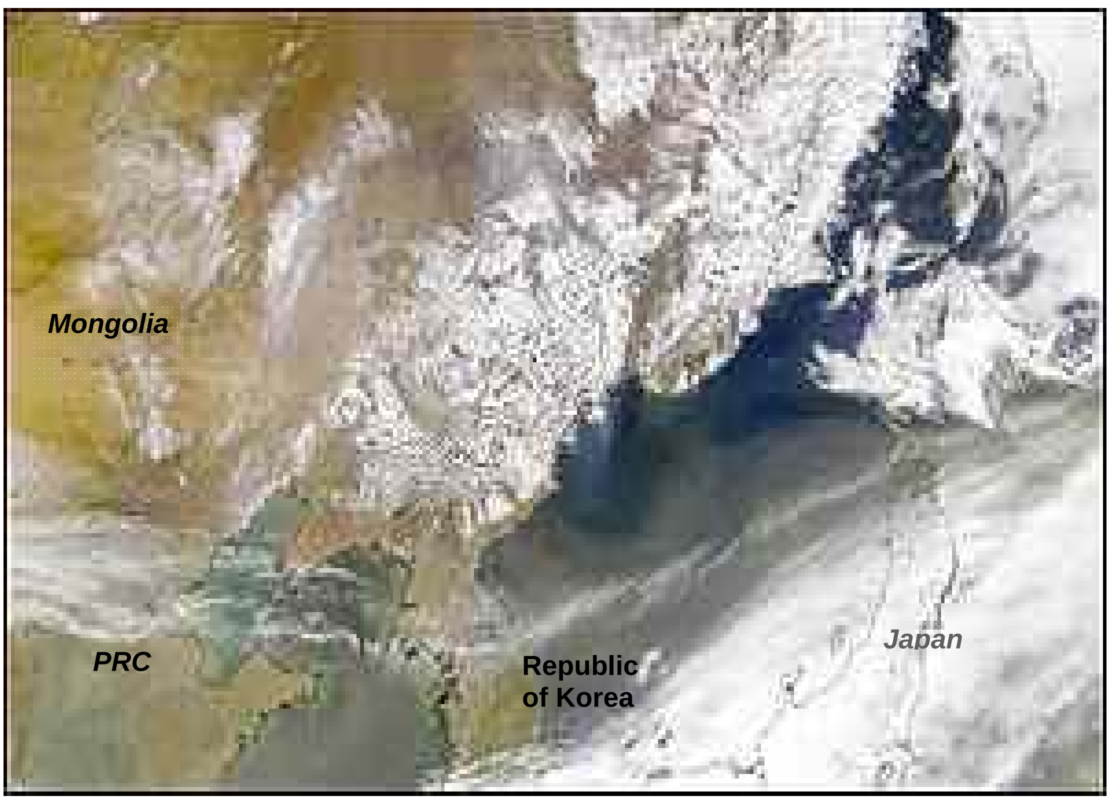
The main objective of this collaborative project is to promote the establishment of a regional cooperation mechanism for the prevention and control of DSS in Northeast Asia. In this connection, the specific output of the study is a master plan to guide regional collaborative activities to alleviate DSS in Northeast Asia. The components of the regional master plan are: (a) a phased program to establish a regional monitoring and early warning network for DSS in Northeast Asia, and (b) an investment strategy to strengthen mitigation measures to address root causes of DSS in source areas. The first component was implemented under the guidance and supervision of a technical committee chaired by UNEP and focused on the establishment of a regional network for monitoring, early warning, and forecasting of DSS. It presents a phased program to establish a regional DSS monitoring and early warning network by strengthening the monitoring capacity in the two DSS source countries (i.e., the PRC and Mongolia), establishing an institutional framework among the four partner countries, and improving the information flow for effective early warning services.

The second component was implemented under the guidance and supervision of a technical committee chaired by UNESCAP and focused on: (i) the selection of sites for nine demonstration projects (four in PRC and four in Mongolia and a sub-regional demonstration site that straddles the border of both countries), (ii) the identification of best practices for the demonstration projects for DSS prevention and control, and (iii) the development of an investment strategy including recommendations on sustainable financing mechanisms for the promotion and dissemination of best practices in addressing the causes of DSS.

1.2 Scope of the Project

Although DSS in Northeast Asia affects a wide geographic area, the project involves four participating countries—PRC, Japan, the Republic of Korea, and Mongolia—all are members of ADB. Specifically, the geographic area covered includes part of continental Asia (PRC, the Korean peninsula, and Mongolia) and the neighboring islands of Japan (see Figure 1.1). However, the wind and weather patterns of the DSS force may originate in the Russian Federation to the north and west and in Kazakstan to the west of the PRC and Mongolia (see Figure 1.2) and the DSS impact may be felt in Democratic People's Republic of Korea (DPRK) and in North America. Thus, DSS is an example of a transboundary environmental problem.

Figure 1.1 DSS Geographic Coverage



Note: A fast cloud of dust over Mongolia and the PRC with transport path towards the Republic of Korea and Japan.
Source: NASA, May 2001 satellite image

Figure 1.2 DSS Transport Process by Air Flows

Source: SEPA, Beijing

As for the planning timeframe targeted in the project for DSS prevention and control for Northeast Asia, 15 to 20 years was used commencing from 2004/2005. Due to advances in technology and the development of new and substantial information about DSS, however, recommendations specifically on monitoring and early warning are planned within the next two to five years. Recommendations for implementing the demonstration site projects, on the other hand, can take on a longer development period depending on the availability of resources.

1.3 The Dust and Sandstorm (DSS) Phenomena in Northeast Asia

DSS involves strong winds that blow a large quantity of dust and fine sand particles away from the ground and carry them over a long distance with severe environmental impacts along the way. It often has severe impacts across the countries in the region. The major sources of DSS in the region are the DSS originating source areas in the desert and semi-desert areas of the PRC and Mongolia. Long distance transport of dust aerosol particles links the biogeochemical cycles of land, atmosphere and ocean, possibly even influencing the global carbon cycle, and having a significant effect on regional radiative balances, and human health.

DSS as a natural phenomenon has occurred for thousands of years in the region. During the past 50 years, however, the frequency has increased, geographic coverage has expanded, and damage intensity has accelerated. Available PRC statistics indicate that average occurrence of DSS was 5 times a year in the 1950s, 8 times in 1960s, 14 times in 1970s, and 23 times in 1990s. The region experienced 32 DSS in 2001 and the most severe DSS for decades in early 2002.

Large-scale DSS has significant environment effects that cause enormous economic losses, present serious public health concerns over a wide geographic area, and sometimes take human lives. For instance, the DSS on 5 May 1993 directly affected 1.1 million square kilometers in the PRC, which resulted in human casualties (i.e., 85 deaths and 246 injuries) and destruction of 4,412 houses, 120,000 livestock, and 373,000 hectares of crop land[1]. The direct economic cost of this DSS within the PRC alone was more than CNY550 million (about US$66 million at 2002 exchange rate). The two most severe DSS events in decades took place in March and April 2002. They swept across Mongolia and hit 18 provinces in PRC, the Korean peninsular, and a large area of Japan. Total suspended particulate levels in these affected areas were recorded from tens to hundreds of times higher than the national standards in these countries. The DSS in early April 2002 was so severe that Mongolia had to close its international airport in Ulaanbaatar for three days. Also, the Republic of Korea had to close their primary schools and cancel more than 40 flights departing from Gimpo Airport in Seoul. Satellite images of DSS events and analysis of the dust samples collected on the ground have revealed that impacts of strong DSS are not limited to the region, but reached as far as North America across the Pacific Ocean.

The occurrence of DSS is built upon two prerequisites. They are (i) dry and loose surface and (ii) strong[2] and persistent wind. Understanding a DSS event would entail the study of meteorological conditions and soil surface properties and how these interface with each other. DSS in Northeast Asia mainly originates from the mid-latitude Desert Zone (N 40-45°E 90-120°). Driven by the East Asia winter monsoon, DSS generated from areas above moves southeast and then to the east parallel along N 40°, passing the Korean Peninsula and Japan to the northern areas of the Pacific Ocean.

[1] Yang Youlin and Lu Qi In *"Global Alarm: Dust and Sandstorms from the World's Drylands*". UN 2002 for an account of the severe DSS event in the Hexi corridor of Gansu Province, PRC

[2] Generally 6.5 meters/second (m/s) is regarded as the threshold wind velocity to initiate a dust outbreak provided that the soil surface is dry. Soil texture is also a determining factor.

2. FORMULATION OF THE REGIONAL MASTER PLAN

2.1 General Approach for Master Plan Formulation

The formulation of the master plan for the prevention and control of DSS in Northeast Asia basically builds on the outputs of two main components of the project, which were earlier undertaken. That is, the study on the establishment of a regional monitoring and early warning network for DSS in Northeast Asia and the study on an investment strategy to address the root cause of DSS in the source areas of the PRC and Mongolia. Hence, the results of studies for this Technical Assistance on the Prevention and Control of Dust and Sandstorms in Northeast Asia project have been organized into a three-volume report that can be referred to independently but remain interrelated in substance. The report organization is as follows:

- Volume 1: *A Regional Master Plan for the Prevention and Control of Dust and Sandstorms in Northeast Asia*
- Volume 2: *Establishment of a Regional Monitoring and Early Warning Network for Dust and Sandstorms in Northeast Asia*
- Volume 3: *An Investment Strategy for the Prevention and Control of Dust and Sandstorms through Demonstration Projects*

The conduct of the study is in accordance with the overall design of the project with detailed framework carefully set out to guide the entire flow of the project (see Appendix 1). Each of the project component employed different approaches and methodologies in response to their study purpose and goal. These are explained in succeeding sections.

2.2 Methodology and Approach for DSS Regional Network Development

Transboundary environmental problems such as DSS can most effectively be solved through regional cooperation. The merit of regional cooperation is that it will be possible to achieve much more through a network than by each country acting alone. There is considerable value-adding when neighbors combine their efforts to establish a regional monitoring and early warning network. Early warning of impending DSS events based on a regional monitoring network will be facilitated by data sharing with rapid communications on the progress and geographic extent of any DSS outbreak.

For the development of the regional network for DSS, the study looked into the capabilities of partner countries for DSS monitoring, forecasting, and early warning. This entailed the review of each partner country's institutional set up and linkages, technologies, and processes related to DSS monitoring. An inventory of geographically important monitoring stations was made and the monitoring indicator system utilized by each partner country was reviewed. A set of common monitoring indicators was then identified accommodating the different needs of the partner countries without compromising the technical and operational feasibility of the regional network. Likewise, mechanisms and operation for cross country data sharing were explored and worked out.

Specifically, the following points were identified through the review of the current DSS monitoring programs in the partner countries for consideration in view of establishing a regional network for monitoring and early warning:

Firstly, the perception, terminology, definition, monitoring method, current capacity, needs and expectation, etc. are all different from country to country. For example, there is a perception gap among the participating countries. DSS is considered as a phenomenon of natural disaster for countries in the source areas or the upstream countries while DSS is a problem of air quality concerning public health for downstream countries. The definition of DSS is also different from country to country depending not only on monitoring method but also threshold value. In addition, needs and expectations are also different from country to country, even from agency to agency within a country. Accordingly, optimization and flexibility with step-by-step approach is necessary in formulating a feasible program for a regional monitoring and early warning network.

Secondly, although a few bilateral initiatives are already in place, these projects are limited to some specific field and national boundary areas. Since DSS is one of the transboundary environmental problems at a regional scale, multi-lateral cooperation mechanisms can solve the problem effectively and this is true for a regional monitoring and early warning network.

Thirdly, although Mongolia is one of the major source areas of DSS, there is no special monitoring site for DSS in the country. Moreover, most meteorological stations in Mongolia do not have any direct relation to DSS. In this regard, from a regional perspective, helping Mongolia develop its national capacity is one of the key tasks in terms of establishing a regional monitoring network, particularly on data sharing among participating countries.

2.3 Methodology and Approach for the Investment Strategy for the Prevention and Control of DSS in Northeast Asia

The investment strategy is intended to provide a framework that is flexible and can effectively harness the capabilities of interested partner countries, international organizations and other stakeholders. The general principles of the investment strategy for DSS prevention and control in the Northeast Asian region are twofold[1]: (1) Demonstration projects are used as the main vehicle for attaining the objective of reducing the intensity of DSS and mitigating the impact; and (2) The demonstration projects are viewed as a first step of continuing efforts with a scope for expansion and replication. Moreover, the selection of the demonstration sites was conducted in the context of regional cooperation.

Demonstration project approach is, therefore adopted in implementing the investment strategy. The governments of the PRC and Mongolia have nominated four focus areas each. The four focus areas of the PRC are all located in Inner Mongolia Autonomous Region, namely: Hulunbuir, Xilingol, Ordos, and Alashan. The four areas in Mongolia are Sukhbaatar, Omnogobi, Dornogobi, and Ovorhangai. In addition, a joint demonstration area straddling the Sino-Mongolian border was selected at Erinhot on the PRC side and Zamiin-Uud on the Mongolian side.

The investment strategy is proposed in the context of the international, regional, and national frameworks for the control of land degradation, with particular emphasis on goals, priorities, scope, feasibility, affordability, effectiveness, sustainability, novel approaches and methodologies, and policy/institutional initiatives. There were a number of methodologies that were explored, during the course of the investment strategy formulation, for possible application in assessing and justifying mitigation measures intended for the prevention and control of DSS. These are the risk management, the application of the “Least-Cost-Plus-Loss” principle[2] and the selection of budget levels.

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[1] The principles for the investment strategy were agreed upon by the partner countries and international organizations during the First International Workshop on Investment Strategy held in Ulaanbaatar, 11-12 May 2004.

[2] This model used in forest fire management programs provides one option to analyze the cost effectiveness of interventions to deal with the uncertainties and widespreading damages associated with disastrous phenomena like DSS.

In addition to the approaches in drawing up the investment strategy, approaches to be employed during the actual implementation of the demonstration projects were identified. One is the building on past experiences addressing DSS concerns as well as creating new and innovative approaches to DSS prevention and control. Another is allowing greater participation of individuals, households, communities, private sector, civil groups, academia as well as agencies of various levels of government and international organizations in the selection of focus areas and the identification of best practices.

3. ESTABLISHMENT OF THE REGIONAL NETWORK FOR DUST AND SANDSTORM MONITORING AND EARLY WARNING

3.1 Overview

With the growing social-environmental implication of dust and sandstorms (DSS), the concern to improve DSS monitoring and early warning has significantly increased. In Northeast Asia, countries primarily affected by DSS have conducted DSS forecasting and early warning services through their National Meteorological Services. The People's Republic of China (PRC) initiated its forecasting service of DSS and early warning service for severe DSS for the public in 2001. The Republic of Korea did the same in 2002, Japan in early 2004, and the Mongolian Meteorological Service is presently trying out similar services for the public.

The partner countries are member states of the World Meteorological Organization (WMO) network that works well with a defined purpose[1]. The national Meteorological Services of the WMO member nations have agreed to a free and unrestricted international sharing of meteorological data and products. Although meteorological data and services are essential for DSS monitoring and early warning, they are far from being adequate to analyze and predict a complex phenomenon like DSS.

Based on the review of the current DSS monitoring programs in the partner countries for consideration in establishing a regional network for monitoring and early warning, the following issues and challenges are apparent:

Firstly, the perception, terminology, definition, monitoring method, current capacity, needs and expectation, etc. are all different from country to country. For example, there is a perception gap among the participating countries. DSS is considered as a phenomenon of natural disaster for countries in the source areas (upstream countries) while DSS is a problem of air quality concerning public health for downstream countries. The definition of DSS is also different from country to country depending not only on monitoring method but also threshold value. In addition, needs and expectations are also different from country to country, even from agency to agency within a country. Accordingly, optimization and flexibility with step-by-step approach is needed in formulating a feasible program for a regional monitoring and early warning network.

Secondly, although a few bilateral initiatives are already in place, these projects are limited to some specific field and national boundary areas. Moreover, these initiatives on DSS between partner countries are presently focused on academic research and are not designed as operational tools to improve public awareness of impending DSS disasters. Despite these agreements, it is still a hurdle for DSS researchers from other agencies in Northeast Asia to get real-time data, particularly the data across countries in the region. Since DSS is one of the transboundary environmental problems at a regional scale, multi-lateral cooperation mechanisms can solve the problem effectively and this is true for a regional monitoring and early warning network.

Thirdly, although Mongolia is one of the major source areas of DSS, there is no special monitoring site for DSS in the country. Moreover, most meteorological stations in Mongolia do not have any direct relation to DSS. In this regard, from a regional perspective, helping

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[1] The WMO is a specialized agency of United Nations with the purpose to promote meteorology and hydrology and facilitate cooperation for the benefit and protection of humans through, among others, the establishment of networks of observation stations, development and maintenance of systems for rapid data exchange, and standardization of observation and processed products.

Mongolia develop its national capacity is one of the key tasks in terms of establishing a regional monitoring network, particularly on data sharing among participating countries.

3.2 Selection of Monitoring Indicators

To establish a regional network for DSS monitoring and early warning among the partner countries, there is a need to develop a monitoring indicator system. The establishment of the common DSS monitoring indicators should start with the data that is easily available or can be easily acquired at present. It should take into account the technique and method being used for monitoring in each partner country and the long-term observational data status at the regional level in Northeast Asia, and in particular, in the originating source areas of DSS. Moreover, the initial monitoring indicator system should be adaptable to the evolution of DSS monitoring and modeling techniques and should be able to meet the increasing needs of the forecasting and early warning service.

To provide for early warning services, on the whole, DSS forecasting needs the following data or information on weather and surface conditions:

(a) Information about meteorological observation and analysis covering the following:

- Meteorological observation in the northern hemisphere for the analysis of the atmospheric circulation, which will basically cause DSS in Northeast Asia;
- Detailed meteorological observational data in DSS source area and DSS affected area (such as atmospheric pressure, temperature, rain, humidity, visibility, and wind) and its three-dimensional distribution;
- Diagnosis and analysis on atmospheric thermo-dynamic information based on the weather observation data; and
- Numerical weather prediction products from different meteorological centers.

(b) Geographic information and surface monitoring information covering the following:

- Desert distribution and soil texture information (distribution, grain size, etc.);
- Land use/cover change information; and
- Soil moisture status, including snow cover.

(c) Dust related monitoring information as follows:

- Atmospheric optical properties measurement including horizontal visibility (by transmissometers), optical depth and size mode (by solar radiation and sun photometer), vertical visibility and vertical profile (by LIDAR), light scattering (by nephelometer), etc.;
- The mass concentration and size mode of dust including TSP, PM_{10}, and dust deposition, etc.; and
- Satellite monitoring and retrieval data for DSS, which can be acquired from a variety of meteorological satellites.

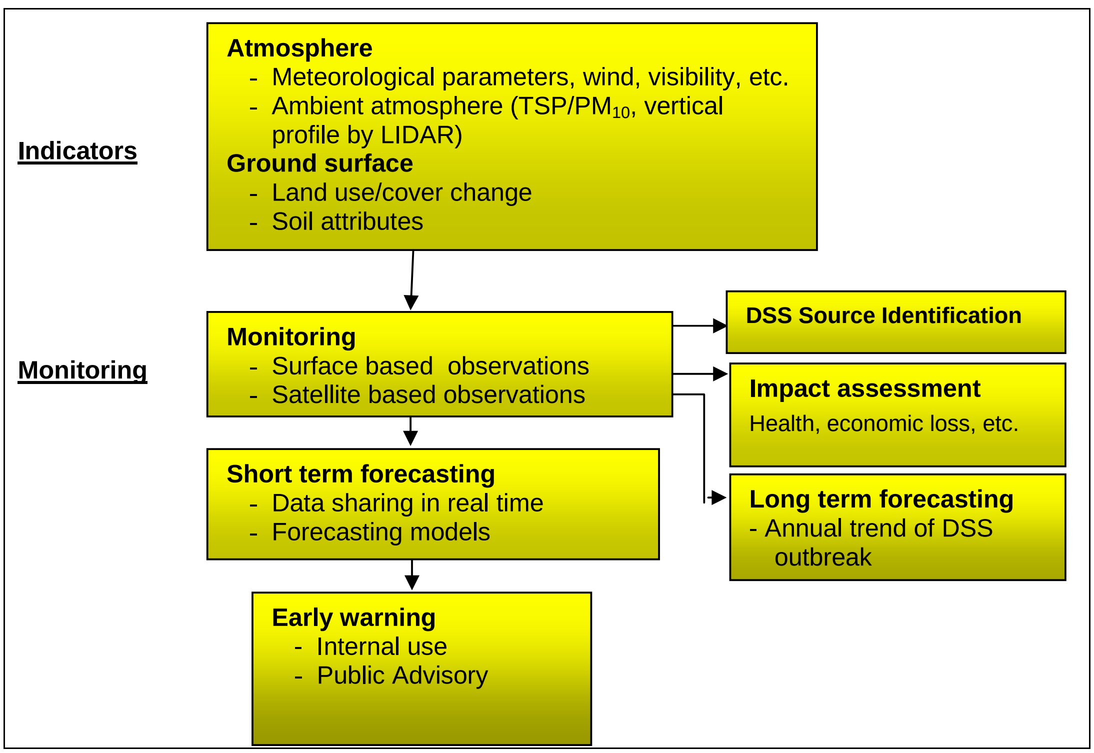
All these information belong to the basket of indicators for DSS monitoring, which are currently collected and utilized differently by partner countries. For instance, Japan and the Republic of Korea, which are relatively far from DSS originating source areas and where DSS is regarded mainly an air pollution concern, attach great importance to air quality indicators like TSP, PM_{10}, dust deposition, etc. Accordingly, significant efforts have been given in developing the monitoring instruments and techniques that can detect and monitor potential DSS impacts on air quality over a long distance for real-time data transmission like LIDAR. The Republic of Korea has also developed a PM_{10} concentration indicator based early warning system for DSS events.

In the PRC and Mongolia, where most of the DSS occurs in Northeast Asia, visibility is considered the most widely used indicator, given the tangible nature of DSS and the meteorological observation capacity in these countries. Collection of relevant meteorological observation started quite early in both these countries and they have established corresponding data sets. Based on such a data set, the PRC has achieved progress in the studies on characteristics and regularities of DSS, which forms the basis of their simulation and modeling of DSS events and early warning services.

3.3 Common Monitoring Indicators

The challenge in establishing a reasonable set of common monitoring indicators rests on the manner of accommodating the different needs (or "preference") among the partner countries without compromising the technical/operational feasibility of the proposed regional network, particularly at its initial stage. The monitoring indicators included in the core basket for cross-country exchange within the network need to be: (a) relevant to forecast models in all the partner countries, (b) readily available or which can be made available with minimal investment, and (c) capable for real time transmission from one country to another along the identified DSS transport routes in Northeast Asia.

The following chart illustrates the course towards establishing a regional monitoring network.



The purpose of the regional monitoring network was confirmed to focus on short-term forecasting for early warning. It was agreed that other purposes for a regional monitoring network such as long-term forecasting would be the focus in the next step with necessary expansion of the network.

Further, through extensive and comprehensive discussions by the experts and researchers from the partner countries involved in the project, the partner countries agreed that the initial monitoring indicators for an effective short-term forecasting for the regional network should comprise of:

(a) Instrument-measured visibility;
(b) PM_{10} (particulate matters with diameter smaller than 10 μm); and
(c) LIDAR-based observation data[2].(vertical profile of dust cloud by Light Detection and Ranging)

There are differences in the relative importance each partner country has given to individual monitoring indicators. The existence these differences do not prohibit, however, the partner countries from reaching an agreement on working with such a set of the commonly agreed DSS monitoring indicators for the regional network.

3.4 Regional Network of DSS Monitoring Stations

The objective of the regional monitoring network is to have a hierarchy of monitoring stations from the source areas in Mongolia and northern provinces of the People's Republic of China (across the Yellow Sea and the Democratic People's Republic of Korea area) to the Republic of Korea and Japan for effective early warning. Ideally, such network could make it possible for leeward forecasters to make rolling forecasts by incorporating data from windward monitoring stations. The network would also be advantageous for windward forecasters because the validation of their short-term forecasting methods will be greatly enhanced if there is progressive feedback from leeward forecasters.

Real time data that can be used for short-term forecasting or early warning comes from the results of monitoring the identified three common indicators as well as the basic meteorological observation data. Based on these four data sources and the geographical importance of the stations for forecasting and early warning, a hierarchy of network monitoring stations was proposed as follows:

(a) Class-A Network Monitoring Stations

Class A stations are the *key stations* of the regional network since they are geographically important (e.g., located in DSS source areas). These stations have (or are going to have) the capability to measure all four data in real time. There are currently a few stations in this category that are fully equipped in the People's Republic of China and none in Mongolia. Visibility, PM_{10}, and LIDAR allows Class A Stations to provide real time data on spatial distributions and vertical profile of an ongoing DSS, which have special importance for the remote forecast centers to capture the physical details of a DSS event for simulation and early warning. It is crucial for the regional network to ensure data exchange in real time between the partner countries, or among these stations that are fully equipped.

(b) Class-B Network Monitoring Stations

Class B stations comprise of the *general stations* in the regional network that can monitor and report PM_{10} data in real time over a long distance, in addition to reporting visibility data. The important feature of these stations is their capability to measure

[2] An agreement reached during the Second Workshop on DSS Regional Monitoring and Early Warning Network in November 2003.

suspended particles like PM_{10} (and TSP by batch sampling). PM_{10} data is essential to measure air quality. The data from these stations together with those from the Class A stations are vital for DSS simulation and modeling at remote forecast centers because it can be monitored in real time. Not all the designated Class B stations in the network have the capacity to measure dust particle concentration. It will take time to upgrade the monitoring capacity of these existing stations, particularly those in Mongolia where there is none capable of monitoring PM_{10}.

The list of monitoring stations of each partner country that is proposed for the regional DSS network is shown in Table 3.1. In phase one, all the stations have been identified for the network while the proposed stations for the Republic of Korea and Japan for phase two are still to be identified and confirmed by authorities of each country. For the PRC, selected stations with LIDAR capacity/potential would be included in the DSS monitoring network, but the time of their inclusion will be decided based on resources availability and agreement with concerned parties.

3.5 Proposed Phases of Development

A phased program offers a practical approach for the development of the regional monitoring network especially under the circumstance of limited funds and resources. Moreover, the phased development need not be thought of as a rigid sequence where each phase is completed before the next begins. An alternative way to look at the phased approach is to acknowledge that the priority is to implement each phase's activities as soon as possible. Each phase described below has its own time span to reach its specified goal and the opportunity for equipment upgrades, capacity building, and network augmentation is a continuing one. The proposed three phases of development are as follows:

Phase-1 (short term): Data sharing with the existing monitoring capacity

In this phase, the network of monitoring stations is identified (25 in the People's Republic of China and 6 in Mongolia, plus designated stations in the Republic of Korea and Japan) and arrangements will be finalized to allow data sharing in real time. A decentralized network is preferred with data sharing for the purpose of short-term forecasting. Priority is given to gathering instrumented visibility reading, PM_{10} data and LIDAR at selected stations in a step wise approach in accordance with each country's national priorities.

Phase-2 (medium term): Strengthening of monitoring capacity

This phase involves the expansion of the number of monitoring stations in the network (additional of 18 in People's Republic of China and 12 in Mongolia) and upgrading of equipment at selected monitoring stations of the network.

Phase-3 (long term): Strengthening of forecasting and early warning capacity

This phase will focus on improvement in forecasting methods (including software development, training, and capacity building) to provide both short-term (early warning) and long-term (seasonal) predictions. Long term forecasting will depend heavily on data derived from ground surface monitoring and on verification of prediction model output.

Table 3.1 Proposed Monitoring Stations for the DSS Regional Network

Phase	Country	Site	Class 1/	Current Instrumented Capacity 2/				
				Visibility	TSP	PM_{10}	LIDAR	AWS
Phase 1	PRC (Upstream Country)	Jiuquan	B		✓			
		Minxian	B					
		Germud	B					
		Lanzhou	B					
		Yinchuan	B					
		Houma	B					
		Datong	A					
		Zhangjiakou	B			✓		
		Erlianhaote	B		✓			
		Huhehaote	A			✓	✓	
		Neimeng-Zhurihe	B					
		Dianjiang	B					
		Nanyang	B					
		Shenyang	B			✓		
		Changchun	B			✓		
		Beijing	A		✓	✓	✓	
		Qingdao	B			✓		
		Zhengzhou	A					
		Lianyungang	B					
		Akesu	B					
		Bayannuoergong	A					
		Xingzi	B					
		Baicheng	B					
		Donggang	B					
		Suniteyouqi	B					
	Mongolia (Upstream Country)	GobiAltai – Altai	B					✓
		Dornod – Choibalsan	B					✓
		Dornogobi – Sain Shand	A					✓
		Umnogobi – Dalanzadgad	A					✓
		Uvs – Ulaangom	B					✓
		Ulaanbaatar	A					✓
	Japan 3/ (Down-stream Country)	Sapporo	A	✓	✓	✓	✓	✓
		Toyama	A	✓	✓	✓	✓	✓
		Tsukuba	A	✓	✓	✓	✓	✓
		Fukue	A	✓	✓	✓	✓	✓
		Nagasaki	A	✓	✓	✓	✓	✓
		Miyako	A	✓	✓	✓	✓	✓
		Matsue	A	✓	✓	✓	(✓)	✓
		Niigata, Maki	B	✓	✓	✓		✓
		Tateyama (Toyama)	B	✓	✓	✓		✓
		Inuyama	B	✓	✓	✓		✓
		Fukuoka	B	✓	✓	✓		✓
		Ryori	B	✓			✓	✓

1/ Class A stations should be equipped with visibility-measured instrument, PM_{10} equipment, and LIDAR. Class B stations should be equipped with visibility-measured and PM_{10} instruments.

2/ ✓ means with existing equipment, and (✓) are to be equipped in 2005. It should be noted that the designated monitoring indicators for the regional network are only visibility, PM_{10}, and LIDAR. TSP and AWS are shown here as references for current capability.

3/ The number of stations for Japan are subject for increase in the near future.

(Cont. Table 3.1)

Phase	Country	Site	Class[1/]	Current Instrumented Capacity [2/]				
				Visibi-lity	TSP	PM_{10}	LIDAR	AWS
Phase 1	Republic of Korea (Down-stream Country)	Incheon – Incheon	A				✓	✓
		Chungcheongnamdo – Gwangdeoksan	B		✓	✓		✓
		Incheon – Bakryengdo	B		✓	✓		✓
		Seol – Gwanaksan	B		✓	✓		✓
		Chungcheongnamdo – Anmyundo	A		✓	✓	✓	✓
		Chungcheongbukdo – Chupungryeng	B		✓	✓		✓
		Jeollabukdo – Gunsan	B		✓	✓	✓	✓
		Gwangjusi – Gwangju	B		✓	✓		✓
		Jeollanamdo – Heuksando	B		✓	✓		✓
		Jejudo-Gosan	B		✓	✓		✓
		Incheon – Gangwha	A		✓	✓	✓	✓
		Chungcheongbukdo – Chunan	B		✓	✓		✓
Phase 2 [2/]	PRC (Upstream Country)	Xinjiang-Hetian	B		✓			✓
		Xinjiang-Hami	B		✓			✓
		Xinjiang-Kashi	B		✓			✓
		Xinjiang-Wulumuqi	A			✓		✓
		Xinjiang-Ruoqiang	B					✓
		Neimeng-Ejimaqi	A					✓
		Neimeng-Xilinhaote	B					✓
		Neimeng-Chifeng	B			✓		✓
		Neimeng-Wulanhaote	B					✓
		Neimeng-Hailaer	B					✓
		Qinghai-Xining	B			✓		✓
		Qinghai-Waliguan	A					✓
		Gansu-Zhangye	A		✓			✓
		Gansu-Xifeng	B					
		Shandong-Jinan	B			✓		✓
		Liaoning-Dandong	B			✓		✓
		Jiangsu-Nanjing	B			✓		✓
		Jilin-Tumen	B	✓				✓
	Mongolia (Upstream Country)	Bayankhongor – Bayankhongor	B					✓
		GobiAltai – Tooroi	B					
		Dornogobi – Khuvsugul	B					
		GobiSumber – Choir	B					✓
		Dundgobi – Mandalgobi	B					✓
		Uborkhangai – Arvaikheer	B					✓
		Umnogobi – Saikhan	B					
		Umnogobi – Gurbantes	B					
		Umnogobi – Khanbogd	B					
		Sukhbaatar - Baruun-Urt	B					✓
		Khovd – Zereg	B					
		Zavkhan – Durvuljin	B					

1/ Class A stations should be equipped with visibility-measured instrument, PM_{10} equipment, and LIDAR. Class B stations should be equipped with visibility-measured and PM_{10} instruments.

2/ ✓means with existing equipment, and (✓) are to be equipped in 2005. It should be noted that the designated monitoring indicators for the regional network are only visibility, $PM_{10,}$ and LIDAR. TSP and AWS are shown as references for current capability.

3.6 Organizational Set Up

On the whole, the establishment of a regional network for DSS monitoring, forecasting, and early warning entails the introduction of a fundamental structure within the national level of the four partner countries (i.e., the PRC, Japan, the Republic of Korea, and Mongolia) as well as on the regional level. On the national level, the Meteorological Administration (MA) and Ministry of the Environment of each partner country should be the designated national focal point where all DSS-related data will flow and be shared on real time basis. Smooth collaboration with non-MA agencies will be encouraged and improved. On the regional level, a decentralized organizational set up is deemed practical since it allows various stakeholders in the region to participate under a formal operational structure of data sharing and reporting and under the coordination and supervision of partner countries' respective national focal agency.

The review of current conditions of the four partner countries for DSS monitoring and early warning has revealed that the downstream countries of Japan and the Republic of Korea have better infrastructure and capacity for DSS monitoring and early warning. Therefore, development of the regional network at their end would entail more of the national and regional organizational arrangements to strengthen data sharing for all aspects of forecasting and early warning. The upstream countries of the PRC and Mongolia, on the other hand, are where most of the DSS events originate and occur. And yet, their infrastructure and capability (especially for Mongolia) are apparently insufficient. As such, the development plan for a Northeast Asian DSS regional network for the prevention and control of DSS initially focuses on improving and upgrading the network of monitoring stations as well as on capability building for DSS monitoring and early warning in these countries.

3.7 Implementation Plan

Speedy operationalization and quality performance of the network will depend on the level of skills the national coordinators possess and the efficacy of the communications between the national coordinators and the members, partners, and other stakeholders and the regional support structures including the UNEP, the UNESCAP, and others. The operationalization of the network would also depend on the commitment of the various country parties on the formulation of well-focused program of work. As such, the key elements of a program to implement the regional network for DSS are set out in Box 3.1 while Table 3.2 lists the recommendations for the overall phased development with the corresponding action plan involving all four partner countries within the purview of a regional network.

Box 3.1 Key Elements of a Program to Implement the Regional Network for DSS

(a) Develop the framework for the conduct of assessment and monitoring of DSS related events (including early warning) at regional, sub-regional, and national levels using in combination the various systems of information technologies and space-based technologies;
(b) Support a national focal point/agency to enhance and improve the linkage of national databases with regional and sub-regional databases applying digital and communication technology;
(c) Develop a regional framework for the conduct of joint or collaborative information gathering and database consolidation for scientific information on DSS related matters, including desertification control;
(d) Formulate programs that will provide for analysis and interpretation of data into usable form;
(e) Encourage the use of information generated by the network and devise systems for the transfer of this information to decision makers and relevant end users (including citizens of affected areas); and
(f) Develop training and research programs for capacity building at the national level.

Preliminary discussions during meetings with scientists and administrators in each of the four partner countries formed the basis of the proposed action plan. Some actions have a suggested time-frame while others are a continuing concern. Some require considerable reorganization while others would be relatively simple to implement.

Table 3.2 Development Program for a Regional Network for DSS

Phase	Recommended Projects	Action Plan
Phase 1 (6 – 12 mos.)	Establishment of Data Sharing Mechanism in Real Time for Short Term Forecasting	(a) Determine the national focal point/agency within each partner country's national DSS monitoring network; (b) Get agreement on the proposed hierarchy of monitoring stations to designate Class A and B stations and assess the cost of upgrading equipment and data transmission (where required). (c) Develop a set of common guidelines to govern the linkages among the national participating institutions and delineate the scope to which the DSS network can utilize the information. All national network members should bear the responsibility for providing their respective DSS monitoring and assessment information to the national focal point. (d) Hold a region-wide technical workshop regarding the construction of DSS network technologies to get agreement on which to use and how. Agree on the common language(s) to be used. (e) Conduct a survey within each partner country to determine the types and patterns of fields in the database to define the content and format of the information to be exchanged in the Meta databases with uniform criteria and formats for DSS monitoring and early warning. (f) Organize one Asian regional workshop with the objective of exchanging information and comparing notes. This workshop should be followed by a study tour of the PRC and Mongolia to allow participants to visit the field monitoring stations and view local conditions in the source areas.
	Enhance Scientific and Technological Cooperation and Exchange	(a) Organize an international symposium aimed at facilitating the exchange of ideas and experiences regarding monitoring and assessment and early warning. (b) Organize a study tour of selected country that is advanced in DSS monitoring modeling. The study tour participants should be relevant personnel of the network. (c) Capacity building such as training, dispatching of experts, or other activities (though already included in Phase 3 of the current phased development configuration) should be launched as soon as possible if and when resources become available.
Phase 2 (3 years)	Expansion of the Regional Monitoring Network	(a) Identify potential funding sources from national and international (including bilateral and multilateral) agencies and private sector. Identify mechanisms and manner to raise and distribute funds (e.g., Trusts, Foundation, etc.). (b) Expand the network by identifying new sites and upgrading others through the installation of new dust monitoring equipment.
Phase 3 (3 - 5 years)	Capacity Building	(a) Upgrade the forecasting technology and modeling capacity in all partner countries, especially in Mongolia. (b) Improve infrastructure and support facilities to support national DSS related activities (training courses, study tours, production of manuals, etc.). (c) Strengthen data management capacity and improve efficiency of network communication of the national DSS centers. Specific activities will include: i) increasing the response speed and information handling capacity of the web servers; ii) expanding data storage capacities of the database servers as well as increasing rate of e-connectivity; and iii) securing authorization from relevant authorities for the designated agency to take charge of the national network's day-to-day operation.

DSS forecasting and early warning system in source areas play an important role in coping with the disaster impact of DSS in advance. On the other hand, in downstream partner countries of DSS should assess the impact on air quality by DSS. Therefore, the predicting system for the concentration and deposition in PM_{10} in the Republic of Korea and Japan during DSS event or afterward should be implemented and developed in line with forecasting and early warning system.

Getting the structure right includes training and other capacity building measures. As such, capacity building is an ongoing or continuing action found in all phases of developing the Northeast Asia DSS network. This includes training, experience sharing workshops, and field visits to the monitoring sites. While the exchange of data and ideas through networking is an important element of the network, exchange visits will be crucial because there is simply no substitution for human interaction.

3.8 Estimated Cost

As mentioned, the physical development of the monitoring network focuses on developing and improving the monitoring stations in the PRC and Mongolia. Table 3.3 presents the recommended phased development of the stations in these two partner countries with corresponding preliminary costs.

Table 3.3 Estimated Costs for the Development of Network Monitoring Stations in the PRC and Mongolia

Country	Phase[1]	No. of Stations Covered	Recommended Activities	Estimated Cost ('000 US$)
PRC	1	Initial 25	• Establish national focal agency and integrate identified monitoring station in the network. • Purchase and install needed hardware and software for instrument-measured visibility, TSP, PM_{10}, and LIDAR for identified stations. • Upgrade communication network.	4,916.90
	2	Add'l. 18	• Expand network of monitoring stations. • Purchase and install needed hardware and software.	3,260.10
	3		• Introduce long term DSS forecasting capacity by remote sensing (annual trend).	3,130.00
Mongolia	1	Initial 6	• Establish a national focal point and integrate identified stations in the network. • Purchase and install AWS, TSP, PM_{10}, visibility sensors, soil moisture sensors, and LIDAR for identified stations. • Construct ground monitoring stations. • Establish and improve communication facilities/network.	8,340.95
	2	Add'l. 12	• Expand network of monitoring stations. • Purchase and install AWS, visibility sensors, soil moisture sensors, and PM_{10}.	1,611.60
	3		• Capability building for DSS modeling, simulation and forecasting by remote sensing.	1,923.80

[1] Phase 1 – short term; Phase 2 – medium term; and Phase 3 – long term.

3.9 Cooperation with Other Regional and International Organizations

As a transboundary problem it is clear that government-to-government agreements could be put in place. One of the important obligations of the regional network for DSS and its host institution(s) is to coordinate network-building efforts and provide specific technological assistance and guidance. Programs will be designed for promoting the role of science and technology in preventing and controlling DSS, on the one hand, and blending indigenous knowledge and modern science and technology, on the other, especially in the early warning system.

The launching of the proposed regional network for DSS would provide opportunities for members of the international community to put in concrete terms scientific cooperation against DSS in Northeast Asia. In particular, interested, affected, and developed country parties will be able to work more closely and effectively, within the framework of the regional network, with international regional and sub-regional organizations. Reference can be made to the existing WMO network and to the Acid Deposition Monitoring Network in East Asia and the contributions that each of the partner countries makes now. Opportunities exist to further enhance these linkages and extend them to cooperation in the Asia-Pacific region (including Australia and other relevant countries), the USA and Central Asia. Close cooperation with existing networks and programs on long-range transboundary air pollution in Northeast Asia should be maintained.

4. DEMONSTRATION PROJECTS FOR THE PREVENTION AND CONTROL OF DUST AND SANDSTORMS

4.1 Rationale

DSS has an enormous damaging effect on the environment, economy, and society in the countries of the Northeast Asian region. The cost of damages is, by and large, a function of the intensity of DSS events as well as the values at risk. Direct damage cost caused by DSS include loss of crops and livestock, loss of topsoil, damage to property, industries and businesses, critical facilities and infrastructure, disruption to transportation systems, road accidents, and closures of schools and services. Indirect damage cost of DSS include: increased medical costs, impact on human health, costs of cleaning residential and commercial buildings, repair and reconstruction costs, and wear and tear on machinery and equipment due to DSS. Chinese researchers[1] estimated that land degradation costs their nation approximately US$6.7 billion each year, and the indirect costs of damages are 4.5 times that of the direct costs. The costs of damages associated with DSS in the PRC alone are estimated to range from US$70 million to US$239 million per year.

Stepping up DSS prevention and control is justified, given the enormous damage costs by DSS and the urgent need to reduce the frequency and severity of DSS. The benefits of anti-DSS efforts include the reduction in economic losses and the restoration of damaged ecosystems. Above all, the most important benefits are the higher standards of living for millions of people in the DSS source areas and pathways as well as the improved public health and safety in all DSS-affected areas. First and foremost, the impact of DSS on human health is of great concern in DSS source areas as well as along the DSS transport routes downwind. Given the high population density of metropolitan centers, health concern with DSS is particularly high.

4.2 Lessons Learned

Mongolia and the PRC have formulated their respective National Action Programs to combat desertification. Due to political commitment and increase in budgetary allocations to desertification control on the part of the central government in each country and technical and financial assistance from a number of donor agencies, some best practices and mitigation approaches have emerged, and a few lessons have been learned as follows:

- The realization that DSS is non-point source and serious transboundary environmental problem, which requires an integrated regional approach. Moreover, a coordinated regional approach is needed in tandem with national initiatives.
- There is need to undertake interventions and remedial actions on a scale that is commensurate with the scale of the DSS–source areas.
- A cross-sectoral approach in combating desertification is more likely to achieve desired results. Likewise, undertaking one activity in isolation (e.g., only the planting of trees) will not solve the DSS problem.
- It is essential for all stakeholders (particularly the local community in the source areas) to work together for DSS reduction. Varying responsibilities are required from the national government, local governments, and local communities.
- It is possible to develop packages of measures that can be applied at reasonable cost over large areas.

[1] Lu Qi and Wu Bo, 2002 Population, Resources and Environment in China 12(2): 29-33.

4.3 Investment Strategy for Demonstration Projects

In the context of existing international, regional and national frameworks for the control of land degradation, environmental protection, and sustainable development at large, an investment strategy for DSS prevention and control is being proposed. The strategy aims at safeguarding the environmental, economic and social sustainability of the Northeast Asian region at a broad level, and envisages improving the health, safety and welfare of the peoples in DSS source areas, pathways and impacted downwind locations. The goals, priorities and scope of investment strategy have been proposed taking into consideration:

- Feasibility;
- Affordability;
- Sustainability;
- Novel approaches and methodologies; and
- Ongoing policy/institutional initiatives.

The situation in the PRC and in Mongolia is somewhat different. Therefore, the investment component of the strategy for each country will be quite different. The PRC is a partner with ADB/GEF under OP12. Over the next 10 years US$1.5 billion will be spent on projects aimed principally at combating land degradation and alleviating poverty. The aims of this effort are complementary with the aims of the DSS prevention and control proposal. Therefore, the PRC should align and tailor its program of evaluating the actions/measures to prevent and control DSS in line with the projects being developed under GEF's OP-12. Moreover, the resolution of *cross boundary issues* requires further international cooperation to augment the bilateral programs and partnerships.

Interventions and actions under the investment strategy to be undertaken on a scale that is commensurate with the size of the DSS source areas and values at risk in DSS-impacted areas. A package that comprises a hierarchy of measures at national/provincial and local levels needs to be designed as follows:

- administrative and policy measures that are applicable over an entire administrative unit and may require action at national or provincial level; and
- measures restricted to specific sites.

Elements of the package in the first category may include the revision of legislative, policy and administrative regulations to relieve the pressures that cause land degradation, technical measures for revegetation of degraded lands using methods such as grassland fencing and exclusion of grazing, and capacity building, training and extension services. Many of the technical approaches are proven to be effective in reducing DSS, but the optimum combination of elements needs to be determined. In the second category measures will be unique to specific field sites although some of these may be applied across a range of ecological conditions.

4.3.1 Selection of Demonstration Sites

In tackling the identified anthropogenic factors in DSS source areas, initially, attention will need to be given to focus areas and, in the interests of cost effectiveness, a demonstration project approach is recommended. The rationale for adopting a demonstration project approach in focus areas is threefold. *First*, the projects are relevant to government mandates, and they can be aligned with existing and emerging priorities of the government and responsive to other related issues, such as public health and safety. *Second*, they can be designed and programmed to suit diverse local conditions, operational requirements and the availability of financial resources and implementation capacities. *Third*, they help provide value adding and generating results within a reasonable timeframe - the demonstration sites will serve as a test bed for evaluating the appropriateness of the technical measures, innovative trials, and institutional arrangements and policies.

The choice of the focus areas for the demonstration projects is the responsibility of the respective governments in the PRC and Mongolia. The selection of these areas should follow a set of criteria as outlined in the table below.

Table 4.1 Criteria for Selecting Demonstration Project Sites

	Criteria
General	• Criteria should be general enough to be used for future project development. • A guiding principle is that land in the process of degradation should be included in the chosen sites. • The project design should entail a comprehensive, integrated approach. • The demonstration projects should have synergy with ongoing work undertaken by local government and communities. • Local stakeholders should be involved in site selection and project implementation, that is, using a bottom up approach. • The recommended sites should be incorporated into each country's NAP. Alternatively, the recommended demonstration projects could be associated with key areas of provincial-level projects that tackle the same issues. • Local experiences and achievements in both technical and policy aspects of land management will be especially valuable in selection and design of the demonstration projects. • These sites must be located in DSS source areas or along the pathways and have an acceptable level of accessibility to the site from abroad. • The demonstration sites should be representative of different natural conditions
Additional	• State of land degradation should be substantial in extent and quantifiable by appropriate indicators that enable scientists to determine the original vegetation level. • Land degradation should be caused by human activity. • Land degradation is currently contributing to the increase of DSS events • Appropriate monitoring is possible to evaluate the effectiveness of DSS measures.
Specific	**Scope** - size of a project site generally greater than 10,000 ha. - components to be tested and demonstrated should be site specific. - focus areas should have a range of land forms, types and uses. - duration should be minimum of 5 years. **Purpose** - environmental - economic (cost effective) - sociological - replicable - contributing to poverty reduction. Livelihood: - The choice of livelihood should be indicated (continue to use land, not to use land, or find another livelihood for the local people; resettlement; etc.) Land Use: - Crop land: Cultivating methods, which avoid bare land between the months of February and April will be introduced. - Grazing land: Measures to avoid over-grazing will be inrtroduced. - Protected area: Enclosure, revegetation, and choice of plan species will be considered. Water Resource: - Estimation of available water resources and the distribution of limited resource will be considered. - Current water table and the appropriate level will be considered. - Control measures against over exploitation of ground water will be introduced. Estimation of the Effects: - The influence of DSS measures to the parameters, which describe dust entrainment will be quantified. - Estimation of the effectiveness of DSS measures by controlling simulation model parameters, which describe dust entrainment. Evaluation of the Demonstration: - The items and methodologies of DSS baseline data monitoring will be indicated. - Both detailed evaluation for the extent of DSS reduction and development of simple monitoring method for routine work will be needed. - Continuous (long span) monitoring to evaluate DSS reduction by using simple method will be needed.

The respective governments in the PRC and in Mongolia have nominated four focus areas within their territory and one cross-border site. Each is in a known DSS source area and/or in the pathway of DSS and all are characterized by poor ecological conditions due to a combination of natural and human-induced causes. The bio-physical, ecological, and socio-economic profile of each focus area has been described in *Volume 3 - Investment Strategy for DSS Prevention and Mitigation through Demonstration Projects* of this report. The focus areas were selected on the basis that they were representative of different ecosystems and as such presented an array of land uses, population densities, household livelihood strategies. Some actions/measures will be unique to some focus areas but others could be evaluated across a range of ecosystems. There is also a hierarchy of actions/measures. At the level of the province or *aimag* in Mongolia, there may be administrative or policy measures that apply over the whole administrative unit, whilst some actions/measures will be restricted to a specific site. Some sites will be large (10,000 ha for some rangeland components) but others such as alternative energy (wind and solar) may occupy <1 ha.

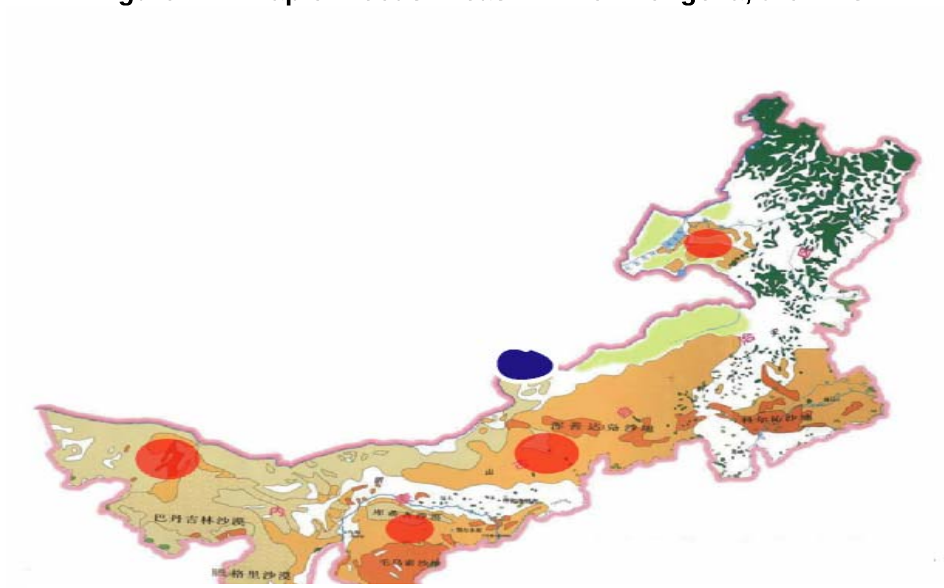
4.3.2 Proposed Focus Areas for Demonstration Projects in the PRC

Although DSS are known to originate in several places in western and northern the PRC, it was the decision of the Government of the PRC to restrict the choice of focus area for each demonstration project to Inner Mongolia Autonomous Region. The four focus areas for the demonstration projects (Alashan, Ordos Plateau, Xilingol and Hulunbuir) are located along a 1,500 km west-east transect that samples the various environments in the DSS source areas. These areas represent four important grassland ecozones, namely, Hulunbuir for mountainous meadow grasslands, Xilingol for typical grasslands, Ordos for dry grasslands, and Alashan for desert grasslands. The focus areas are those that are the degraded rangelands but are reversible, given appropriate measures and timely treatment. In the west, the Alashan area is arid (annual rainfall ranging 40-200 mm). In the Ordos area (annual rainfall ranging 190-300 mm), there is a mosaic of sandy land from source-bordering dunes along the Yellow River system, sand plains on the margins of the various deserts, and Loessal hills. In Xilingol (annual rainfall of >350 mm), there are plains with loess under a layer of sand. The grasslands of Hulunbuir are on rolling plains and the rainfall is > 300 mm. The soil is underlain with deep sand of the Quaternary age. Figure 4.1 shows the location of the PRC focus areas including the area for the cross-border demonstration project.

4.3.3 Proposed Focus Areas for Demonstration Projects in Mongolia

Four focus areas were selected in Mongolia after discussions with the government officials, scientists in research institutes, and after field visits. Each of the focus areas occupies several local administrative areas and each covers a significant range of physical and human resources. The locations, administrative boundaries and some relevant data on DSS are shown in Figure 4.2.

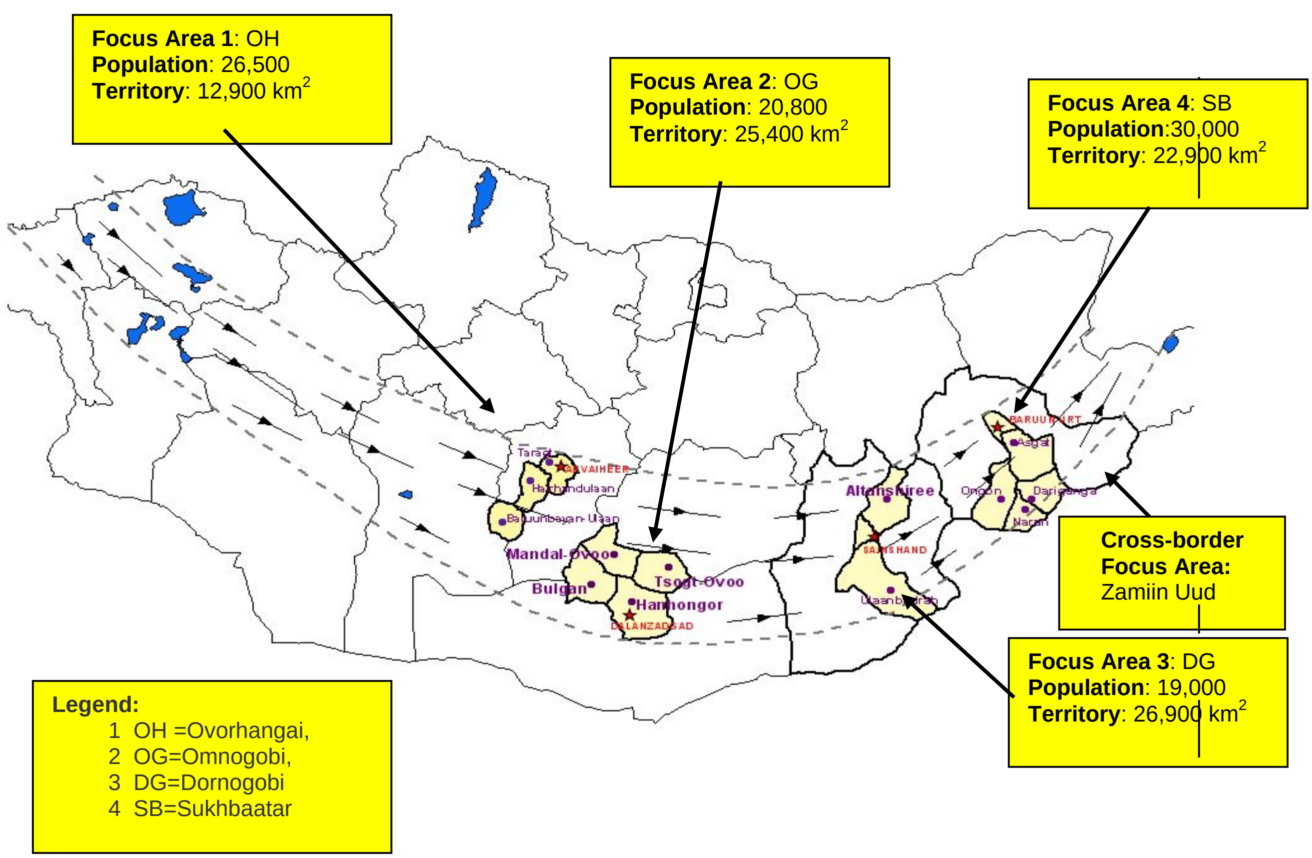
Figure 4.1 Map of Focus Areas in Inner Mongolia, the PRC



Legend:

- 🔴 Four focus areas in the PRC from west to east are Alashan, Ordos, Xilingol, and Hulunbuir
- 🔵 Cross-border focus area at Erinhot on the PRC side

Figure 4.2 Location of Focus Areas in Mongolia (including DSS path)



4.3.4 Proposed Cross-Border Demonstration Focus Area

The proposed focus area for the cross-border or sub-regional demonstration project is in the border region near Erinhot on the PRC side and Zamiin Uud on the Mongolian side (or the Erinhot-Zamiin Uud Focus Area).

Zamiin Uud focus area is located in Dornogobi *aimag*. It has a size of 12,900 km^2 and covers the entire territory of one *soum* (Zamiin Uud) It experiences the same severe climate as Erinhot and lies on the same substrate. Both communities face problems on lack of both surface and ground water. The particular challenge that the geographic location, climate, and general lack of natural resources poses have been addressed in different ways by the people on each side of the border.

In the PRC, much emphasis has been placed on ameliorating the environment through a combination of measures. The banning of grazing within a 10-km radius of the city center, planting of wind breaks and other protection forestry, and innovative uses of waste water (including sewerage) are some of the measures implemented. Technology transfer may be possible so that the Mongolian side can benefit from the lessons learned and techniques perfected by the PRC side.

There is a clear need for involvement in this subregional project by experts from the four partner countries. Potentially, the joint cross-border site should be an especially useful way to validate the ideas and approaches of many stakeholders. A training center should be established to facilitate exchange of technical know-how among the four partner countries. Likewise, a hi-tech plant nursery and plant propagation facility should be constructed. Mongolia recommended that attention be also given to fostering ecotourism with strict environmental safeguard controls in the Gobi regions on the Mongolian side as a means to provide alternative livelihood.

4.4 Proposed Activities and Investment Requirements

4.4.1 Project Activities in Focus Areas of the PRC

Table 4.2 sets out a summary of the major proposed actions/measures for each of the Focus areas in the PRC.

Table 4.2 Summary of Proposed Actions for Focus Areas in the PRC

Items \ Sites		Alashan	Ordos	Xilingol	Hulunbuir
Combating land degradation to prevent and control DSS	Prevention	Cropland conversion to forest/ grassland		Documentation of protection measures	
	Rehabilitation	Rangeland management	• Airseeding • Enclosure	Rangeland management	• Rangeland management • Enclosure
	Development	• Desert-based industries • Alternative energy sources	• Desert-based industries • Ecotourism[1]	• Artificial grassland management	• Artificial and natural grassland management • Alternative energy sources
Capacity Building to implement measures for DSS prevention and control		• Training Center for alternative skills • Capacity building for local government	Capacity building of local government	• Training Center for alternative skills • Capacity building for local government	• Training Base for grassland management • Capacity building for local government
Poverty Alleviation to reduce pressure on land and reduce dust entrainment		Solar/wind-power energy[2]	Better practices for fodder plantations	Better practices for fodder plantations	• Better practices for fodder plantations • Solar/wind power energy[2]
Social Development to improve livelihoods, reduce dependence on farming and animal husbandry, improve infrastructure		Develop off-rangeland skills		Develop off-rangeland skills	

[1] Ecotourism should be dealt within the environmental carrying capacity of the area with strict environmental safeguard controls.

[2] Introduction of renewable energy and other fuel-efficient cooking methods can reduce pressure on woody plants that should be left in place to stabilize the soil surface.

Based on the proposed actions/measures or project activities intended for each focus area in the PRC, an indicative cost and corresponding coverage is shown in Table 4.3.

Table 4.3 Indicative Costs and Coverage of Project Activities in the PRC

Area	Activity	Cost US$ Million	Coverage
Alashan	Rangeland Management	2	50,000 ha (includes training, capacity building, production of manuals, video, and posters)
	Private Sector-Desert based industries	1	10,000 ha
	Alternative Energy sources	5 – 10	5,000 -10,000 ha
	Skills training for Alternative Livelihood	3	500 persons (includes establishment, equipment ,and staffing)
	Capacity building for local government	1	100-150 cadre over 5 years
	Sub-total	**12.0 – 17.0**	
Ordos Plateau	Capacity building for local government	1	100–150 cadre over 5 years
	Desert based industries (Development Models)	20	50,000 – 100,000 ha
	Air seeding techniques	1	100,000 ha
	Fencing techniques	-	-
	Artificial grassland and shrub plantation	0.2	2,000 ha
	Sub-total	**22.2**	
Xilingol	Integrated package for area protection	0.5	25,000 ha
	Capacity building of local government	1	100-150 cadre over 5 years
	Skills training for resettled herders	3	500 persons
	Artificial grassland and shrub plantation	0.2	2,000 ha
	Rangeland Management	2	50,000 ha
	Sub-total	**6.7**	
Hulunbuir	Rangeland Management	2	50,000 ha (includes training, capacity building, production of manuals, video, and posters)
	Artificial grassland	0.2	2,000 ha
	Planting Chinese Pine	0.5	10,000 ha
	Alternative energy sources	10	5,000-10,000 ha
	Capacity building for local government	1	100-150 cadre over 5 years
	Fencing techniques	-	-
	Awareness campaign	2	100,000 ha
	Sub-total	**15.7**	

4.4.2 Project Activities in Focus Areas of Mongolia

Table 4.4 sets out a summary of the major proposed actions/measures for each of the focus areas in Mongolia.

Table 4.4 Summary of Proposed Actions for Focus Areas in Mongolia

Items \ Sites		Ovorhangai	Omnogobi	Sukhbaatar	Dornogobi
Combating land degradation to prevent and control DSS	Prevention		Plant trees to stabilize sand movement around *soums*	• Strengthen Darganga Natural Park • Plant trees to stabilize sand movement	Windbreaks along roads and railways
	Rehabilitation	• Rangeland management • Enclosure	Rangeland management	Rangeland management	Rangeland management
	Development	• Develop ecologically responsible mining • Renewable energy sources	Renewable energy sources		
Capacity Building to implement measures for DSS prevention and control		Capacity building of local government	Capacity building of local government	• Capacity building of local government • Awareness campaign	Capacity building for local government
Poverty Alleviation to reduce pressure on land and reduce dust entrainment		Renewable energy use			Strengthen environment sound poverty reduction policies and programs
Social Development to improve livelihoods, reduce dependence on animal husbandry, improve infrastructure			Develop Alternative Energy		Infrastructure and technology development

Based on the proposed actions/measures or project activities intended for each focus area in Mongolia, an indicative cost and corresponding coverage is set out in Table 4.5.

Table 4.5 Indicative Costs and Coverage of Project Activities in Mongolia

Area	Activity	Cost US$ Million	Coverage
Ovorhangai	Use of environment friendly technology for gold mining	0.7	100,000 ha per year
	Rangeland Management	1	100,000 ha. (includes training, capacity building, production of manuals, video and posters)
	Use of renewable energy resources	1 – 1.5	50 households per year
	Capacity building of local government.	1	100-150 cadre over 5 years
	Artificial grassland plantation	0.2	
	Sub-total	**3.9 – 4.4**	

(Cont. Table 4.5)

Area	Activity	Cost US$ Million	Coverage
Omnogobi	Rangeland Management.	1	100,000 ha (includes training, capacity building, production of manuals, video, and posters)
	Tree planting	1	100,000 ha
	Use of renewable energy sources	1 – 1.5	50 households/year
	Capacity building of local government	1	50-100 cadre over 5 years
	Sub-total	**4.0 – 4.5**	
Sukhbaatar	Strengthen Darganga Natural Park	0.3	20,000 per year
	Rangeland Management	1	100,000 ha (includes training, capacity building, production of manuals, video, and posters)
	Plant Trees to Stop Sand Movement	0.6	50,000 ha
	Capacity building of local government.	1	50-100 cadre over 5 years
	Awareness campaign	0.5	100,000 ha
	Sub-total	**3.4**	
Dornogobi	Windbreaks along roads and railways	0.5	253 ha per year
	Rangeland Management	1	100,000 ha (includes training, capacity building, production of manuals, video, and posters)
	Capacity building of local government	1	50-100 cadre over 5 years
	Strengthen of poverty-environment policies	1	Shainshand *soum* center
	Sub-total	**3.5**	

4.4.3 Project Activities in the Cross-Border Focus Area

The proposed major project activities for the cross-border focus area are given in the table below.

Table 4.6 Summary of Proposed Actions for Cross-border Focus Area

Items \ Sites		Erinhot-Zamiin Uud
Combating land degradation to prevent and control DSS	Prevention	Rangeland and livestock management
	Rehabilitation	Revegetation and tree planting
	Development	• Waste water re-use; Model forest planting with waste water irrigation • Alternative energy
Capacity Building to implement measures for DSS prevention and control		Training center for traditional and hi-tech nursery facility; training of local government officials
Poverty Alleviation to reduce pressure on land and reduce dust entrainment		Ecotourism[1/]
Social Development to improve livelihoods, reduce dependence on farming and animal husbandry, improve infrastructure		Awareness campaign for stakeholders

[1] Ecotourism should be dealt within the environmental carrying capacity of the area with strict environmental safeguard controls.

Table 4.7 Indicative Costs and Coverage of Project Activities in Cross-border Site

Area	Activity	Cost US$ Million	Coverage
Erinhot – Zamiin Uud	Hi-tech nursery and plant propagation facility	0.5	Area size variable; training of 100 technicians per year.
	Establish international training center	0.5	Training of 200 technicians per year
	Use of waste water	0.2	Erinhot
	Alternative energy sources	0.6	100 local herders per year
	Ecotourism [1/]	1.0	Area of a *soum*
	Rangeland/livestock management	2.0	100 households
	Windbreaks/shelter belt	0.2	500 ha
	Sub-total	**5.0**	

1/ Rationale for this is that as a cross-border focus area on the transcontinental railway, there is a steady stream of visitors seeking to experience the Gobi desert and the herders' lifestyle. Income generation from this source can reduce pressure on grazing lands.

4.5 Financing Plans

The scale of the demonstration projects is flexible and can be tailored to the available funds. Preliminary estimates for each focus area range from US$ 3 million to over US$22 million but not all of the money needs to be available at one time. Some of the proposed project components can be funded as stand-alone measures and some are candidates for private sector partnerships. Among the donor community there may be project components that more closely fit their current aid program. A possibility is to establish a regional fund dedicated to prevention and control of DSS, which could receive contributions from the participating countries (including private corporations, international agencies or organizations). The funds could be used as the seed money and could serve as a vehicle to mobilize additional funding support from other sources, public or private.

Every demonstration project has its special capital costs. A major element of each site must be the installation of appropriate monitoring systems whose intent is to measure any reduction in frequency and intensity of DSS that can be attributed to the intervention being tested. The monitoring system will vary between sites but an extra 1% can be added to the cost estimates to provide for it.

There are a few possible funding sources for DSS investments, to wit:

- **Internal sources.** There is budget allocation for environment management in different levels of the national government but not much is available for DSS investment in the PRC and Mongolia. Likewise, internal resources can be tapped from the domestic private sector, communities, and small stakeholders of the project area.

- **Bilateral Channels.** The bilateral donors such as Japan typically concentrate on funding pre-project activities and pilot project. Bilateral assistance is most often given as grants. The bilateral support from donors has an important role in insuring that the projects are well documented and well structured through support for feasibility studies and pilot projects. Without the combination of bilateral assistance for feasibility studies and pilot projects with international financing of subsequent larger scale implementation many projects with important environmental benefits would not be implemented or their scope would be significantly reduced.

- **International Financing Institutions.** Apart from bilateral donors, a number of the international financial institutions are active in connection with the financing of environmental projects in the region. The most important actors are the Asian Development Bank (ADB), the World Bank, and the European Union. There is a well-developed cooperation between the Government of Mongolia and the international financial institutions. The large international financing institutions such as the World Bank and ADB typically provide long-term loans financing large-scale investment projects. However, governments are cautious on increasing their foreign debt and are least likely to borrow funds for the purpose of combating DSS.

- **Global Environment Facility.** GEF considers DSS as a subset of land degradation. However, there is a hope that GEF would consider Mongolia's case for funding because Mongolia has never received any financing from GEF for OP 15[2]. Everybody agrees that land degradation is becoming worse and worse in Mongolia. The PRC, on the other hand, is already a partner of GEF OP 12[3] on Land Degradation in Dryland Ecosystems.

- **Private Sector Involvement.** It should be expected that the opportunities for mobilizing additional resources for environmental investments through involvement of the private sector in a Public-Private Partnership. It should increasingly be tested in both DSS affected countries and source countries in the coming years. The Government of Mongolia will be following these developments and seek to contribute constructively to ensure that such new cooperation models are implemented in a way that secures the public interest. The need to mobilize additional resources for investments in DSS prevention and mitigation leads governments and international financing institutions to consider new forms of cooperation where the private sector is involved in a Public-Private Partnership. In conclusion, both the PRC and Mongolia should mobilize significant internal and external resources for investments, which are necessary for mitigating DSS impacts in the region. .

Since a phased approach is more viable to implement, the financing plan should strictly stick to the phased approach. The project should have three phases for the next 10 years (see Table 4.6).

[2] GEF's Operational Program on Sustainable Land Management, which includes creating appropriate enabling environment, institutional strengthening, and investments.
[3] GEF's Operational Program on Integrated Ecosystem Management.

Table 4.6 Phases of DSS Prevention and Control Program

Phases and Proposed Activities	Funding Needed (US$ 000)	Funding Sources[1/]
Phase I. 2006-2007		
1. Feasibility studies	1,000	GIC, BS, PS
2. Capacity building	8,000	
3. Institutional development and policy framework	500	
4. Public awareness	500	
Subtotal	10,000	
Phase II. 2008-2010		
1. Implementation of pilot projects (Zamiin-Uud and Erinhot)	5,000	GEF, GIC, PS, BS
2. Monitoring (equipment)	1,600	
Subtotal	17,600	
Phase III. 2010-2015		
1. Implementation of projects in three dust source areas based on the feasibility studies and lessons learnt from pilot projects.	24,000	GEF, GIC, PS, BS
2. Monitoring (equipment)	240	
Subtotal	24,240	
Grand Total	**40,840**	

1/ GIC – Government in-kind contribution; GEF – Global Environment Facility; BS – Bilateral sources; PS – Private Sector.

As part of the regional master plan to combat DSS there is a need to replicate and expand the treated area. The "package" of measures/actions that are proven to reduce the frequency and severity of DSS should be scaled up to involve an area more commensurate with the size of DSS source area.

5. WAY FORWARD

Prevention and control of DSS is a long-term endeavor that requires firm commitment and massive investment. Hence, both the establishment of the DSS regional network and the investment strategy for the demonstration projects needs to be implemented in a phased manner. The phased approach for each of the two components of the *Prevention and Control of Dust and Sandstorms in Northeast Asia Project (RETA 6068)* are presented in their respective study reports. That is, Volume 2: Establishment of a Regional Monitoring and Early Warning Network for Dust and Sandstorms in Northeast Asia, and Volume 3: An Investment Strategy for DSS Prevention and Control through Demonstration Projects.

With the completion of both studies, the participating parties (i.e., PRC, Japan, ROK, Mongolia, ADB, UNCCD, UNESCAP and UNEP) discussed a possible way for proceeding with the regional effort for addressing DSS in Northeast Asia. Initially, a follow up technical assistance can be developed to:

(a) provide continued support for the regional cooperation mechanism;
(b) provide support for capacity building for DSS monitoring and early warning; and
(c) provide support for DSS mitigation by undertaking project design and feasibility studies and by implementing selected components under the cross border demonstration project.

Moreover, a GEF package with counterpart funding from the governments can be developed for a sub-regional initiative on DSS. Likewise, the development of a video program (CD form) showing the importance of DSS prevention and control and related ongoing projects and efforts can be explored for educational purposes and presentation to other donors and DSS affected countries.

Specific ideas for capacity building, to be employed for both the strengthening of the DSS regional network and the demonstration projects, will be formalized to:

(a) develop standard operational manual for DSS monitoring and data sharing;
(b) promote exchange and sharing of DSS simulation and forecasting techniques among the partner countries;
(c) promote establishment of regional expert network and training capacities;
(d) provide on-site training for technicians and operational staff; and
(e) provide support for promoting exchange and sharing of experiences and best practices in DSS mitigation techniques.

As the next step activity of each partner country, advocacy of the master plan will be carried out to other agencies within each country. This will entail the translation of the master plan to the languages of the participating countries. Moreover, all stakeholders (e.g., J-Green[1]), including the private sector, are encouraged to carry out preparation researches and implementation activities related to DSS mitigation techniques in the demonstration project sites of this project .

[1] J-Green stands for Japan Green Resources Agency, an incorporated administrative agency under the Ministry of Agriculture, Forestry and Fisheries of Japan.

APPENDIX 1

Technical Assistance for the Prevention and Control of Dust and Sandstorms in Northeast Asia Project (RETA 6068)
(Co-financed by the Japan Special Fund and the Global Environmental Facility)

A. Purpose and Outputs

The objective of the Technical Assistance (TA) is to promote the establishment of regional cooperation ,mechanism for the prevention and control of Dust and Sandstorms (DSS) and to facilitate cooperation for and coordination among interventions by the major stakeholders in the region.

The main outputs of the TA will include (i) an initial regional institutional framework that will enable international policy and operational coordination among the major DSS stakeholders at the regional level, and (ii) a regional master plan for the alleviating DSS, based on a comprehensive assessment of scientific findings. The master plan will include, *inter alia*, (i) a phase program for establishing a regional monitoring and early warning network for DSS, and (ii) an investment strategy including recommendations on sustainable financing mechanisms and identification of eight priority demonstration projects to disseminate the best practices in addressing the causes of DSS; four in PRC and four in Mongolia.

B. Methodology and Key Activities

The TA will be implemented in the context of the ongoing joint efforts of the major DSS stakeholders in the region, including the governments of People's Republic of China, Japan, Republic of Korea and Mongolia; and four international institutions: ADB, UNESCAP, UNCCD and UNEP. These four governments and four institutions will be collectively referred to as the participating parties. The key activities under the TA fall into two major components, one for initiating an institutional framework for regional cooperation on DSS, and the other for developing a master plan for regional cooperation on alleviating DSS.

Initiating the framework. To initiate an institutional framework for regional cooperation on DSS, the participating parties will form a steering committee to be co-chaired by PRC and Mongolia. The committee will provide overall guidance for implementation of the TA. Under the steering committee, the participating parties will set up three technical committees: one for promoting a regional cooperation mechanism, to be chaired by UNCCD; one for preparing a phased program to establish a regional monitoring and early warning network for DSS and a comprehensive assessment of scientific findings, to be chaired by UNEP; and one for preparing an investment strategy for mitigation measures in DSS originating sources areas, to be chaired by UNESCAP. The membership of the technical committees will be open to all the participating parties, and other countries and institutions that can contribute, technically or financially, to alleviating DSS in the region.

By involving DSS-affected countries and international institutions in the initial regional cooperation mechanism, the TA will help establish a standardized DSS monitoring and early warning system in the region covering both DSS-originating and DSS-affected countries. The TA will also help mobilize technical, financial, and operational supports from the DSS-affected countires, international institutions, and other stakeholders to supplement the mitigation actions that have been, and will be, undertaken by the PRC and Mongolia in the DSS-originating source areas. The initial framework will provide a forum and enabling mechanism for these stakeholders to develop a more permanent institutional structure for regional cooperation on DSS that will sustain beyond the implementation period of the TA.

The major activities under the component will include (1) setting up the steering committee and organizing up to four plenary sessions of the steering committee for policy consultation and decision making, (ii) establishing the three technical committees and organizing up to four plenary sessions of each technical committee to provide technical advice and guidance, (iii) setting up a project secretariat under the guidance of the steering committee to provide operational coordination and administrative support to facilitate TA implementation, (iv) establishing and maintaining a computerized data bank for DSS for the participating parties, and (v) launching and operating a public awareness program through a project website and multimedia presentation to strengthen public awareness of the DSS and mobilize public support for alleviating DSS.

Developing a Master Plan. The master plan for regional cooperation on alleviating DSS will be developed through participatory consultation. Specific components of the draft master plan will be reviewed and cleared by the relevant technical committees and approved by the steering committee. Public participation will be facilitated through design workshops and a special web site under the public awareness program. The preparation of the phased program for establishing a regional monitoring and early warning network for DSS will include (i) organizing an international workshop for a review of the national monitoring and early warning system to identify the issue that need to be addressed in developing the program, (ii) providing a team of consultants to develop the draft program, (iii) organizing two design workshops for technical review and participatory design process, and (iv) undertaking official survey and site visits to selected DSS monitoring facilities.

For preparing the master plan and investment strategy, emphasis will be placed on examining innovative financing mechanisms to mobilize continued support from public and private stakeholders and civil society to strengthen the sustainability of the regional cooperation on combating DSS. In designing the investment strategy, special emphasis will be placed on disseminating the best practices that can offer environment friendly jobs to improve the livelihood of people in the DSS originating source area. This will be done by introducing and promoting the successful demonstration projects that have both poverty reduction and DSS mitigation effects. The major activities will include (i) providing a team of consultants to draft a master plan and an investment strategy; (ii) organizing two design workshops to present the best practices and to enable a technical review and participatory design process; (iii) organizing site visits of the officials concerned to selected pilot and anti-desertification projects in the DSS originating source areas, to identify the best practices and suitable demonstration projects; and (iv) inviting international experts as resource persons to present at the workshops best international practices for technology transfer and experience sharing.

C. Cost and Financing

The TA is estimated to cost US$ 1.215 million equivalent, comprising US$745,000 foreign exchange and US$470,000 equivalent in local currency costs. ADB will provide US$500,000 equivalent to cover US$426,400 of the foreign exchange cost and US$73,600 equivalent of the local currency cost. The TA will be financed on a grant basis from the Japan Special Fund, funded by the Government of Japan. The TA will be cofinanced by GEF on a grant basis in the amount of US$500,000 equivalent to cover US$318,600 of foreign exchange cost and US$181,400 of the local currency cost. The governments of PRC and Mongolia will finance US$125,000 equivalent and US$90,000 equivalent, respectively, to cover the in-kind expenditures for counterpart support services and office space and office facilities occurred in their countries.

D. Implementation Arrangements

The TA will be implemented over an 18 month period from January 2003 to June 2004. ADB will be the Executing Agency, responsible for overall management and administration of the TA. The TA will be implemented in cooperation with UNESCAP, UNCCD, and UNEP. UNEP, which services as the GEF implementing agency for the GEF cofinancing resources, will chair the technical committee for developing a program for establishing a regional monitoring and early warning network for DSS and comprehensively assessing the scientific findings. In this connection, UNEP will provide 12 persons months of professional services and office space, free of charge, as its in-kind contribution to the TA. UNESCAP, which services as a coexecuting agency for technical coordination, will chair the technical committee for developing an investment strategy. UNESCAP will provide 10 person months of professional services as its in-kind contribution. In cooperation with UNCCD, the TA will establish a project secretariat to provide operational and administrative support for the steering committee and ADB as Executing Agency. In this connection, UNCCD will provide 18 person months of professional services and office space, free of charge, for the project secretariat. All the three agencies of the United Nations – UNCCD, UNEP, and UNESCAP – will endeavor to mobilize, with their influence and expertise, supplementary technical and financial resources to support the TA.

The PRC Government as designated its State Development Planning Commission as the national coordination agency for the TA. The PRC Government will establish a multi-agency working group including representatives from the State Development Planning Commission, Ministry of Finance, State Environmental Protection Administration, and State Forestry Administration to guide and support the TA. The Government of Mongolia has designated the Ministry of Nature and Environment as the national coordination agency for the TA. The representatives from the Ministry of Nature and Environment, Ministry of Finance and Economy and other concerned agencies to guide and support the TA.

The TA will require about 11 person months of international consulting services in policy and strategic planning, DSS monitoring and mitigation, anti-desertification, and international investment. The TA will require about 42 person months of domestic consulting services from PRC and Mongolia in strategic planning, DSS ground monitoring, remote sensing, sandy land revegetation, and environmental management. All consultants will be selected and engaged by ADB as individuals in accordance with it *Guidelines on the Use of Consultants* and other arrangements for the selection and engagement of domestic consultants.

Logical Framework of the Technical Assistance

Design Summary	Performance Indicators/Targets	Monitoring Mechanisms	Assumptions and Risks
Goal To reduce the frequency, severity, and damage of the transboundary environmental problem of dust and sandstorms (DSSs) in Northeast Asia through regional cooperation.	Reduced damage by introducing an effective regional monitoring and early warning network. Reduced frequency and severity by arresting the land degradation in the originating source areas of DSS in the People's Republic of China (PRC) and Mongolia.	Continued monitoring of DSS and the damage reports. Continued monitoring and regular report on land degradation and improvement in the originating source area.	The frequency, severity, and damage of DSS can be reduced through well planned and coordinated public intervention. Land degradation in the DSS originating area is one of the major causes of increased DSSs in the region.
Purpose To promote establishment of a regional cooperation mechanism for prevention and control of DSS in Northeast Asia to encourage and facilitate coordinated interventions of all the stakeholders on DSS at regional level.	To establish a regional cooperation mechanism that is supported with operational capacity to coordinate interventions on DSS and to mobilize support of stakeholders for combating DSS. To prepare a regional master plan for combating DSS that will be supported with the following: (i) a phased development program for establishing a regional monitoring and early warning network for DSS (ii) an investment strategy including recommendations for sustainable financing mechanism and identification of eight demonstration projects.	All the parties involved (i.e., the PRC, Japan, Republic of Korea, and Mongolia and Asian Development Bank (ADB), United Nations Convention to Combat Desertification (UNCCD), United Nations Environment Program (UNEP), and United Nations Economic and Social Commission for Asia and Pacific (UNESCAP)) will establish a steering committee to provide overall guidance for project implementation. All the parties will also set up three technical committees to provide technical advice on specific technical issues during implementation of the technical assistance (TA).	All the four countries have the political will and policy commitment to addressing DSS through regional cooperation. All the four international institutions will cooperate with due diligence.
Outputs • An initial institutional framework for regional cooperation on DSS. • A regional master plan for regional cooperation on alleviating DSSs, which will be supported with, *inter alia*, the following: (i) a phased program to establish a well-functioning regional monitoring and early warning network for DSS, and (ii) an investment strategy including recommendations for sustainable financing mechanisms and identification of 8 demonstration projects, four in the PRC and four in Mongolia	The initial institutional framework will provide a forum and enabling mechanism for the major DSS stakeholders to coordinate their policy and intervention on DSS at a regional level. The master plan will be approved by the steering committee.	All the activities of the initial institutional framework will be under close monitoring of the major stakeholders through the steering committee. The master plan will be based on a comprehensive assessment of existing scientific findings and be developed in cooperation with the multiagency national working groups under the guidance of the national coordination agencies of PRC and Mongolia. The master plan will be reviewed by the technical committees concerned before being submitted to steering committee.	The steering committee can make decisions on policy and operational issues on behalf of the governments concerned. The technical committees concerned are capable of providing technical advice and guidance.
Activities 1. To establish (i) an initial institutional framework for regional cooperation on combating DSS; (ii) a regional data bank on DSS; and (iii) a website for the TA as part of the public awareness program. 2. To review and analyze: (i) existing scientific research findings on DSS and the	The initial institutional framework and the web site for public awareness should be in operation within one month of approval of the technical assistance (TA). The detailed work program for all the activities should be available for review and endorsement by the technical committees concerned, and for review and consideration by the steering committee at the inception meeting Findings of the review and analysis should be available for timely review by the technical committees concerned.	The work program will be reviewed by the technical committees and approved by the steering committee. Consultants are requested to submit weekly report to the project secretariat and ADB. Project secretariat will submit a monthly report to ADB, national coordination agencies, and the steering committee. Project secretariat will circulate a newsletter for information dissemination and public awareness	The governments will provide the consultants with access to the data and documents for their study. The project secretariat should be able to provide operational and administrative support to monitor and facilitate day to day operation of the field work.

Design Summary	Performance Indicators/Targets	Monitoring Mechanisms	Assumptions and Risks
existing national monitoring and forecasting systems for DSS in the region; (ii) existing national program/action programs on DSS and the national experiment/demonstration projects in PRC and Mongolia; (iii) best practices for alleviating DSSs; and (iv) initiatives from the private sector or non-government organizations. 3. To recommend a regional master plan for alleviating DSS through cooperation at regional level; the master plan should be supported with: (i) a phased program to establish a regional monitoring and early warning network for DSS, and (ii) an investment strategy including recommendations on sustainable financing mechanisms and identification of 8 demonstration projects, 4 in PRC and 4 in Mongolia		and supervision.	

APPENDIX 2

LIST OF PARTICIPATING PARTIES AND THE STUDY TEAM

1. Focal Points

GOVERNMENTS

Country	Office / Agency	Name / Designation[1]
People's Republic of China	International Department Ministry of Finance	Ms. Liu Fangyu Director, TA Division (Steering Committee Member)
	Department of Regional Economy State Development and Reform Commission	Mr. Yang Chaoguang Deputy Director General (Steering Committee Member)
Japan	Multilateral Cooperation Department Foreign Policy Bureau Ministry of Foreign Affairs	Mr. Hidenobu Sobashima Director, Global Environment Division (Steering Committee Member)
	Global Environment Bureau Ministry of Environment	Mr. Tokuya Wada / Ms. Keiko Segawa[2] Deputy Director, Global Environment Issues Division (Steering Committee Member)
Republic of Korea	Ministry of Environment	Mr. Won-min Kim Director, International Affairs Division (Steering Committee Member)
		Mr. Chi-ho Bai Deputy Director, International Affairs Division
		Mr. Jeong-Gyoo Park Deputy Director, International Cooperation Division, Korea Meteorological Administration
Mongolia	Department of Economic Cooperation, Management and Coordination Ministry of Finance and Economy	Mr. Khosbayar Amarsaikhan Director General (Steering Committee Member)
	Ministry of Nature and Environment	Ms. N. Oyundari Director, International Cooperation Department

[1] Designation in government agency represented. Steering committee members are also indicated.
[2] Ms. Segawa assumed the position of Mr. Wada during the course of the study.

1. Focal Points

INTERNATIONAL ORGANIZATIONS

Organization	Office	Name / Designation[1]
Asian Development Bank (ADB)	East and Central Asia Department	Mr. Adrian Ruthenberg Director, Operations Coordination Division
		Mr. Fei Yue Country Programming Specialist, Operations Coordination Division (Steering Committee Member)
		Ms. Carmela C. Espina Economics Officer
United Nations Convention to Combat Desertification (UNCCD)	Asia Regional Coordination Unit	Mr. U Wai Lin Regional Coordinator (Steering Committee Member)
		Mr. Yang Youlin Assistant Regional Coordinator
United Nations Environment Programme (UNEP)	Regional Office for Asia and the Pacific	Mr. Choei Konda Deputy Regional Coordinator (Steering Committee Member)
		Mr. Mylvakanam Iyngararasan Senior Programs Officer, Regional Resources Center for Asia and the Pacific
United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)	Environment and Natural Resources Development Division	Mr. M.A. Khan Chief, Environmental Section (Steering Committee Member)
		Mr. Il Chyun Kwak Environmental Affairs Officer

[1] Designation in organization represented. Steering committee members are also indicated.

2. Participants to Technical and Steering Committee Meetings and International Workshops

GOVERNMENTS

Country	Office / Agency	Name / Designation[1]
People's Republic of China	International Department Ministry of Finance	Mr. Huang Huiping Deputy Division Director
	Department of Regional Economy State Development and Reform Commission	Mr. Yang Chaoguang Deputy Director General (Steering Committee Member)
		Ms. Guo Xujie Senior Officer
	International Cooperation Dept. State Environment Protection Agency	Mr. Guo Jing Division Director
		Ms. Wang Yu
	National Bureau to Combat Desertification State Forestry Administration	Ms. Jia Xaioxia Deputy Division Director
		Ms. Li Mengxian Deputy Division Director
		Ms. Jian Tian Fa Deputy Division Director, Project Management Office
	China Meteorological Administration	Mr. Yu Jixin Director General, Department of Observation and Telecommunication
		Ms. Li Dongyan Deputy Director, Department of International Cooperation
	Development and Reform Commission of Inner Mongolia Autonomous Region	Mr. Li Xueyan Section Chief
Japan	Global Environment Bureau Ministry of Environment	Mr. Tokuya Wada / Ms. Keiko Segawa [2] Deputy Director, Global Environment Issues Division (Steering Committee Member)
	International Forestry Cooperation Office Forestry Agency	Mr. Masato Yoneda Deputy Director
		Mr. Kazutaka Okamoto Deputy Director
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	Meteorological Research Institute	Dr. Masao Mikami Senior Researcher
	Environmental Chemistry Division National Institute of Environmental Studies	Dr. Masataka Nishikawa Head
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	Overseas Activities Department Japan Green Resources Agency	Mr. Takahito Misaki Managing Director
		Mr. Yasuyuki Nakanishi Assistant Director

[1] Designation in government agency represented. Steering committee members are also indicated.
[2] Ms. Segawa assumed the position of Mr. Wada during the course of the study.

2. Participants to Technical and Steering Committee Meetings and International Workshops

GOVERNMENTS

Country	Office / Agency	Name / Designation[1]
Republic of Korea	Ministry of Environment	Mr. Young Woo Park Director General International Affairs Division
		Mr. Won-min Kim Director International Affairs Division (Steering Committee Member)
		Mr. Young Kee Lee Senior Deputy Director International Affairs Division
		Mr. Jeong-Gyoo Park Deputy Director International Cooperation Division, Korea Meteorological Administration
Mongolia	Ministry of Nature and Environment	Mr. A. Namkhai Director, Environmental and Sustainable Development Department
		Mr. Gonching Ganzorigt Officer, Policy Implementation Department
		Mr. Naranbayar Purevsuren Assistant to the Minister
		Mr. Yadmaa Gantumur Project Officer, International Cooperation Department
		Ms. Tuul Gulgun Officer, Department of State Administration, Management and Control
		Ms. Tserenlkham Baatarsuren Officer, Agency of Forest, Water and Natural Resources
	Special Protected Area Administration	Mr. Uuganbayar Ulambayar Environmental Protection Officer

[1] Designation in government agency represented. Steering committee members are also indicated.

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INTERNATIONAL ORGANIZATIONS

Organization	Office	Name / Designation[1]
Asian Development Bank (ADB)	East and Central Asia Department	Mr. Fei Yue Country Programming Specialist, Operations Coordination Division (Steering Committee Member)
		Ms. Carmela C. Espina Economics Officer
United Nations Convention to Combat Desertification (UNCCD)	Asia Regional Coordination Unit	Mr. U Wai Lin Regional Coordinator (Steering Committee Member)
		Mr. Yang Youlin Assistant Regional Coordinator
United Nations Environment Programme (UNEP)	Regional Office for Asia and the Pacific	Mr. Choei Konda Deputy Regional Coordinator (Steering Committee Member)
		Mr. Mylvakanam Iyngararasan Senior Programs Officer, Regional Resources Center for Asia and the Pacific
United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)	Environment and Natural Resources Development Division	Mr. M.A. Khan Chief, Environmental Section (Steering Committee Member)
		Mr. Il Chyun Kwak Environmental Affairs Officer

[1] Designation in organization represented. Steering committee members are also indicated.

3. Consultant Team

INTERNATIONAL CONSULTANT

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The work on THE ESTABLISHMENT OF A REGIONAL MONITORING AND EARLY WARNING NETWORK FOR DUST AND SANDSTORMS IN NORTHEAST ASIA is part of the project on the Regional Master Plan for the Prevention and Control of Dust and Sandstorms in the Northeast Asia. The project has been financed by the Asian Development Bank (ADB), on a grant basis with US$500,000 from the Japan Special Fund funded by the Government of Japan and co-financed by the Global Environment Facility (GEF) on grant basis with US$500,000. The project was jointly initiated and conducted by the ADB, The United Nations Convention to Combat Desertification Secretariat (UNCCD), the United Nations Economic and Social Commission for Asia and Pacific (UNESCAP), and the United Nations Environment Programme (UNEP). The four governments involved (i.e., the People's Republic of China, Japan, the Republic of Korea, and Mongolia) have made in-kind contributions in the form of counterpart staff, professional services, national experts, or office facilities to support the implementation of this project.

The regional master plan, which is composed of three volumes, namely: Volume 1: A Master Plan for Regional Cooperation for the Prevention and Control of Dust and Sandstorms; Volume 2: Establishment of a Regional Monitoring and Early Warning Network for Dust and Sandstorms in Northeast Asia; and Volume 3: An Investment Strategy for Dust and Sandstorms Prevention and Control through Demonstration Projects.

This report has been prepared by a team of consultants engaged by ADB in cooperation with national experts from Japan and Republic of Korea under the technical guidance and supervision of a Technical Committee chaired by the United Nations Environment Programme (UNEP). Finally, this report was reviewed and cleared by members of the Steering Committee. Appendix 1 lists the participating parties for this undertaking while Appendix 2 lists the consultants and national experts.

ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
ADEC	Aeolian Dust Experiment on Climate Change Impact
AVHRR	Advanced Very High Resolution Radiometer
AWS	Automatic Weather System
CAA	Civil Aviation Authority
CAREERI	Cold and Arid Regions Environment and Engineering Research Institute
CAS	Chinese Academy of Sciences
CMA	China Meteorological Administration
DPRK	Democratic People's Republic of Korea
DSS	dust and sandstorm
DSSFS	Dust and sandstorm forecasting system
ESCAP	United Nations Economic and Social Commission for Asia and Pacific
EW	Early Warning
FC	Forecasting
FS	Forecasting System
GAW	Global Atmospheric Watch
GEF	Global Environment Facility
GMS	Geostationary Meteorological Organization
GTS	Global Meteorological Telecommunication System
JMA	Japan Meteorological Agency
KEI	Korea Environment Institute
KMA	Korea Meteorological Administration
LIDAR	Light Detection & Ranging instrument
MA	Meteorological Agency
MODIS	Moderate Resolution Imaging Spectroradiometer
NAMHEM	National Agency for Meteorology, Hydrology, & Environmental Monitoring (Mongolia)
NIER	National Institute of Environmental Research (ROK)
NIES	National Institute for Environmental Studies (Japan)
NOAA	National Oceanic & Aeronautical Administration (USA)
NWP	Numerical Weather Prediction
PM_{10}	Particulate Matter of < 10µ
PRC	People's Republic of China
R&D	Research and Development
RETA	Regional Technical Assistance
RMB/CNY	Chinese currency; yuan
ROK	Republic of Korea
SEPA	State Environment Protection Administration (PRC)
SFA	State Forestry Administration (PRC)
TA	Technical Assistance
TM	Thematic mapper (satellite mounted)
TOMS	Total Ozone Mapping Spectrometer
TSP	Total Suspended Particles
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Programme
US$	US dollar
WMO	World Meteorological Organization

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EXECUTIVE SUMMARY

1. Background and Objective

Dust and sandstorms (DSS) are natural phenomena that have occurred for thousands years in the Northeast Asia Region. During the past 50 years, however, the frequency has increased, geographic coverage has expanded, and damage intensity has accelerated. Now, DSS are considered to be among the most serious environmental problems in the region as a disastrous hazard. It causes considerable hardship, loss of income, disrupts communications, affects people's health and, in extreme cases, leads to human casualties and destruction of livestock and crops over large areas in the affected countries.

To cope with such serious environmental problem, the Asian Development Bank (ADB), the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), the United Nations Convention to Combat Desertification (UNCCD) and the United Nations Environment Programme (UNEP) together with the governments of the People's Republic of China, Japan, the Republic of Korea, and Mongolia initiated a joint project on "Prevention and Control of Dust and Sandstorms in Northeast Asia" in March 2003.

The objective of the collaborative project is to promote the establishment of a regional cooperation mechanism for prevention and control of DSS in Northeast Asia. The main outputs expected are: (1) an initial institutional framework for regional cooperation on DSS, and (2) a regional master plan to guide regional cooperation to alleviate DSS in Northeast Asia. The regional master plan has two major components: (a) a phased program to establish a regional monitoring and early warning network for prevention and control of DSS in Northeast Asia, and (b) an investment strategy to strengthen mitigation measures to address root cause of DSS in source areas.

This report contains the outcome of the study on "a phased program to establish a regional monitoring and early warning network for prevention and control of DSS in Northeast Asia." The report has been prepared by a team of consultants in cooperation with national experts under the technical guidance and supervision of the Technical Committee chaired by UNEP and reviewed by the participating parties at the Steering Committee.

2. Issues and Challenges

Transboundary environmental problems such as DSS can most effectively be solved through regional cooperation. The merit of regional cooperation is that it will be possible to achieve much more through a network than by each country acting alone. There is considerable value-adding when neighbors combine their efforts to establish a regional monitoring and early warning network. Early warning of impending DSS events based on a regional monitoring network will be facilitated by data sharing with rapid communications on the progress and geographic extent of any DSS outbreak.

The following points were identified through the review of the current DSS monitoring programs in the partner countries for consideration in view of establishing a regional network for monitoring and early warning:

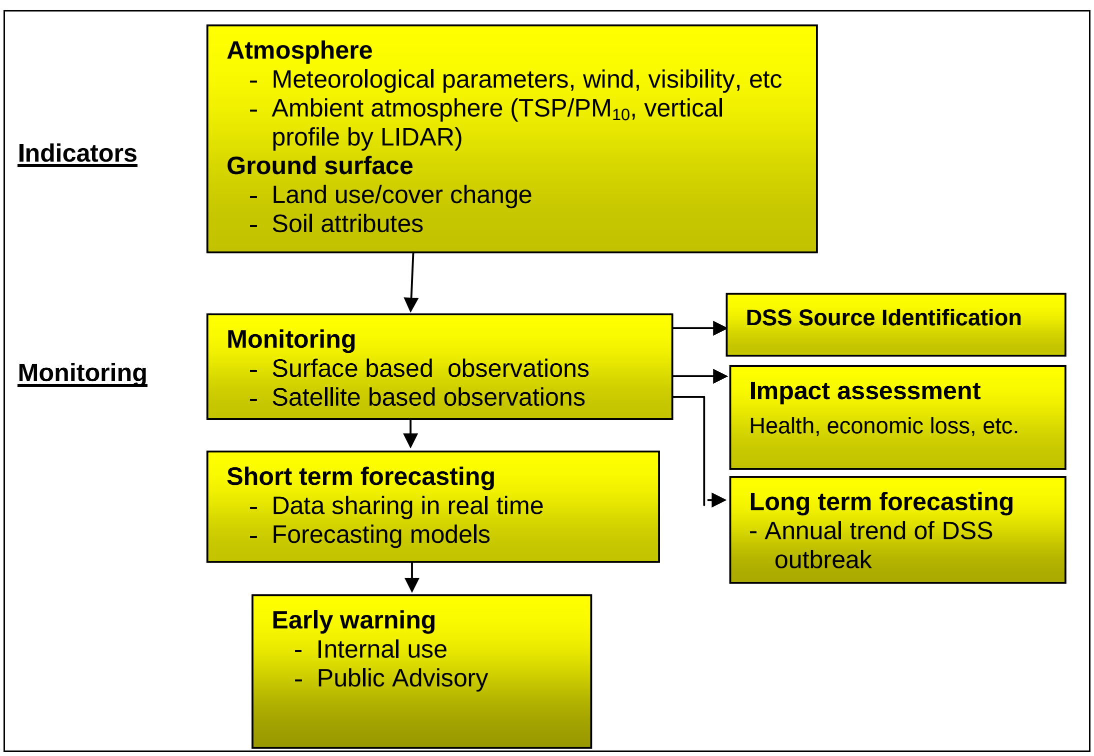
Firstly, the perception, terminology, definition, monitoring method, current capacity, needs and expectation, etc. are all different from country to country. For example, there is a perception gap among the participating countries. DSS is considered as a phenomenon of natural disaster for countries in the source areas (upstream countries) while DSS is a problem of air quality concerning public health for downstream countries. The definition of DSS is also different from country to country depending not only on monitoring method but also threshold value. In addition, needs and expectations are also different from country to country, even from agency to agency within a country. Accordingly, optimization and flexibility with step-by-step approach is needed in formulating a feasible program for a regional monitoring and early warning network.

Secondly, although a few bilateral initiatives are already in place as mentioned in the main text, these projects are limited to some specific field and national boundary areas. Since DSS is one of the transboundary environmental problems at a regional scale, multi-lateral cooperation mechanisms can solve the problem effectively and this is true for a regional monitoring and early warning network.

Thirdly, although Mongolia is one of the major source areas of DSS, there is no special monitoring site for DSS in the country. Moreover, most meteorological stations in Mongolia do not have any direct relation to DSS. In this regard, from a regional perspective, helping Mongolia develop its national capacity is one of the key tasks in terms of establishing a regional monitoring network, particularly on data sharing among participating countries.

3. Common Monitoring Indicators

The following chart illustrates the course towards establishing a regional monitoring network. First of all, the purpose of the regional monitoring network was confirmed to focus on short-term forecasting for early warning. It was agreed that other purposes for a regional monitoring network such as long-term forecasting would be the focus in the next step with necessary expansion of the network.



Next, common monitoring indicators for the regional monitoring network were selected from a basket of indicators for an effective short-term forecasting through data sharing. Availability of real time data is the most important criterion for selecting a set of common indicators. These indicators are:

(a) Visibility (instrumented)
(b) PM_{10} (particulate matters with diameter smaller than 10 μm), and
(c) LIDAR (vertical profile of dust cloud by Light Detection and Ranging)

4. Regional Network of DSS Monitoring Stations

The objective of the regional monitoring network is to have a hierarchy of monitoring stations from the geographically important areas in Mongolia and northern provinces of People's Republic of China (across the Yellow Sea and Democratic People's Republic of Korea area) to Republic of Korea and Japan for effective early warning. Ideally, such network could make it possible for leeward forecasters to make "rolling" forecasts by incorporating data from windward monitoring stations. It would be also advantageous for windward forecasters because the validation of their short-term forecasting methods will be greatly enhanced if there is progressive feedback from leeward forecasters.

The real time data that can be used for short-term forecasting or early warning comes from the results of monitoring the three common indicators identified above as well as the basic meteorological observation data. Based on these four data sources and the geographical importance of the stations for forecasting and early warning, a hierarchy of network monitoring stations[1] was proposed as follows:

(a) Class-A Network Monitoring Stations

Class A stations are the *key stations* of the regional network since they are geographically important (e.g., located in DSS source areas). These stations have (or are going to have) the capability to measure all four data in real time. There are currently a few stations in this category that are fully equipped in the People's Republic of China and none in Mongolia. Visibility, PM_{10}, and LIDAR allows Class A Stations to provide real time data on spatial distributions and vertical profile of an ongoing DSS, which have special importance for the remote forecast centers to capture the physical details of a DSS event for simulation and early warning. It is crucial for the regional network to ensure data exchange in real time between the partner countries, or among these stations that are fully equipped.

(b) Class-B Network Monitoring Stations

Class B stations comprise of the *general stations* in the regional network that can monitor and report PM_{10} data in real time over a long distance, in addition to reporting visibility data. The important feature of these stations is their capability to measure suspended particles like PM_{10} (and TSP by batch sampling). PM_{10} data is essential to measure air quality. The data from these stations together with those from the Class A stations are vital for DSS simulation and modeling at remote forecast centers because it can be monitored in real time. Not all the designated Class B stations in the network have the capacity to measure dust particle concentration. It will take time to upgrade the monitoring capacity of these existing stations, particularly those in Mongolia where there are none capable of monitoring PM_{10}.

[1] The hierarchy of stations is not correlated with the proposed phases of development.

5. Proposed Phases of Development

A phased program offers a practical approach for the development of the regional monitoring network especially under the circumstance of limited funds and resources. Moreover, the phased development need not be thought of as a rigid sequence where each phase is completed before the next begins. An alternative way to look at the phased approach is to acknowledge that the priority is to implement each phase's activities as soon as possible. Each phase described below has its own time span to reach its specified goal and the opportunity for equipment upgrades, capacity building, and network augmentation is a continuing one. The proposed three phases of development are as follows:

Phase-1 (short term): Data sharing with the existing monitoring capacity

In this phase, the network of monitoring stations is identified (25 in the People's Republic of China and 6 in Mongolia, plus designated stations in the Republic of Korea and Japan) and arrangements will be finalized to allow data sharing in real time. A decentralized network is preferred with data sharing for the purpose of short-term forecasting. Priority is given to gathering instrumented visibility reading, PM_{10} data and LIDAR at selected stations in a step wise approach in accordance with each country's national priorities.

Phase-2 (medium term): Strengthening of monitoring capacity

This phase involves the expansion of the number of monitoring stations in the network (additional of 18 in the People's Republic of China and 12 in Mongolia) and upgrading of equipment at selected monitoring stations of the network.

Phase-3 (long term): Strengthening of forecasting and early warning capacity

This phase will focus on improvement in forecasting methods (including software development, training, and capacity building) to provide both short-term (early warning) and long-term (seasonal) predictions. Long term forecasting will depend heavily on data derived from ground surface monitoring and on verification of prediction model output.

In phase one, all the stations have been identified for the network by the partner countries while the proposed stations for the Republic of Korea and Japan for phase two are still to be identified and confirmed by authorities of each country. For the PRC, selected stations with LIDAR capacity/potential would be included in the DSS monitoring network, but the time of their inclusion will be decided based on resources availability and agreement with concerned parties.

CHAPTER 1 INTRODUCTION

1.1 Background and Objective of the Project

Dust and sandstorms (DSS) is the generic term for a serious environmental phenomenon in Northeast Asia. It causes considerable hardship, loss of income, disrupts communications, affects peoples' health and, in extreme cases, leads to death of people and destruction of livestock and crops over large areas in the affected countries.

At the request of the governments of the People's Republic of China (PRC) and Mongolia, the Asian Development Bank (ADB), United Nations Economic and Social Commission for Asia and Pacific (UNESCAP), United Nations Convention to Combat Desertification Secretariat (UNCCD), and United Nations Environment Programme (UNEP), initiated their own projects for the prevention and control of DSS in Northeast Asia. ADB prepared the concept paper for a regional technical assistance (TA) in early May 2002 and the three agencies of the United Nations made a project proposal to seek support from the Global Environment Facility (GEF) to address the same environmental problem in the region.

During a meeting among the environment ministries of PRC, Japan, Republic of Korea , and Mongolia in June 2002, it was proposed by the governments of the four countries that ADB, UNESCAP, UNCCD, and UNEP jointly develop an expanded TA to integrate the support from the international community, maximize the effects of the undertaking, and promote regional cooperation on DSS to be co-financed by ADB and GEF. A joint fact-finding and consultation mission comprising of representatives from the four international organizations led by ADB visited PRC and Mongolia from 26 August to 2 September 2002. The mission reached an understanding with the governments of PRC and Mongolia on all aspects of the Terms of Reference for the TA. The joint project on "Prevention and Control of Dust and Sandstorms in Northeast Asia (RETA 6068)" was then approved by ADB and GEF in December 2002 and its implementation commenced in March 2003.

The TA project was implemented together by ADB, UNESCAP, UNCCD, and UNEP in collaboration with the governments of PRC, Japan, the Republic of Korea, and Mongolia. A Steering Committee and three Technical Committees were organized for the implementation of the project with ADB as the executing agency responsible for the overall management and administration of the TA. UNEP, which is the implementing agency for the GEF co-financing resources, chairs the Technical Committee for the "Establishment of the Regional Monitoring and Early Warning Network."

The framework for the TA is shown in Appendix 3. The main objective of this collaborative project is to promote the establishment of a regional cooperation mechanism for the prevention and control of DSS in Northeast Asia. In this connection, specific outputs of the study come in two parts: (1) an initial institutional framework for regional cooperation on DSS, and (2) a regional master plan to guide regional cooperation to alleviate DSS in Northeast Asia. The components of the regional master plan will be (a) a phased program to establish a regional monitoring and early warning network for DSS in Northeast Asia, and (b) an investment strategy to strengthen mitigation measures to address root cause of DSS in source areas.

This report is the output of the study for the "Establishment of a Regional DSS Monitoring and Early Warning Network" conducted by the consultants under the guidance of a technical committee. It presents a phased program to establish a regional DSS monitoring and early warning network by strengthening the monitoring capacity in the two DSS source countries (i.e., PRC and Mongolia), establishing an institutional framework among the four partner countries, and improving the information flow for effective early warning services.

1.2 Scope of the Project

1.2.1 Geographic Coverage

Although DSS in Northeast Asia affects a wide geographic area, the project involves four participating countries—PRC, Japan, the Republic of Korea, and Mongolia—all are members of ADB. Specifically, the geographic area covered includes part of continental Asia (PRC, the Korean peninsular, and Mongolia) and the neighboring islands of Japan. However, the wind and weather patterns of the DSS force may originate from the Russian Federation to the north and west and from Kazakstan to the west of PRC and Mongolia (see Figure 1.1). The DSS impact may be felt in Democratic People's Republic of Korea (DPRK) and in North America. Thus, DSS is an example of a trans-boundary environmental problem.

Figure 1.1 DSS Geographic Coverage in the PRC, Japan, the Republic of Korea, and Mongolia

1.2.2 Planning Timetable

The planning target of this project has a time horizon of 20 years commencing from 2004/2005. Due to advances in technology and the development of new and substantial information about DSS, recommendations specifically on monitoring and early warning are planned within the next two to five years.

1.3 The Dust and Sandstorms (DSS) Phenomena in Northeast Asia

1.3.1 Description and Classification

DSS involves strong winds that blow a large quantity of dust and fine sand particles away from the ground and carry them over a long distance with severe environmental impacts along the way. It often has severe impacts across the countries in the region. The major DSS originating source areas in the region are the desert and semi-desert areas of the PRC and Mongolia. Long distance transport of dust aerosol particles links the biogeochemical cycles of land, atmosphere, and ocean, possibly even influencing the global carbon cycle and having a significant effect on regional radiative balances and human health. A geochemically significant quantity of dust from Asian source regions, estimated to be 400-500 Tg, is deposited in the North Pacific each year. Approximately 240 Tg of dust is re-deposited in deserts of PRC each year while 140 Tg falls out over other parts of PRC.

DSS as a natural phenomenon has occurred for thousands of years in the region. During the past 50 years, however, the frequency has increased, geographic coverage has expanded, and damage intensity has accelerated. Available PRC statistics indicate that average occurrence of DSS was 5 times a year in the 1950s, 8 times in 1960s, 14 times in 1970s, and 23 times in 1990s. The region experienced 32 DSS in 2001 and the most severe DSS for decades in early 2002.

Large-scale DSS has significant environment effects that cause enormous economic losses, present serious public health concerns over a wide geographic area, and sometimes take human lives. For instance, the DSS on 5 May 1993 directly affected 1.1 million square kilometers in PRC, which resulted in human casualties (i.e., 85 deaths and 246 injuries) and destruction of 4,412 houses, 120,000 livestock, and 373,000 hectares of crop land[1]. The direct economic cost of this DSS within the PRC alone was more than CNY550 million (about US$66 million at the 2002 exchange rate). The two most severe DSS events in decades took place in March and April 2002. They swept across Mongolia and hit 18 provinces in PRC, the Korean peninsular, and a large area of Japan. Total suspended particulate levels in these affected areas were recorded from tens to hundreds of times higher than the national standards in these countries. The DSS in early April was so severe that Mongolia had to close its international airport in Ulaanbaatar for three days. Also, the Republic of Korea had to close their primary schools and cancel more than 40 flights departing from Gimpo Airport in Seoul. According to quantitative analysis report of DSS damages, the total damage cost of DSS amount to 5,922 billion Korean won (0.8% of GDP or about US$ 4.6 billion at the exchange rate that time) all over ROK in 2002.[2] Satellite images of DSS and analysis of the dust samples collected on the ground have revealed that impacts of strong DSS events are not limited to the region, but reach as far as North America across the Pacific Ocean.

Of the 32 DSS events in 2001, 18 originated from the deserts of Mongolia while the remaining 14 originated from the desert or semi-desert areas of Inner Mongolia Autonomous Region in PRC. Natural elements, large desert and semi-desert areas, the strong winds from Siberia (Russian Federation) sweeping through these DSS originating source areas, severe and persistent drought, late killing frosts, and other natural disasters, contribute to DSS. Moreover, their effects have been strengthened and intensified significantly by human interventions over the last few decades, particularly through overgrazing, overly-optimistic

[1] Yang Youlin and Lu Qi In *"Global Alarm: Dust and Sandstorms from the World's Drylands*". UN 2002 for an account of the severe DSS event in the Hexi corridor of Gansu Province, PRC

[2] K.K. Kang, J.M. Chu, H.S. Jeong, H.J. Han, 2004. A Study on the Analysis of Damage of Northeast Asian Dust and Sandstorm and of the Regional Cooperation Strategies, Korea Environment Institute, p. 106

conversion of grassland to cropland, deforestation, and over-exploitation of water resources in the DSS originating source areas, which led to rapid land degradation and desertification. Although all the countries in the region are affected by DSS, urgent actions are needed in the DSS originating source areas in PRC and Mongolia to arrest deterioration of the land, before the situation becomes irreversible.

In addition to various initiatives of the governments, non-government organizations and volunteers from the DSS-affected countries have been actively undertaking cross-border activities to mitigate DSS events (e.g., planting trees in the DSS originating source areas), but in a sporadic and uncoordinated manner.

The occurrence of DSS is built upon two prerequisites. They are: (i) dry and loose surface, and (ii) strong[3] and persistent wind. In meteorology, DSS has long been treated as one of the observational elements, as it is classified a disastrous weather phenomenon. It has been further divided into 11 categories by the World Meteorological Organization (WMO) to represent different characteristics and developing stages of the phenomenon (see Table 1.1).

Table 1.1 Classification of DSS by WMO

Code	Symbol	Description
6		Widespread dust in suspension in the air not raised by wind at time of observation
7		Dust or sand raised by wind at time of observation
8		Well developed dust devil(s) within past hour
9		Dust storm or sand storm within sight of the station during past hour
30		Slight or moderate dust storm or sand storm has decreased during past hour
31		Slight or moderate dust storm or sand storm no appreciable change during past hour
32		Slight or moderate dust storm or sand storm has increased during past hour
33		Severe dust storm or sand storm has decreased during past hour
34		Slight or moderate dust storm or sand storm no appreciable change during past hour
35		Slight or moderate dust storm or sand storm has increased during past hour
98		Thunderstorm combined with duststorm or sandstorm at time of observation

Note: Meteorological codes associated with DSS storms.

[3] Generally 6.5 meters/second (m/s) is regarded as the threshold wind velocity to initiate a dust outbreak provided that the soil surface is dry. Soil texture is also a determining factor.

WMO has not established the unified criteria for distinguishing these categories. Therefore, different criteria are used in different countries. In PRC, for example, the China Meteorological Administration (CMA) has classified DSS into four categories based on visibility and wind speed for its technical regulation for operational observation (see Table 1.2). In ROK, a dust and sand concentration observation network has been established to measure PM_{10} value, which is used to determine the category of DSS.

Table 1.2 The Classification of DSS in PRC

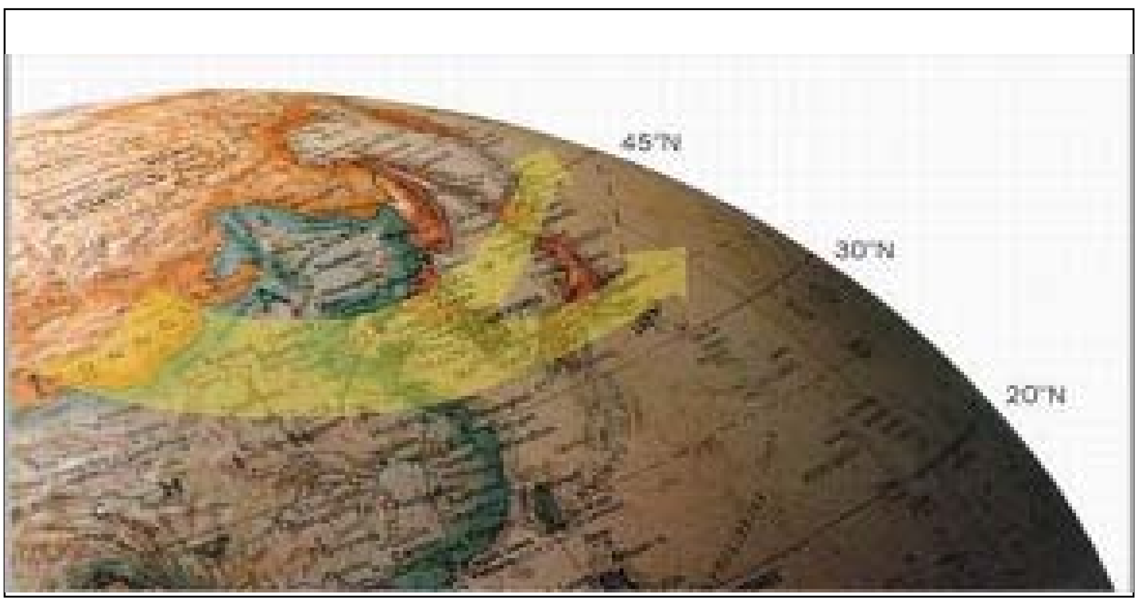
Categories	Characteristics	Horizontal Visibility	Weather Condition
Drifting dust	Dust suspending in the air	<10 km	Weak wind
Blowing dust	Dust or sand raising by wind	<10 km	Moderate wind
Dust and sand storm	Dust and sand raising by strong or turbulent wind	<1 km	Strong or turbulent wind
Severe dust and sand storm	Dust and sand raising by very strong or turbulent wind	<50 m	Very strong or turbulent wind

Source: China Meteorological Administration

1.3.2 Scientific and Technical Dimensions

Understanding a DSS event would entail the study of meteorological conditions and soil surface properties and how these interface with each other. This is briefly explained in this section. DSS in Northeast Asia mainly originates from the mid-latitude Desert Zone (N 40-45°E 90-120°). Driven by the East Asian winter monsoon, DSS generated from areas above moves southeast and then to the east parallel along N 40°, passing the Korean Peninsula and Japan to the northern areas of the Pacific Ocean (see Figure 1.2).

Figure 1.2 DSS Transport Process by Air Flows



Source: SEPA, Beijing

Normally, it takes one or two days to move from source areas to ROK and two or three days to Japan. In winter and spring, the area at N 40-45° is under the influence of the Mongolian high pressure system, which is cold and dry, while the land surface is very cold. Seasonal soil freezing may occur but temperature differentials between the land surface and the air mass develop as spring progresses.

A. Meteorological Conditions

The types of climatic conditions associated with DSS are as follows:

- *Cold wave* – Large scale DSS is always associated with strong cold wave, which comes from the areas of Siberia and Mongolia in winter and spring, generating strong air motion and, thus providing dynamic conditions for the occurrence and development of DSS.

- *Cyclone weather* – Mongolian cyclone is a typical weather system that may trigger and consequently facilitate the development of DSS. A strong Mongolian cyclone will form eddy circulation. Its size can be from the ground to a height of several thousand meters within which air flows violently both in the horizontal and vertical direction. Such a weather pattern is favorable for dust emission outbreak and transportation of DSS.

- *Atmospheric thermo-instability* – In desert areas, the near surface thermo-instability will cause vertical air motion and near surface turbulent motion, which will induce wind erosion and vertical transport of soil.

- *Sharp changes of weather elements* – Before and after the occurrence of DSS, some meteorological elements will change significantly such as low level pressure, temperature, humidity, wind, and visibility etc.

As DSS occurs under some typical weather conditions, the evolution of DSS outbreaks is predicable. Weather forecasts are the scientific basis for DSS forecasting.

B. Soil Surface Properties

The most critical surface parameters controlling the soil dust emission and associated DSS are the surface roughness length (highly related with land use/cover), soil texture, and moisture content. There is very limited information with respect to soil grain size distribution in the DSS source areas in Northeast Asia.

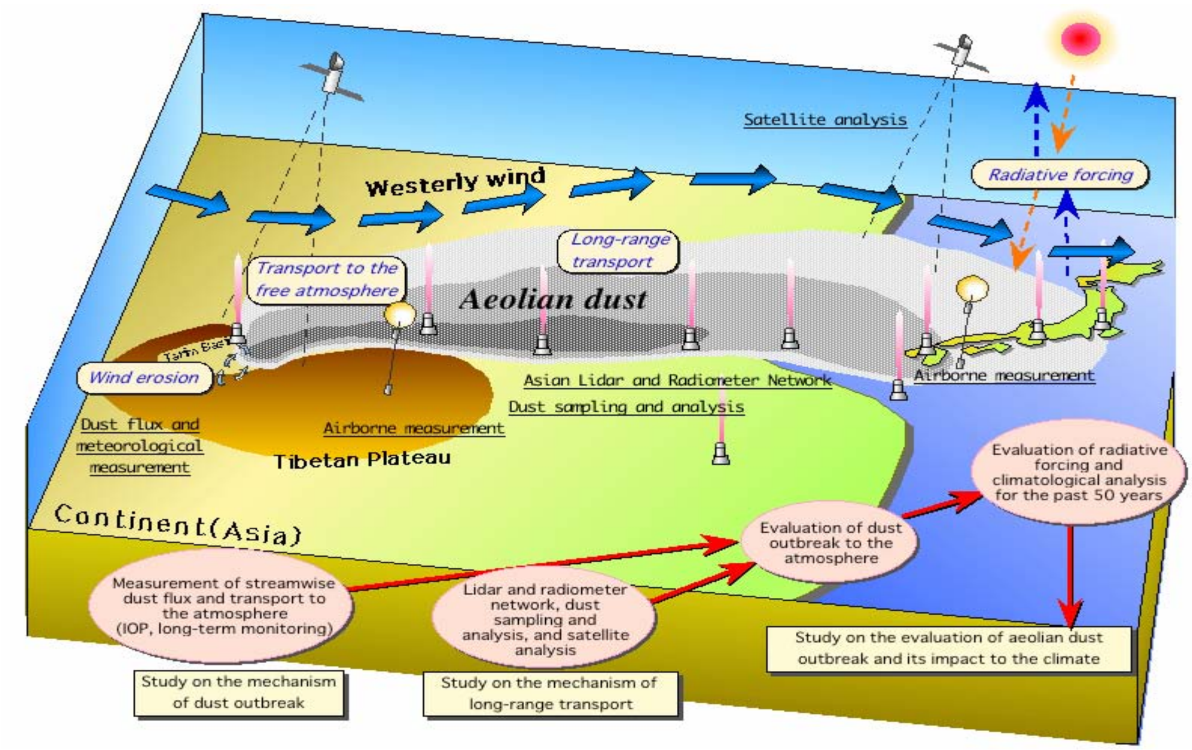
Dry and loose surface soil is a prerequisite for DSS. The types of soil and vegetation cover in the DSS source area are all factors influencing a DSS outbreak. A conceptual model shown in Figure 1.3 was developed by researchers of the Aeolian Dust Experiment Change Impact (ADEC)[4] to help us better appreciate the factors and distances involved in DSS. It shows the components of DSS events in western PRC. It also shows the winds from the north that is implicated in the transboundary transport of dust aerosols to the Korean peninsula and Japan and areas beyond. It recognizes three important processes in each DSS event as follows:

(1) The mechanism of the DSS "outbreak" (contributing factors and "drivers");
(2) The mechanism of long-range transport (contributing factors and "drivers"); and

[4] Aeolian Dust Experiment on Climate Change Impact. (ADEC) is cooperative effort between Japan and PRC to assess the mechanism of dust supply to the atmosphere on a global scale and to evaluate the impact of Aeolian dust on climate through radiative forcing.

(3) The evaluation of DSS and its impact (on people, on commerce, and on the regional climate via its effect on radiative forcing[5]).

Figure 1.3 ADEC Chart on Major Components of DSS Events



The model shows that the *first* step is the measurement of surface condition (even the dust flux and the associated meteorological conditions) in the source regions. This involves long term monitoring at ground based monitoring stations.

Secondly, airborne measurements are also used to assess dust transport, usually via aerosol sampler, weather balloons and instruments like transmissometer (visibility), sun photometer (optical depth), radar, radiometers and LIDAR (light detection and ranging equipment). Dust collection through sampling equipment installed along the expected storm path aids in the analysis and identification of dust sources. Satellite data are also used as both PRC and Japan have dedicated weather satellites. Data can also be obtained from geostationary and polar-orbit satellites maintained by USA, Russia, and other nations.

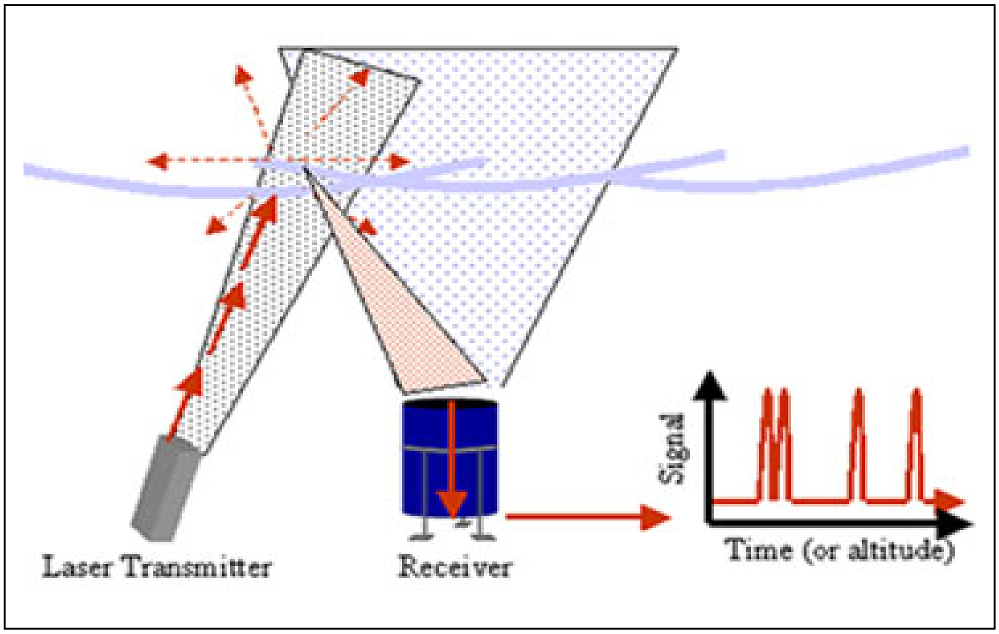
Thirdly, analysis of long-term weather records and associated data on DSS is helpful in the development of transport models as predictors of the DSS behavior and its impact on long-term climate change through the effect of radiative forcing.

[4]Radiative forcing refers to the adsorption and scattering of both incoming and terrestrial radiation. It has the potential to impact on global climate.

Box 1.2 LIDAR – A Useful Tool for DSS Monitoring

LIDAR (Light Detection and Ranging) is a kind of radar using light instead of radio waves. It transmits pulsed laser light to the atmosphere: and collects the light reflected from the atmospheric molecules, clouds, and aerosols with the help of a receiving microscope. Distribution of the atmospheric minor constituents of vapor, temperature, aerosols, and clouds are derived from the intensity of the received light; and distribution of wind is derived from the Doppler shift.

Figure 1.4 Illustration on the Operation of LIDAR



1.4 Technology and Methodology of DSS Monitoring, Forecasting, and Early Warning

This section presents some definition of terms and general view on technologies and methodologies relating to DSS monitoring, forecasting, and early warning in support of the flow of discussion in this report. An expanded explanation of the technologies and methodologies involved in DSS monitoring and forecasting is given in Appendix 4.

A. Monitoring

Monitoring is the systematic and repeated observation of a specific phenomenon, usually organized through appropriate planning for some particular purpose(s). It is focused on the occurrence frequency, significance or severity, dimension, and duration of the target events. For DSS events, the contributing factors that need to be monitored are the climatic conditions and land surface conditions. Impacts of the events that also need to be monitored are the damages to infrastructure and adverse effects on social and economic activities, air quality, and public health.

Monitoring can help build up a profile of events for better understanding, which in turn help in preparing appropriate actions for response to subsequent events. Moreover, analysis can be conducted based on a large quantity of monitored data and through the application of very sophisticated analytical instruments.

B. Forecasting

Forecasting is an assessment made (based on the analysis of data derived from monitoring activities) of the possibility of the occurrence of certain events in a certain future timeframe, which may include the scope, dimension, severity, duration, and impacts of the events under consideration. Forecasting can be classified by different criteria. One commonly used classification is based on the following timeframe of the forecasting assessment:

- Short Term Forecasting – the possibility of occurrence of the event within a short timeframe of say one or two days;
- Medium Term Forecasting for one or two weeks; and
- Long Term Forecasting for one or two years.

Actual duration varies from place to place and may depend on the purpose of the forecast.

C. Early Warning

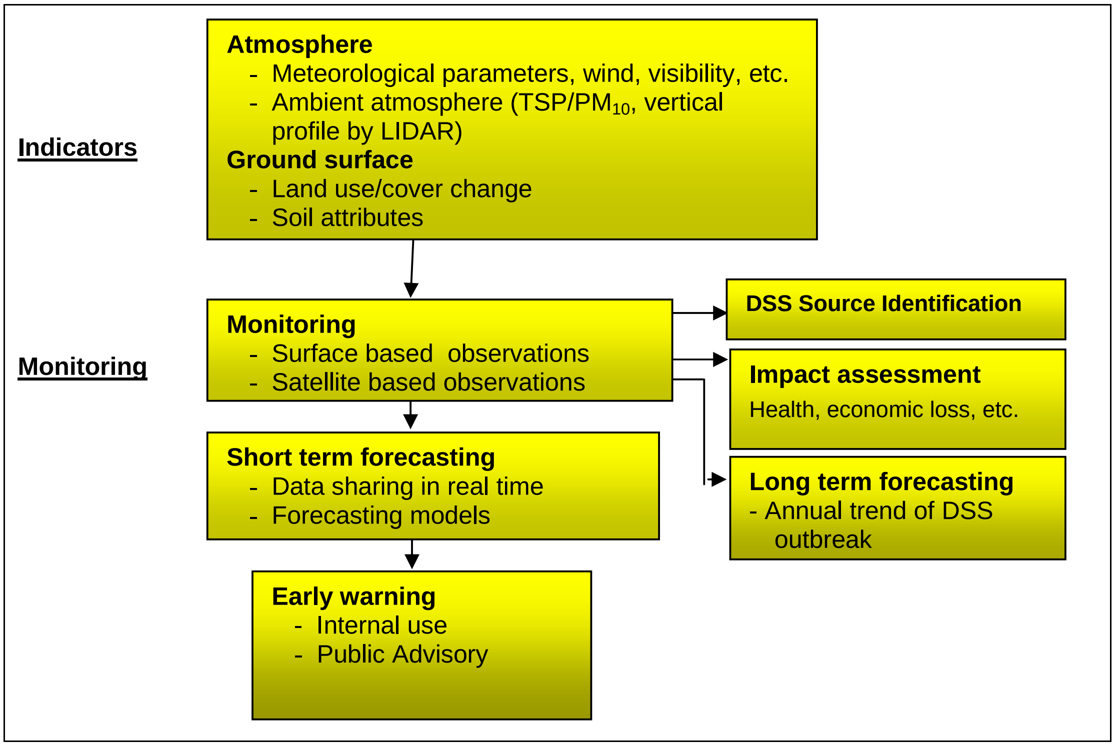
Early warning (EW) is the advice that is provided, normally based on monitoring and forecasting analysis, to concerned parties of a forthcoming event before it occurs. The purpose of the early warning is to raise awareness and preparedness of the concerned/affected parties for minimizing, if not avoiding, possible adverse consequence.

The relationship among monitoring, forecasting, impact assessment, and early warning are shown in Figure 1.5. DSS monitoring systems rely on data that are either derived from surface-based observations or satellite-based observations. With the use of available forecasting systems, DSS outbreaks can be predicted and a system of EW can be employed. Moreover, monitoring systems can be expanded to assess DSS impacts and source identification for other analytical studies.

Modern technologies for monitoring include satellites that provide imagery and other digital data. The first earth resources satellite went into orbit in 1972. Since then many different satellites have been launched. The main characteristics of the data provided by these satellites that are relevant to EW relate to cost-effectiveness, image quality, and frequency. Aspects include Orbit Return time (repetitive), scene area coverage, ground resolution (pixel size) and spectral resolution. There are both polar-orbiting and geostationary weather satellites maintained by USA, Russia, and others. Both China and Japan maintain their own dedicated satellite systems that aid in tracking and mapping DSS events. The Japanese satellites are ADEOS I and II.

The use of advanced aerospatial technology, remote sensing, and Geographical Information Systems (GIS) as well as ground-based radar and LIDAR have enhanced rapid development of early warning in a more visually useful and cost-effective manner.

Figure 1.5 Relationship of DSS Monitoring, Forecasting, Early Warning, and Impact Assessment



CHAPTER 2 CURRENT DSS MONITORING AND EARLY WARNING IN THE PARTNER COUNTRIES

2.1 People's Republic of China

The DSS monitoring situation in the People's Republic of China (PRC) is complicated in that many different agencies and institutions maintain monitoring stations within the nation. Many stations collect data that are relevant to dust and sandstorms (DSS) forecasting and early warning. Access to the data within the timeframe required by modelers and forecasters is not always possible.

There are at least four institutions at the central government level directly involved in DSS monitoring and, to varying extent, forecasting and early warning. These are the China Meteorological Administration (CMA), the State Environment Protection Administration (SEPA), the State Forestry Administration (SFA), and the Chinese Academy of Sciences (CAS).

All the four institutions have developed their own individual network. However, there is general lack of cooperation among these institutions. It seems that each institution strives to be self-sufficient in data gathering. Data sharing has not been encouraged in the past and much archival material is inaccessible

There are numerous data, and several databases available in the PRC related to DSS. Table 2.1 gives a summary of databases. However, there is need for a reasonable data sharing policy, mechanism, and facility to make the data sharing realizable, accessible, operable and feasible. It is clear that the priority must be on getting the maximum value out of the existing databases and on getting access to data in real time (where necessary for forecasting and prediction).

Table 2.1 Overview of Data Sources in the PRC with Relevance to DSS

Organization	Human Resources	Contact Information	Database	Availability	Requirement	Cost
National Satellite Meteorological Center, China Meteorological Administration	10 experts	Mr. Luo Jingning Data Service Center, National Satellite Meteo-rological Center, CMA	GMS images NOAA images DSS density map retrieval from NOAA image Visibility retrieval from NOAA image	Open to public, can be download from www.dear.cam.gov.cn	DSS real time monitoring	Free
State Environment Protection Administration	A research unit within Sino-Japan Research Center, Beijing. Over 100 experts and staff from China National Environment Monitoring Center	Mr Wang, Ruibin National Environ-mental Monitoring Center, SEPA, Beijing	43 sites, including LIDAR, PM_{10}, and TSP (some in real time)		Data on particle size of particulate matter and DSS source identification	Need for nego-tiation with SEPA

(cont. Table 2.1)

Organization	Human Resources	Contact Information	Database	Availability	Requirement	Cost
Ministry of Land and Resources (MLR): Project on Remote Sensing for Land Resources and Ecological Environment Monitoring in Beijing and Surrounding Regions. (Three organizations within MLR are involved in this project)	More than 100 experts involved in the project. About 20 are Remote Sensing experts while others are involved in ground survey.	Mr. Sha Zhigang Department of Cadastral Management - Ministry of Land and Resources	Based on Landsat TM, SPOT integrated with ground survey Output: 1:10,000 and 1: 50,000, scale thematic maps: Land Use Map Ecological Environment Map, Land Degradation Map, Vegetation Map, Soil Map, Slope Grade/Slope Aspect Map, and Standard Image Map. Monitoring Target: Cultivated Land Degradation, Rangeland Degradation, Land Salinization, and Wetland Change	Internal Use	Information on deserti-fication, land degradation, rangeland degradation, land salinity in the source region and the transport path are essential for DSS monitoring and early warning.	Need Nego-tiation With MLR
State Forestry Administration (National Project on Sand Land and Desertification Monitoring)		Mr. Zhou Weidong, China National Deserti-fication Monitoring Center	Mainly based on ground survey, using Landsat TM images as the base map to monitor desertification. Produce the desert and deserti-fication map and build up the desert and desertification database in 1:100,000 scale.	The primary data and database are only for internal use. The statistical data are open for public use.	Information on distribution of desert and desertification as well as severity of desertification are essential for DSS monitoring.	Need nego-tiation with SFA
Cold and Arid Regions Environment and Engineering Research Institute, CAS (Research on Desertification Process and Prevention in Northern China, National Fundamental Research Program (1973))	58 experts are involved in desert and desertification research	Dr. Wang Tao Key Lab of Desert and Deserti-fication, CAS Division of Desert and Deserti-fication, CAREERI, and CAS	Based on Landsat TM image to monitor the desertification evolution and tendency in Northern China. Output: Map of Desert and Desertification Distribution in China in scales of 1:200,000; 1:500,000; and 1:4,000,000	1:200,000 scale, and 1:500,000 scale maps are for internal use. 1:4,000,000 scale map will be published and available for public use soon.	High resolution information on distribution of desert and desertification as well as severity of desertification are essential for DSS monitoring.	Need nego-tiation with CARE-ERI, CAS
Beijing Digital View Ltd.	Unknown	Mr. Zhuang Dafang Beijing Digital View Ltd. Tel: 86-10-82332473 Fax: 86-10-82332472	National Resource and Environment Database at scale of 1:100,000 and 1 km grid land use database 1 km grid Ecological Environment Database	For sale: 1. 1000 RMB per Land Use map in 100,000 scale 2. 5000 RMB for 1km grid Land Use Map 3. 12000 RMB for 1km grid Ecological Environment Map	Need approximately 850 scene Land Use Maps	850000 RMB for 1: 100000 scale maps

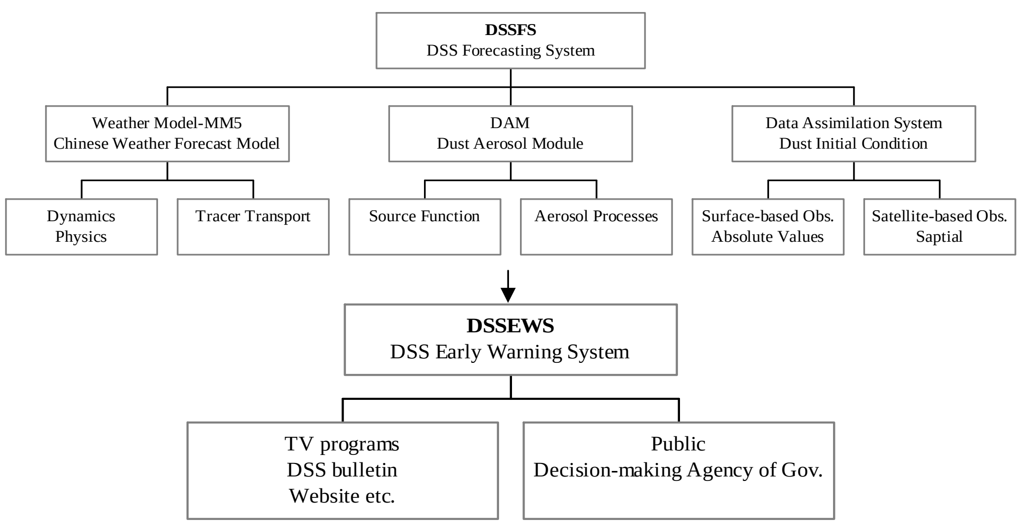
Source: Compilation of Consultant Team

2.1.1 The China Meteorological Administration

The China Meteorological Administration (CMA) maintains a network of over 2,400 stations, with 60 stations located in the DSS source areas. The major activities of CMA include construction of relevant observation sites, development of human resources, establishment of information system and issuance of regular relevant information bulletins, setting up data-bank, and development of software. CMA is the only authorized agency to issue public advisories on forthcoming DSS events.

CMA developed a forecasting and early warning system that became operational in 2001 (see Figure 2.1). Its DSS Forecasting System (DSSFS) normally consists of three components: (1) Weather Forecast Model, (2) Dust Aerosol Module, and (3) Data Assimilation System. Monitoring can provide absolute values of visibility, TSP, PM_{10}, etc, mainly derived from surface- based observation, and data of land use/cover, soil moisture as well as the spatial distribution of DSS derived from satellite-based observation. All the information is to be quickly transferred to the Data Assimilation System of DSSFS to provide new dust initial condition for rolling forecasting. The soil moisture data retrieved from satellite can also be compared with the model-estimated data derived from Dust Aerosol Module in the DSSFS. Because the DSSFS can output the dust emission flux, the direct indicator of the source of DSS, source information can serve as the basis of DSS source identification for government decision makers. The spatial distribution and deposition of dust aerosol derived from DSSFS can be employed as the scientific basis to assess the impact of DSS to human health, economic loss, etc.

Figure 2.1 The DSS Forecasting and Early Warning System in the PRC



Source: CMA

CMA has since 1 March, 2001 decided to input the results on forecasting (for the normal sandstorms) and early warning (for the stronger sandstorms) into the regular meteorological forecasting-system. The first early warning for the stronger dust and sandstorms was issued on 18 March 2001 in the parts of Gansu Province and Inner Mongolia and Ningxia Autonomous Regions with some indicators about stronger-wind and lower-temperature. They are now developing the so-called “the state services system for monitoring and early warning sandstorms in the first-stage” which involves a lot of data concerning the formation (outbreak), movement and distribution of dust and sandstorms. CMA issues the forecast of DSS events after analyzing the main meteorological indicators such as wind, visibility and radiation collected from about 60 meteorological observation-sites in the north and north-west PRC.

2.1.2 State Environment Protection Administration

The State Environment Protection Administration (SEPA) launched a research-program on dust and sandstorms in August, 2000 and set up the first ground-network for monitoring dust and sandstorms covering Inner Mongolia, Hebei, Shanxi, Xinjiang, and Gansu. SEPA had 43 observation-sites in the PRC at the beginning of 2001 (see Table 2.2).

Table 2.2 List of DSS Monitoring Stations Maintained by SEPA, PRC

	Location	Province	Equipment		
			TSP, Visibility	PM_{10}	LIDAR
1	Beijing	Beijing	X	Automatic	Equipped
2	Bole	Xinjiang	X	Manual	
3	Kashi(Kaxgar)	Xinjinag	X	Manual	
4	Hami(Kumul)	Xinjiang	X	Manual	
5	Aksu	Xinjiang	X	Manual	
6	Hotan	Xinjiang	X	Manual	
7	Xining	Qinghai	X	Manual	
8	Golmud	Qinghai	X	Manual	
9	Lanzhou	Gansu	X	Automatic	To be equipped
10	Dunhuang	Gansu	X	Manual	
11	Jiayuguan	Gansu	X	Manual	To be equipped
12	Zhangye	Gansu	X	Manual	
13	Jinchang	Gansu	X	Manual	
14	Wuwei	Gansu	X	Manual	
15	Yinchuan	Ningxia	X	Automatic	To be equipped
16	Yulin	Shaanxi	X	Manual	
17	Xi'an	Shaanxi	X	Automatic	To be equipped
18	Tongchuan	Shaanxi	X	Manual	
19	Hohhot	Inner Mongolia	X	Automatic	Equipped
20	Bayam Hot	Inner Mongolia	X	Manual	
21	Ejin Qi	Inner Mongolia	X	Manual	
22	Baotou	Inner Mongolia	X	Manual	
23	Erinhot	Inner Mongolia	X	Manual	To be equipped
24	Xilin Hot	Inner Mongolia	X	Manual	
25	Siziwang	Inner Mongolia	X	Manual	
26	Sonid Youqi	Inner Mongolia	X	Manual	
27	Jining	Inner Mongolia	X	Manual	
28	Duolun	Inner Mongolia	X	Manual	
29	Chifeng	Inner Mongolia	X	Manual	
30	Tongliao	Inner Mongolia	X	Manual	
31	Ulanhot	Inner Mongolia	X	Manual	
32	Datong	Shanxi	X	Manual	
33	Shijiazhuang	Hebei	X	Manual	
34	Zhangjiakou	Hebei	X	Manual	
35	Chengde	Hebei	X	Manual	
36	Shenyang	Liaoning	X	Automatic	To be equipped
37	Dalian	Liaoning	X	Automatic	Equipped
38	Baicheng	Jilin	X	Manual	
39	Songyuan	Jilin	X	Manual	
40	Tongyu	Jilin	X	Manual	
41	Changchun	Jilin	X	Automatic	To be equipped
42	Hefei	Anhui	X	Automatic	Equipped
43	Qingdao	Shandong	X	Automatic	To be equipped

Note: TSP measurement in each station above is manually done. Visibility is measured by the naked eye. All the stations operate throughout the year.
Source: SEPA

Most of the stations are in the bigger cities. The chief tasks for these observation-sites are collecting samples of sands and dust for identifying source areas and reporting meteorological changes that are conducive to DSS. Two types of data are collected: Total Suspended Particulates (TSP) and the atmospheric vertical profile of DSS derived from the LIDAR.

SEPA also collects relevant basic data such as the sand-dust particle size, mineral composition, chemical composition, storm duration and intensity and the path for long range transport of dust.

2.1.3 State Forestry Administration

The State Forestry Administration (SFA) is the institution mandated by law to prevent and control desertification in the PRC. It maintains a National Desertification Monitoring Center. A three-level national desertification and sandification monitoring system covering 30 provinces and 851 counties has been in operation in SFA. This system includes macro-monitoring (land use change, vegetation cover, soil, and land degradation dynamic), sensitive region monitoring, and positioning monitoring. The desertification and sandification database has been established. It has a network of 30 monitoring stations in the northern and western PRC . Those shown in Table 2.3 are illustrative of the range of data collected. In addition, SFA has a special responsibility to mitigate the impact of DSS in the PRC

Table 2.3 Status of Permanent Observation Stations Maintained by SFA, PRC

<table>
<tr><th>Stations</th><th>Year of Start</th><th>Location</th><th>Purpose</th><th colspan="4">Normal Factors for Observation</th><th>Facilities Needed</th></tr>
<tr><td>Cele, XJ</td><td>1998</td><td>S Edge, Taklimakan desert</td><td>Dust disaster and dune movement monitoring</td><td>Meteo-rological</td><td>Soil</td><td>Vegetation</td><td>Dust Weather</td><td></td></tr>
<tr><td>Shazhuyu QH</td><td>1998</td><td>Gonghe Basin</td><td>Impact of dune reactivation and range land degradation to Longyangxia Dam</td><td rowspan="7">- Local meteorolo-gical factors;

- Auto meteorolo-gical observation system, if there is no meteorolo-gical station nearby</td><td rowspan="7">-Erosion;
-Moisture;
-Texture;
-Organic matter,
-Nutrient status
-Porosity.</td><td rowspan="7">-Prevailing species;
-Coverage;
-Height;
-Density;
-Biomass.</td><td rowspan="7">-Wind velocity;
-Dominant wind direction;
-Visibility;
-Continuity of dust;
-Times and intensity of dust occurred.</td><td rowspan="7">-Light-electronic dust collectors;
-Neutron moisture meters;
-Dust sediments collector and spare parts;
-Ground auto meteo-rological observation system</td></tr>
<tr><td>Minqin, GS</td><td>1998</td><td>E Edge, Baidan Jilin Desert</td><td>Wind-sand harm and water quality change in Hexi Corridor</td></tr>
<tr><td>Yanchi, NX</td><td>2000</td><td>SW edge of Mu Us</td><td>Dust weather at marginal and transitional areas</td></tr>
<tr><td>Dengkou, IM</td><td>1998</td><td>E of Ulan Buh Desert</td><td>Dust frequency, dune movement, vegetation degradation and secondary salinization</td></tr>
<tr><td>Ulan Aodu, IM</td><td>1998</td><td>Centre of Horqin Sandy Land</td><td>Dust weather and revegetation</td></tr>
<tr><td>Yulin, ShX</td><td>1998</td><td>SE of Mu Us</td><td>Wind-sand status and impacts of mining and steppe degradation</td></tr>
<tr><td>Huang Yangtan HB</td><td>2001</td><td>Low part of Hebei Upland</td><td>Dust weather in Yanshan Basin and monitoring effect of Beijing-Tianjin Project to Control Dust-sand Storm</td></tr>
</table>

Notes: XJ=Xinjiang, GS=Gansu, QH= Qinhai, ShX=Shaanxi, IM= Inner Mongolia, HB=Hebei
Source: State Forest Administration (SFA)

SFA launched a project on monitoring wind-sand resource in five provinces around Beijing and Tianjing on 11 April 2002. The monitoring system of the Three-North Shelterbelt Program has also been established to monitor vegetation recovery and project effectiveness. SFA monitoring is different from other systems and consists of ground surface monitoring (soil, vegetation, and land use change), onset and spread of desertification, the supervision of control-sand-project, and the evaluation of sand control projects. Recently, SFA has been constructing a new system for short-term forecasting of DSS events based on monitoring the duration, severity, and processes of DSS. An impact assessment of DSS is also included in SFA's program. Remote Sensing technology and Ground Monitoring technology are combined.

Since 2001, SFA and CMA have set up a consultative mechanism for prediction and forecasting of DSS events and early warning by combining land surface field observation information (land use, vegetation and land degradation dynamics, soil structure and moisture) provided by positioning monitoring stations and information on weather condition. The operation of the consultative mechanism has made a great contribution to improving the accuracy of DSS prediction and forecasting. The permanent positioning stations provide valuable information for DSS prevention by conducting long term field observation and analysis on the coherence of precipitation and vegetation species coverage and community dynamics. Improvement of the capacity and facilities of some of the stations for DSS monitoring in Northeast Asian network is, however, still needed.

2.1.4 Chinese Academy of Sciences

The Chinese Academy of Sciences (CAS) established a monitoring network on dust and sandstorms in 7 provinces of northern China with 12 observation-sites developed since 2002. These observation-sites collect relevant information about DSS and record meteorological change day by day with the use of the LIDAR. CAS now plays an important role in understanding the principles required to prevent and control DSS.

2.2 Japan

Various types of organizations are currently involved in DSS monitoring in Japan. Governmental research institutions and universities play a substantial role in studying meteorological and climatic phenomena of DSS. Governmental agencies, on the other hand, provide financial support for the research activities and conduct public awareness programs for DSS in the country.

2.2.1 Japan Meteorological Agency

There is an extensive network of meteorological stations throughout Japan, maintained by Japan Meteorological Agency (JMA). As an external agency of the Ministry of Land, Infrastructure and Transport of Japan, JMA is responsible as the National Meteorological Service for improving public welfare through the prevention and mitigation of natural disasters, safety of transportation, prosperity of industries, and international cooperation activities. Its major services include, among others, the issuance of weather forecasts and issuance of warnings/advisories against severe weathers. JMA uses the following numerical prediction models for its operational forecasting: (a) Objective Analysis, (b) Global Spectral Model, (c) Asia Spectral Model, (d) Japan Spectral Model, (e) Typhoon Spectral Model, and (f) Aerosol Chemical Transport Model..

In addition, there are 113 meteorological sites throughout Japan where DSS phenomena are monitored (based on visibility). The release of DSS aerosol dust forecasts started in January, 2004. DSS aerosol distribution that could affect transportation and the daily activities of people are provided by JMA over the internet and broadcasted by the weather companies.

2.2.2 Ministry of the Environment of Japan

Ministry of the Environment of Japan maintains a network of air monitoring stations (including DSS monitoring). The ministry plays a lead role in the monitoring of air quality for the whole country. The network is called the Atmospheric Environment Regional Observation System (AEROS), or otherwise referred to as "Soramamekun." It enables an hourly interval real-time air pollution data to be accessed worldwide over the internet.

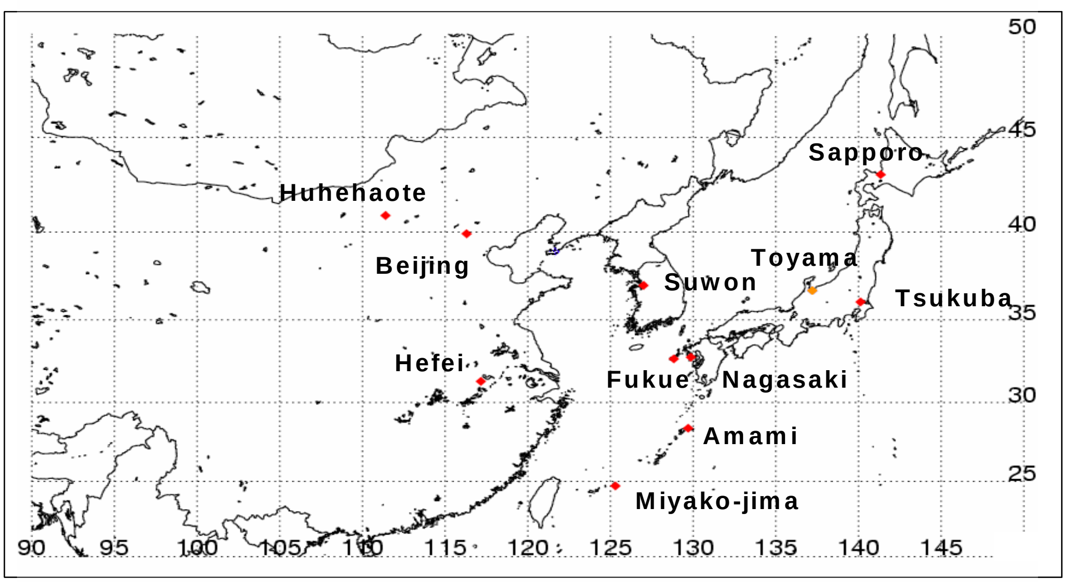
There are 1,541 stations in the network conducting continuous PM_{10} monitoring. TSP and data from the LIDAR are also the principal indicators monitored by the stations in the network. In Japan, 100µg/m^3 is the environmental regulated value for atmospheric aerosols. However, it has been reported from various sites that concentrations of atmospheric aerosols often exceed this limit. Therefore, administrative authorities in charge of air quality monitoring are also paying attention to dust aerosol events since floating dust is one of the country's environmental problems.

The ministry has also installed LIDAR in Toyama in 2003. The equipment is integrated into the NIES-LIDAR network.

2.2.3 The National Institute for Environmental Studies

The LIDAR is an important equipment for DSS monitoring. Japan is at an advance stage in the use of LIDAR for monitoring and analysis of DSS events specifically at the National Institute for Environmental Studies (NIES). The NIES-LIDAR system was originally developed in Dr. Sugimoto's laboratory. The LIDAR can be operated automatically at a 15-minute interval and can detect all DSS aerosols transported by wind at any altitude (even to the troposphere). DSS monitoring, as shown in Figure 2.2 is currently carried out at 11 NIES-LIDAR Observation sites; 7 in Japan, 1 in Korea, and 3 in the PRC. The LIDAR data can be viewed in real time by any registered user.

Figure 2.2 The Present Day Distribution of NIES-LIDAR Stations in Northeast Asia



Source: NIES, Japan

Figure 2.3 illustrates the results from the NIES-LIDAR network monitoring conducted for a period of one month in April 2002. The changes in color represent aerosol signals received through LIDAR signals, with green and red representing low and high concentrations, respectively. Dust aerosol blown to Beijing between April 7 and April 8 was observed several hours later in the Republic of Korea (Suwon). In Japan, low-level dust aerosol phenomena were observed in Kyushu (Nagasaki), which is located close to the PRC. However, only trace levels of dust aerosols were observed at trace concentration level in Tokyo (Tsukuba). It is reported that dust concentration at the ground surface level in Beijing during this time exceeded $1 mg/m^3$, and that those in Kyushu was 0.1-$0.2 mg/m^3$. The LIDAR monitoring results show that dust aerosols reached Beijing five times during the month of April, 2002, whereas, in Tokyo it was only three times of very weak dust.

The mutual sharing of real-time data in the meteorological and environmental fields enables quantitative determinations of the transported area and atmospheric concentrations of dust aerosols (DSS), and is thus extremely effective. As a representative example, Figure 2.4 shows the results for PM_{10} (air quality monitoring information by "Soramamekun") and visibility (meteorological information) monitoring for a DSS event observed in Japan during March 21 and 22, 2002. The NIES-LIDAR observation results obtained in Beijing proved that the DSS event had its origin in the PRC. The DSS event, which occurred there on the morning of March 20, was subsequently blown to Japan.

Figure 2.3 Vertical Profiles of Observed DSS Phenomena at Four NIES-LIDAR Sites (April, 2002)

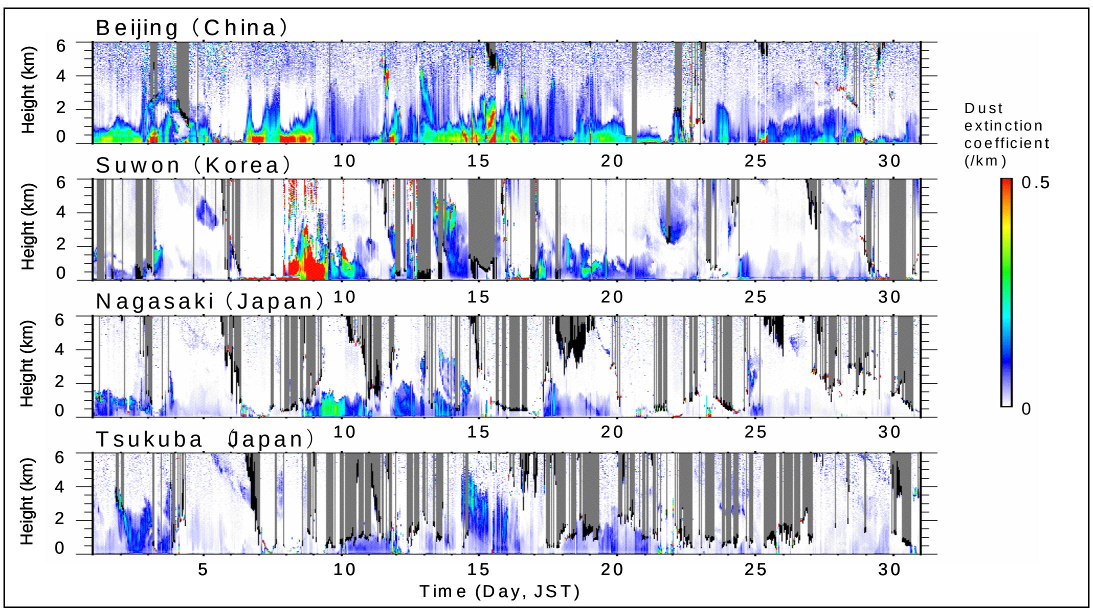
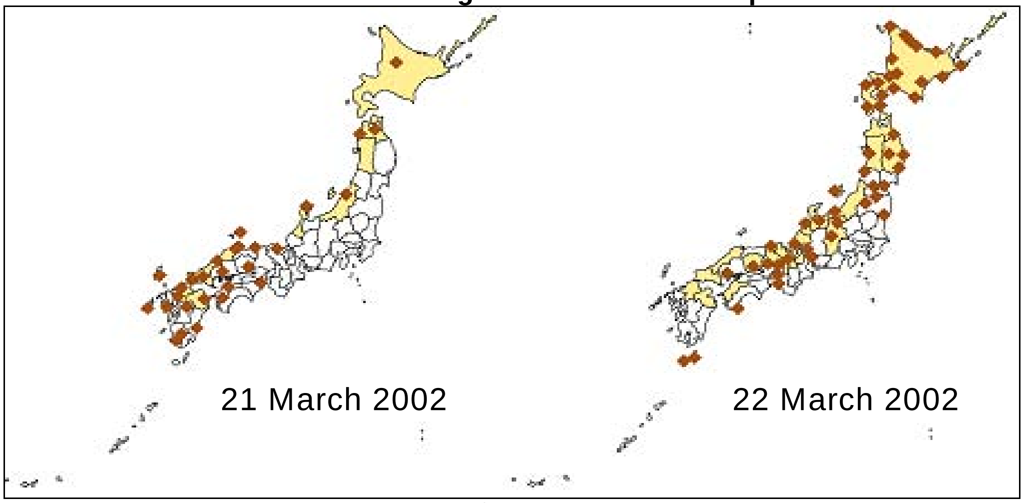


Figure 2.4 Collaborative Monitoring Results of PM_{10} and Visibility Relating to a DSS Event in Japan



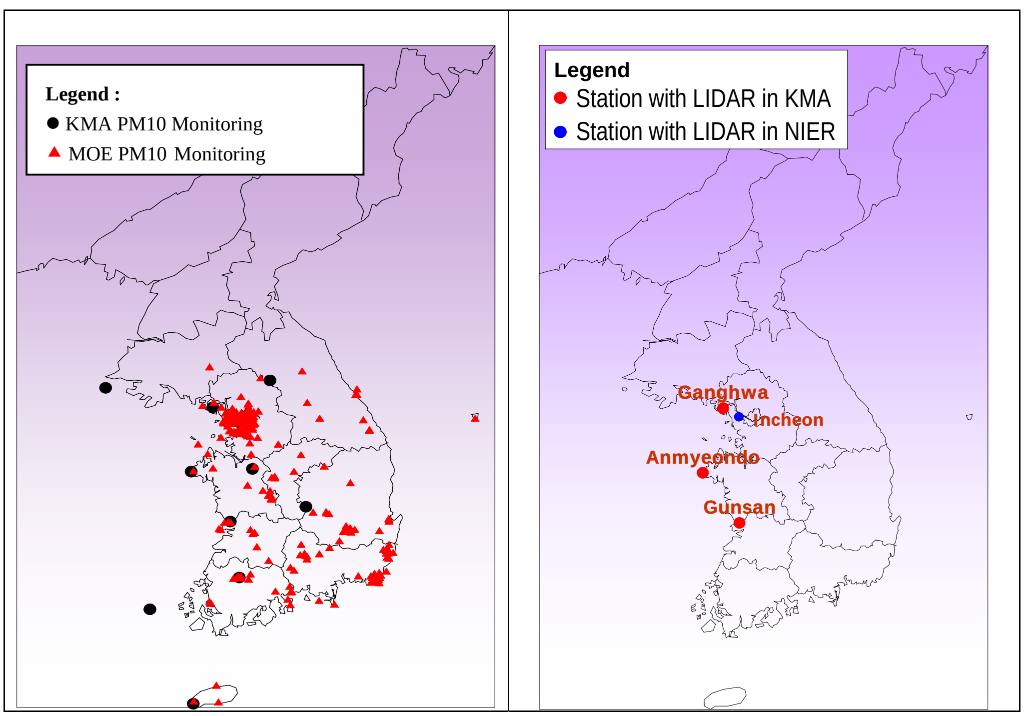
Note: Yellow area indicates each site with over 100 ug/m^3 in the daily average value of PM_{10} and brown square mark indicates each site that identified a DSS event through visibility monitoring.

Source: NIES, Japan

2.3 Republic of Korea

Republic of Korea (Republic of Korea) is subjected to periodic DSS that can involve both blowing dust and floating dust. The Ministry of Environment (MOE) and Korea Meteorological Administration (KMA) are both involved in DSS monitoring with stations located throughout the country (see Figure 2.5). LIDAR located in Republic of Korea's west coast are operated by KMA and National Institute of Environment Research (NIER).

Figure 2.5 DSS Monitoring Sites in the Republic of Korea



Meteorological Research Institute (METRI) and NIER play a major role in researching the phenomena of DSS. Korea Environment Institute (KEI) makes a role of research on quantitative analysis of DSS damages and possible policy alternatives in domestic and international level.

2.3.1 Ministry of Environment

The Ministry of Environment (MOE), through NIER, maintains 224 automatic air pollution-monitoring stations to measure the atmospheric pollutants including dust (PM_{10}) in the air (see Figure 2.5). The system collects data on a five-minute interval and electronically transmits the data to MOE and KMA in real time to support the operation for the warning system.

2.3.2 Korea Meteorological Administration

Figure 2.5 reflects the monitoring sites (black circles) managed by KMA, which measure the concentration of DSS.

KMA observe and monitor Asian dust events in the following ways:

1) Visual observation for the occurrence of Asian dust event at 42 synoptic weather stations within the country and also some stations in the the PRC (Table 2.4);
2) PM_{10} measurement at 11 sites (Anmyondo and Baek-Ryeongdo located in the western part of the Korean peninsula, and Mt. Gwanak in Seoul, Gunsan, Ganghwa, Heuksando, Gosan, Gwangduksan, Chupungryung, Gwangju and Cheonan, which are all shown in Figure 2.5;
3) LIDAR measurement at the Global Atmospheric Watch (GAW) observatory in Anmyondo, Ganghwa, and Gunsan;
4) Modified Satellite images from GOES, NOAA, TERRA, and SeaWiFs;[1] and
5) Hwangsa Concentration Model for operational use.

Table 2.4 DSS Joint Republic of Korea / PRC Monitoring Stations in the PRC

Station	Equipment
Tongliao	PM_{10}, TSP
Dalian	PM_{10},TSP,LIDAR
Huimin	PM_{10}, TSP
Zhurihe	PM_{10}, TSP, Visibility,[1] (Sunphotomener)
Yushe	PM_{10}, TSP, Visibility,[1] (Sunphotomener)

[1] data are measured by meter
Source: KMA

In the Republic of Korea, there is an active weather forecast and early warning advisory service provided by KMA. Table 2.5 gives the flow of this advisory and warning service.

[1] Refer to Appendix 4: Technology and Processes on DSS Monitoring, Forecasting and Early Warning.

Table 2.5 Republic of Korea's DSS Advisory and Warning Service

Advisory	Warning
When an hourly averaged dust concentration (PM_{10}) expects to exceed 500㎍/㎥ for over two hours	When an hourly averaged dust concentration (PM_{10}) expects to exceed 1000㎍/㎥ for over two hours

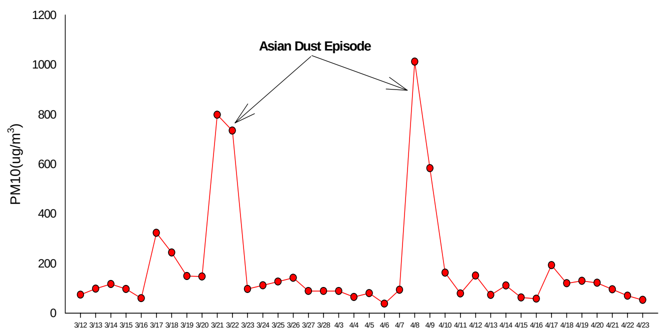
Source: KMA

2.3.3 The National Institute of Environmental Research

The National Institute of Environmental Research (NIER), which belongs to MOE, carries out research on DSS (also commonly known as "Yellow Sand") with the aim of understanding the long-range transportation phenomenon and its impact from DSS source areas to Korea.

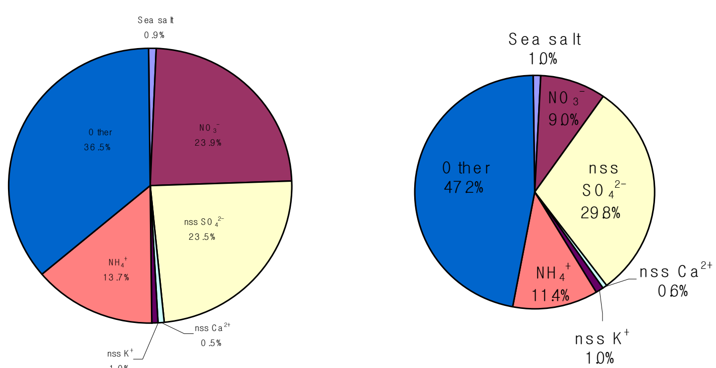
NIER has continuously monitored the PM_{10} at 224 stations (see Figure 2.6 for output sample) and has analyzed ion components for PM_{10} and $PM_{2.5}$ in urban and remote areas during DSS events (see Figure 2.7).

Figure 2.6 Variation in PM_{10} Concentration in Seoul (March & April, 2002)



Note: concentration of PM_{10} reached 1,000㎍/m^3 during the DSS.

Figure 2.7 Ion Components in $PM_{2.5}$ in Seoul and Deokjeok Island (March & April, 2003)



Note: The sulfate (SO_4^{2-}) in Seoul and Deokjeok Island, located in the West Sea of the Korean Peninsula increased by 10% during the DSS event in comparison with non-DSS periods.

2.3.4 Korea Environment Institute

Korea Environment Institute (KEI) carries out impact assessment and damage investigation of DSS. KEI has launched a research project on quantitative analysis and reduction measures of DSS damages in Northeast Asia from 2003 to 2004. The purpose of this project is to analyze the occurrence, effects, and damages of DSS in an integrated method and to estimate the actual damage costs, especially focusing on the areas of human health and amenity. The analysis revealed that the scope of the damage costs include medical costs and opportunity costs (time loss and welfare loss) due to the discomfort brought about by the DSS. According to estimates, the total damage cost of DSS was 5,922 billion Korean won (0.8% of GDP or about US$4.6 billion) all over country in 2002. Of the total damage costs, medical costs mainly due to premature mortality account for about 37%, welfare losses due to discomfort account for 34%, and avoidance costs account for 30% (see Table 2.6).

Table 2.6 Damage Costs of DSS in the Republic of Korea in 2002

Damage Scope	Costs (billion Korean won)	Share to Total (%)	Estimation Method
Discomfort	20,015.1	33.8	Contingent Valuation Method (CVM)
Medical cost	21,673.2	36.6	
Avoidance cost	17,528.1	29.6	
Total	**59,216.4**	**100.0**	

Source: K.K. Kang, J.M. Chu, H.S. Jeong, H.J. Han, 2004. A Study on the Analysis of Damage of Northeast Asian Dust and Sandstorms and of the Regional Cooperation Strategies, KEI, p.106.

2.4 Mongolia

Mongolia currently has 117 weather stations, 219 meteorological posts, 7 upper air sounding stations, 22 air pollution controlling stations, 8 environmental monitoring stations, 1 satellite receiving station, and 1 weather radar observation station (see Figure 2.8).

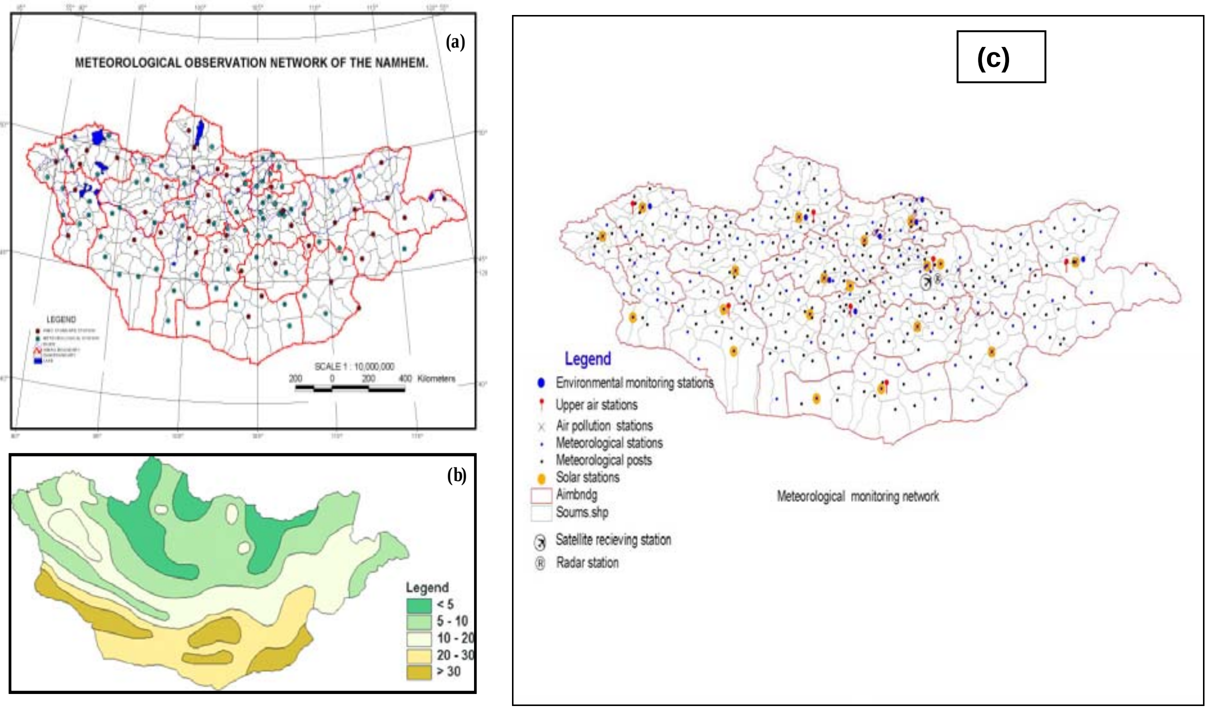
The principal monitoring stations are maintained by National Agency for Meteorology, Hydrology and Environmental Monitoring (NAMHEM) and data sharing is easily arranged. NAMHEM operates a network for meteorological survey that consists of 117 meteorological stations and 185 meteorological observation posts. Of these, 40 stations report their data to the World Meteorological Organization (WMO). The main objectives of the NAMHEM network are: (i) to provide survey information on the weather condition to the relevant organizations and to the public, and (ii) to issue forecasts at 12 hourly, daily, 3-day, and monthly as well as warning information on emergency and extreme emergency phenomena to the weather forecasting department in accordance with the established rules.

All the observation data from these stations is collected in the Information Center (ICC) of the Ministry of Nature and Environment. After checking, sorting, and primary processing, the data is transmitted to the Institute of Hydro-Meteorology, the provincial meteorological centers, and the WMO regional centers (through Beijing and Novosibirsk).

The meteorological sites in Mongolia measure the following DSS related parameters:

- Dust storm(duration, maximum wind speed);
- Wind speed and direction (8 times per day);
- Visibility at daytime;
- Soil moisture at 22 points during the spring; and
- Surface temperature at 0800 and 2000 hrs.

Figure 2.8 Monitoring Stations in Mongolia



Note: (a) Network of meteo stations maintained by NAMHEM ;
(b) The yearly average number of days with dust storms observed based on horizontal visibility in Mongolia during 1937-1999 [Natsagdorj et al., 2003]; and
(c) Network of ecological stations. Note the distribution of dust days in relation to the existing network of monitoring sites.
Source: NAMHEM

Only 15 stations have wind measurement instrument known as the "M-63" while the rest of the stations conduct wind observation visually. As such, visibility is defined by the observer in these stations. The upper air stations measure wind speed and direction at levels up to 13 km and sounding twice per day at 00 and 24 hrs (GMT).

Although there are 22 air quality monitoring stations in the country, the measurement of TSP is carried out only at one station in Ulaanbaatar. Due to financial constraints, there are no stations for dust monitoring along the path taken by the DSS events.

The Civil Aviation Authority has its own Airport Surface Meteorological Observation and Data Acquisition System that consists of meteorological data collectors for its airdrome needs in the 18 airports that are located in aimag (province) centers. Seven aerodromes at the aimag centers are adjoined to the meteorological observation fields of NAMHEM, therefore the real-time monitoring data of these automated stations could be used also for weather stations if the communication problem is solved.

The main problem in Mongolia is the lack of a good database. Since 1936, the meteorological observation system has been developed and expanded. At present, the existing ground meteorological monitoring network in Mongolia is virtually unavailable to meet the DSS monitoring needs due to the following reasons:

- Insufficient density of ground meteorological stations, especially in remote and desert area;

- Measurement of wind and visibility are visually conducted in most stations without the use of any instrument;
- Outdated observation instruments in some stations; and
- Poor infrastructure of stations (e.g., many stations do not have power supply).

Although the highest proportion (~30% (±10%) during the last 43 years) of DSS sources are located in Mongolia [*Zhang et al.*, 2003], there are no special monitoring sites for DSS in the country. Most meteorological stations in Mongolia do not have any direct relation to DSS. Table 2.7 lists the existing meteorological stations in Mongolia by type. Mongolia has only one satellite receiving station that receives SeaWiFs and AVHRR data from SeaDas and NOAA satellites. The methodology for using the NOAA data for DSS monitoring is still in its developmental stage. However, some output information on DSS indicators (desertification and drought, snow cover, and land surface temperature) can be provided.

Table 2.7 Types of Meteorological Monitoring Sites in Mongolia

Location (Province)	Number of Stations[1]	
	Instrumented Stations (Basic Stations)	Meteostations
Bayankhongor	1	3
Gobi-Altai	2	4
GobiSumber	1	0
Dornod	1	1
Dornogobi	2	2
Dundgobi	1	2
Khovd	1	0
Khentii	0	1
Ulaanbaatar	1	0
Umnogobi	3	3
Uvorkhangai	1	1
Uvs	1	2
Sukhbaatar	1	2
Tuv	0	2
Zavkhan	0	1
Total	16	24

[1] Instrumented stations are where the monitoring program will include TSP/PM_{10} measurement and instrumented measurement of visibility, and soil moisture. The meteostations are with visual observation of visibility and other meteorological parameters.

2.5 Bilateral Initiatives on DSS Monitoring and Early Warning in Northeast Asia

All the partner countries are members of the WMO's worldwide network. Selected monitoring stations in each country supply meteorological data at frequent intervals to the WMO centers. Data on visibility, wind direction and strength, and other parameters of relevance to DSS are collected routinely as part of the WMO requirement using similar standards and indicators. This is an example of an "official" (government to government) data exchange mechanism. Other mechanisms exist but they are research focused, rather than a key role in any network that provides an operational basis for forecasting or early warning.

There are a number of bilateral initiatives already in place between partner countries that are related to DSS monitoring and early warning. These include the following:

a) The Meteorological Research Institute of Japan (JMRI) has carried out the Japan-China cooperative project known as ADEC in conjunction with the Chinese Academy of Sciences. DSS monitoring stations have been set up in the DSS source areas in the western PRC and along the transport route of the dust aerosols on their way to Japan. The fully instrumented monitoring site in the Taklamakan desert in Xinjiang provides data on the DSS outbreak and entertainment in eastward air flows. Transport and deposition are also analyzed. Numerical experiments using the Global Climate Model (GCM) on dust forecast have also been carried out to assess the impact of dust aerosols on global climate.

b) The Sino-Japan Friendship Environmental Protection Center and the National Institute for Environmental Studies of the Ministry of Environment of Japan have undertaken joint research on DSS. The principal focus was on DSS transport and the environmental effect of DSS aerosols originating in the northern PRC. A DSS monitoring network was established in the northeast PRC and Japan in February 2001. Six stations were established along the route from Beijing to Erinhot - the designated source area sites were at Beijing, Zhangjiakou, Zhangbei, Huade, Sonid Youqi, and Erinhot over a distance of more than 1,000 km. In addition to the sites in the PRC, three sites were monitored in Japan[2].

c) The Korea-China Environmental Science and Technology Exchange Center was established in 1999 in the National Institute of Environmental Research (Seoul). The principal function is to facilitate exchange of environmental information (and personnel) and the promotion of joint research. KMA is cooperating with CMA on Asian Dust forecasting. Five DSS monitoring stations will be set up (three in the eastern PRC and two in the Asian Dust path). These stations will be operated during the DSS season from February to May with the sharing of information and exchange of experts.

[2] Mori, I. Nishikawa, M. Quan, H. Morita, M., 2002. Estimation of the concentration and chemical composition of kosa aerosols at their origin *Atmospheric Environment* 36: 4569-4575

CHAPTER 3 PROPOSED ESTABLISHMENT OF A REGIONAL NETWORK FOR DSS MONITORING AND EARLY WARNING

3.1 Context for a Regional Network for DSS Monitoring and Early Warning

With the growing social-environmental implication of dust and sandstorms (DSS), the concern to improve DSS monitoring and early warning has significantly increased. In Northeast Asia, countries primarily affected by DSS, such as People's Republic of China (PRC), Japan, the Republic of Korea , and Mongolia, have conducted DSS forecasting and early warning services through their National Meteorological Services. The PRC initiated its forecasting service of DSS and early warning service for severe DSS for the public in 2001. Republic of Korea did the same in 2002 and Japan in early 2004. At present the Mongolian Meteorological Service is trying out similar services for the public.

The partner countries are member states of the World Meteorological Organization (WMO) network that works well with a defined purpose[1]. The national meteorological services of the WMO member nations have agreed to a free and unrestricted international sharing of meteorological data and products. Although meteorological data and services are essential for DSS monitoring and early warning, they are far from being adequate to analyze and predict a complex phenomenon like DSS. Also, the meteorological stations that are part of the WMO network are often those in urban and near urban locations and not many are located in remote areas, which are known to be the source areas of DSS.

Transboundary environmental problems such as DSS can most effectively be solved through regional cooperation. The merit of regional cooperation is that it will be possible to achieve much more through a network than by each country acting alone. There is considerable value-adding when neighbors combine their efforts to establish a regional monitoring and early warning network. Early warning of impending DSS events based on a regional monitoring network will be facilitated by data sharing with rapid communications on the progress and geographic extent of any DSS outbreak.

Based on the review of the current DSS monitoring programs in the partner countries for consideration in establishing a regional network for monitoring and early warning, the following issues and challenges are apparent:

Firstly, the perception, terminology, definition, monitoring method, current capacity, needs and expectation, etc. are all different from country to country. For example, there is a perception gap among the participating countries. DSS is considered as a phenomenon of natural disaster for countries in the source areas (upstream countries) while DSS is a problem of air quality concerning public health for downstream countries. The definition of DSS is also different from country to country depending not only on monitoring method but also threshold value. In addition, needs and expectations are also different from country to country, even from agency to agency within a country. Accordingly, optimization and flexibility with step-by-step approach is needed in formulating a feasible program for a regional monitoring and early warning network.

Secondly, although a few bilateral initiatives are already in place as mentioned chapter 2, these projects are limited to some specific field and national boundary areas. Moreover, these initiatives on DSS between partner countries are presently focused on academic

[1] The WMO is a specialized agency of United Nations with the purpose to promote meteorology and hydrology and facilitate cooperation for the benefit and protection of humans through, among others, the establishment of networks of observation stations, development and maintenance of systems for rapid data exchange, and standardization of observation and processed products.

research and are not designed as operational tools to improve public awareness of impending DSS disasters. Despite these agreements, it is still a hurdle for DSS researchers from other agencies in Northeast Asia to get real-time data, particularly the data across countries in the region. Since DSS is one of the transboundary environmental problems at a regional scale, multi-lateral cooperation mechanisms can solve the problem effectively and this is true for a regional monitoring and early warning network.

Thirdly, although Mongolia is one of the major source areas of DSS, there is no special monitoring site for DSS in the country. Moreover, most meteorological stations in Mongolia do not have any direct relation to DSS. In this regard, from a regional perspective, helping Mongolia develop its national capacity is one of the key tasks in terms of establishing a regional monitoring network, particularly on data sharing among participating countries.

3.2 Selection of Monitoring Indicators

To establish a regional network for DSS monitoring and early warning among the partner countries, there is a need to develop a monitoring indicator system. The establishment of the common DSS monitoring indicators should start with the data that is easily available or can be easily acquired at present. It should take into account the technique and method being used for monitoring in each partner country and the long-term observational data status at the regional level in Northeast Asia, and in particular, in the originating source areas of DSS. Moreover, the initial monitoring indicator system should be adaptable to the evolution of DSS monitoring and modeling techniques and should be able to meet the increasing needs of the forecasting and early warning service.

To provide for early warning services, on the whole, DSS forecasting needs the following data or information on weather and surface conditions:

(a) Information about meteorological observation and analysis covering the following:

- Meteorological observation in the northern hemisphere for the analysis of the atmospheric circulation, which will basically cause DSS in Northeast Asia;
- Detailed meteorological observational data in DSS source area and DSS affected area (such as atmospheric pressure, temperature, rain, humidity, visibility, and wind) and its three-dimensional distribution;
- Diagnosis and analysis on atmospheric thermo-dynamic information based on the weather observation data; and
- Numerical weather prediction products from different meteorological centers.

(b) Geographic information and surface monitoring information covering the following:

- Desert distribution and soil texture information (distribution, grain size, etc);
- Land use/cover change information; and
- Soil moisture status, including snow cover.

(c) Dust related monitoring information as follows:

- Atmospheric optical properties measurement including horizontal visibility (by transmissometers), optical depth and size mode (by solar radiation and sun photometer), vertical visibility and vertical profile (by LIDAR), light scattering (by nephelometer), etc.;
- The mass concentration and size mode of dust including TSP, PM_{10} and dust deposition, etc.; and
- Satellite monitoring and retrieval data for DSS, which can be acquired from a variety of meteorological satellites (as explained in Appendix 4).

All these information belong to the basket of indicators for DSS monitoring, which are currently collected and utilized differently by partner countries. For instance, Japan and Republic of Korea, which are relatively far from DSS originating source areas and where DSS is regarded mainly an air pollution concern, attach great importance to air quality indicators like TSP, PM_{10}, dust deposition, etc. Accordingly, significant efforts have been given in developing the monitoring instruments and techniques that can detect and monitor potential DSS impacts on air quality over a long distance for real-time data transmission like LIDAR. Republic of Korea has also developed a PM_{10} concentration indicator based early warning system for DSS events.

In the PRC and Mongolia, where most of the DSS occurs in Northeast Asia, visibility is considered the most widely used indicator, given the tangible nature of DSS and the meteorological observation capacity in these countries. Collection of relevant meteorological observation started quite early in both these countries and they have established corresponding data sets. Based on such a data set, the PRC has achieved progress in the studies on characteristics and regularities of DSS, which forms the basis of their assimilation and modeling of DSS events and early warning services.

The challenge in establishing a reasonable set of common monitoring indicators rests on the manner of accommodating the different needs (or "preference") among the partner countries without compromising the technical/operational feasibility of the proposed regional network, particularly at its initial stage. The monitoring indicators included in the core basket for cross-country exchange within the network need to be: (a) relevant to forecast models in all the partner countries, (b) readily available or which can be made available with minimal investment, and (c) capable for real time transmission from one country to another along the identified DSS transport routes in Northeast Asia. With this realization, through extensive and comprehensive discussions by the experts and researchers from the partner countries involved in the project, the partner countries agreed that the initial real time monitoring indicators for the regional network should comprise of: (i) instrument-measured visibility, (ii) $PM_{10,}$ and (iii) LIDAR-based observation data[2]. There are differences in the relative importance each partner country has given to individual monitoring indicators. The existence these differences do not prohibit, however, the partner countries from reaching an agreement on working with such a set of the commonly agreed DSS monitoring indicators for the regional network.

3.3 DSS Regional Network Structure

3.3.1 Organizational Structure

It is without question that there is the need to adjust the institutional system or framework at both the regional and national levels for the DSS regional network. It is important to decide on: (a) the type of organizational structure for the regional network, which can, in theory, be developed either as a centralized system or a decentralized one; and (b) to decide on a single agency within each partner country to serve as the national focal agency.

<u>Centralized Regional System</u>

A centralized system assumes that it is necessary to establish an operational regional center for DSS monitoring and early warning for the region, or at least for all the partner countries. This implies that all the relevant data collection agencies in each of the four countries would be reporting to the regional center, which can be operated by the experts and technicians

[2] An agreement reached during the Second Workshop on DSS Regional Monitoring and Early Warning Network in November 2003.

from the partner countries. Among others, the regional center should be responsible for data processing, DSS model simulation, and forecasting for early warning services for all the partner countries. This would require a centralized regional institution supported by a central facility and special purpose-built infrastructures and equipment to collect, transmit, analyze and store data. To establish a centralized system would be full of financial and administrative challenges. Furthermore, it is not always appropriate and desirable for a regional center vis-à-vis the concerned national authorities to provide early warning services in the form of public advisory for a forthcoming disastrous event like DSS.

Within the notion of a centralized system, however, there is quite a reasonable suggestion that data concerning DSS collected by various domestic agencies flow into a national center for DSS monitoring and early warning services. The national center of each partner country can coordinate all the agencies involved in data collection within the country to avoid overlapping or duplication. Moreover, each national center can then serve as the focal point for participating in and cooperating with the proposed regional DSS monitoring and early warning network. The data on DSS centralized at the national center, including the selected real time monitoring data, may be stored in a national databank and shared with its counterparts in other partner countries through the proposed network.

Decentralized Regional System

Decentralized system does not require a regional operational center for the partner countries. The four countries will continue to have their own independent DSS monitoring and early warning systems, which will be connected to each other through an operational network. Through participating in the regional network, each national DSS monitoring and early warning system expects to receive additional benefits through sharing and exchanging data and experiences in DSS monitoring and modeling for forecasting and early warning. The network does not require the construction of new centralized facilities, except for the additional monitoring and communication facilities that enable all the partner countries to collect and report the required data in a pre-determined manner. Under the decentralized system, there is still the possibility of having bi-lateral agreements between specific partner countries for specific data collection and sharing arrangement(s).

Viable Regional Organization Arrangement

The centralized system with the construction of a regional center does not appear to be a feasible and desirable model for the proposed regional network. A decentralized network can be established as a flexible and informal network for various institutions or agencies in the region to participate on a voluntary basis. Alternatively, it can be established as a formal operational structure that requires mandatory data sharing and reporting among the agencies of the partner countries in accordance with a commonly agreed manner for the forecasters and modelers of the partner countries.

It appears practical that the regional network be established as a decentralized regional network, which is supported with a monitoring system comprising a set of carefully designated DSS monitoring stations in the partner countries. These stations are to collect and report the selected DSS monitoring data under the coordination and supervision of the designated national center for real time sharing and exchanging among the partner countries.

National Focal Point and Inter-agency Coordination

Selection of a single agency to serve as the national focal point for the regional network on DSS could be a challenging issue that needs to be addressed carefully. It should be noted that most countries have mandated their meteorological agency (MA) to make forecasts on weather-related phenomena or providing public advisory or early warnings on the disastrous events like DSS. MA in each country has a wide range of monitoring stations that can provide DSS monitoring for the regional network. The meteorological system has a high-speed cross-country data transmission network that can serve as the basic infrastructures for DSS data sharing among the partner countries. It seems to be difficult to expect an operational network for DSS monitoring and early warning without the participation of the MA in the partner country. For some countries, it seems natural that their MA be nominated as the lead agency to serve as the national focal point for the regional network on DSS.

It should be noted, however, that MA is not the only agency that collects DSS monitoring data and works on DSS forecasting and early warning. Furthermore, the work done by MA has its limitations because the focus of its analysis is on forecasting weather-related adverse effects. Air quality concern and DSS source identification and mitigation are not within the main stream activities of the MA. One specific concern for non-MA agency is that the data collected or reported through the MA systems are not readily available to the non-MA modelers and researchers. These observations are of special importance for Japan where the core DSS researchers and modelers are from research institutes or universities who do not have direct access to meteorological data system. Inter-agency coordination of DSS monitoring and early warning between MA and non-MA agencies at the national level would be essential for the success of the network.

Given the limitations of the MA, it should be recognized that DSS monitoring and early warning could not done by the MA itself. The regional network, which requires free flow of DSS information between partner countries, needs to be established on the smooth collaboration among the DSS concerned agencies within each country first. There are many administrative hurdles to overcome before full and free flow of information between agencies and institutions become routine. There are reasons for this. The principal one is that the monitoring sites that were set up by each institution were designed for its own special purpose. There was little thought been given to how compatible their data sets might be with the others because it was never envisaged that they would be shared for DSS monitoring. Links should be formed between institutions to avoid unnecessary competition and duplication of effort. Institutions working on similar issues may arrange to specialize and to dovetail their activities to enhance cost-effectiveness.

Within the purview of their overall mandate and responsibility, the Ministry of Environment (MOE) of each partner country could stand as the sub-national focal point for the DSS regional network. Its role in the network would place support for the national focal point agencies to improve the environment with emphasis on air quality and health concerns. This public institution would also play a part in the data sharing scheme of the network.

Establishment of the network for DSS monitoring and early warning has offered the possibility for the partner countries to promote integration of the separate and isolated DSS monitoring efforts by the various institutions in their countries into one coordinated and coherent endeavor, not only on a national level, but also on a regional level across countries. Through regional cooperation, the network would be able to develop among the partner countries: (i) a set of DSS monitoring indicators, (ii) a commonly agreeable monitoring techniques equipped with standardized monitoring instruments, (iii) a standardized data sharing, reporting, and exchanging mechanism, and (iv) an agreed operational procedure and supervision mechanism.

Setting up a regional network implies agreement among the four partner countries and their various institutions and agencies to share relevant data for the purpose of facilitating more accurate and reliable forecasts of DSS events and the provision of early warning to reduce hazard. It also suggests the setting up and maintenance of long-term monitoring for the purpose of assessing the success of mitigation efforts.

3.3.2 The Selection of Network Monitoring Stations

Functions of the Network Monitoring Stations

For an improved DSS monitoring, forecasting, and early warning, it is envisioned that the main function of the designated stations within a country for DSS regional network is to provide real-time data of selected monitoring indicators, specifically to their respective national focal agency. This is for purposes of sharing the data with the national focal agencies of other partner countries and for the data assimilation model within their own national forecast system at their respective national focal agencies. Through this arrangement, these regional network stations can play two specific operational functions for the national focal agency in each partner countries: (i) to facilitate an early capture of the breakout and/or movement of DSS events in the region, and (ii) to enable the national focal agencies to have a rolling assimilation of DSS events through timely and repeated updating of the monitoring of DSS events along its transportation route within the region. By comparing the ground-based monitoring data selected with the monitoring indicators obtained through other techniques (e.g. remote sensing data through satellite images), the national focal agencies will be able to verify, on a timely and continuous basis, their assimilation models in their forecast system to significantly improve their capacity in providing accurate early warning services.

Given the long-distance transportation route of DSS from its breakout through dust deposition across the Northeast Asia region, it is most important to make an assessment of the relevance of the existing monitoring stations in each partner country to identify an appropriate group of the network monitoring stations as initial network monitoring stations. Based on assessment of their significance in capturing the breakout and movement of DSS event in the region, these network monitoring stations needs to be classified into two different categories, to be equipped with different monitoring capacity for their expected roles in the regional network. The classification is important because it is neither feasible nor necessary to equip all network monitoring stations with the same capacity at the initial stage of the network development, which is expected to handle a minimum set of the most relevant monitoring indicators for improving the early warning capacity for the region as a whole.

Classification of Monitoring Stations and Specification of Relevant Instrumentation

Based on the geographical locations of the stations and the selected monitoring indicators discussed, the network monitoring stations fall into the following two categories:

1) Class A Stations: are the *key stations* since they are geographically important (e.g., located at the DSS source areas). These stations have (or are going to have) the capability to measure ground surface conditions, meteorological data (as prescribed by the WMO), suspended particles by instrument measured visibility, LIDAR and PM_{10} (and TSP). There are currently a few Class A Stations in the PRC and none in Mongolia. Visibility, PM_{10}, and LIDAR allows Class A Stations to provide real time data on spatial distributions and vertical profile of an ongoing DSS, which have special importance for the remote forecast centers to capture the physical details of a DSS event for simulation and early warning. It is crucial for the regional network to ensure data exchange in real time between the partner countries, or among these stations that are fully equipped. It is an urgent priority to upgrade the capacity of the station(s) that have been designated as Class A Station.

2) **Class B Stations:** comprise of the *general stations* in the regional network that can monitor and report PM_{10} data in real time over a long distance, in addition to reporting visibility data. The important feature of these stations is their capability to measure suspended particles like PM_{10} (and TSP by batch sampling). PM_{10} data is essential to measure air quality. The data from these stations together with those from the Class A stations are vital for DSS simulation and modeling at remote forecast centers because it can be monitored and reported in real time. Not all the designated Class B stations in the network have the capacity to measure dust particle concentration. It will take time to upgrade the monitoring capacity of these existing stations, particularly those in Mongolia where there are none capable of monitoring PM_{10}.

It should be noted that in this two-layer hierarchy, there is a relatively large number of Class B Stations at present that can offer visibility data and PM_{10} data. Likewise, very few Class A Stations at geographically important locations have LIDAR equipment.

To develop the network monitoring stations, different strategy should be adopted for the instrumentation of stations. The widely applied naked-eye-based observation of visibility should be replaced with instrumented data. It is expected that instrumental measured visibility data would allow standardization of monitoring operation, and provide a more solid basis for cross-country reporting and comparison. The main constraints to successful operation of Class A Stations will be the availability of LIDAR monitoring equipment and the operating capacity including the required support infrastructure facilities. The key for successful operation of Class B Stations is to ensure the availability of instrument-measured visibility and PM_{10} monitoring equipment and a standardized monitoring operation for real time reporting.

In addition, it should be noted that the network monitoring stations downwind of the DSS source areas, such as those on the coastal areas of the PRC, in Japan and the Republic of Korea are usually well equipped. They have a very important role to monitor the impact of DSS, analyze deposition process of DSS, and provide early warning services. The existence of these stations provides a greater possibility for the modelers and researchers in the region to establish, by incorporating the monitoring data collected from these stations, a full simulation cycle of DSS event from its outbreak to deposition.

Phased Development of the Regional Network

Taking into account the financial and technical (including human capacity) constraints, a phased approach is necessary for the development of the network of monitoring stations in each of the partner countries. The partner countries need to identify a set of designated network monitoring stations and reach a consensus on their classification, based on their significance in DSS monitoring and early warning for the region. Upon commencement of the operation of the regional network, monitoring data available from the existing monitoring stations in each partner country could be shared immediately. Continued efforts should be made through cooperation by all the partner countries to improve the network gradually but steadily, by standardizing the monitoring operation, data reporting and sharing mechanism, and upgrading both the human resource and equipment capacity at a later stage or phase, probably along with the necessary expansion of the network. Moreover, the phased development should carry the experiences of the ongoing cooperation between the PRC-Korea and the PRC-Japan and need not be thought of as a rigid sequence where each phase needs to be completed before the next phase begins.

The phased development should include upgrading selected network monitoring stations along the hierarchical structure over the short- to medium-term. The salient features of the envisioned three phases of development are as follows:

- **In Phase 1** (short term) The emphasis of this phase is on *data sharing and capacity development for monitoring and early warning and data transmission.* The forecasting result sharing is encouraged whenever possible. The agreed DSS monitoring data will be shared among the partners. A system of network monitoring stations will be established to comprise 25 stations in the PRC and 6 in Mongolia plus the stations in Japan and the Republic of Korea. These stations are expected to form a chain of key monitoring stations from the DSS source areas to the depositional areas along the main DSS transportation route across the region. Apart from standard meteorological data, the main indicators for data sharing would be *particulate concentration* data (measured by PM_{10} and LIDAR) and *visibility*. Phase 1 should also include necessary technical upgrading. A target should be set to upgrade, within the short-term, the traditional naked-eye based visibility measurement at each network monitoring station to an instrumented one (to do away with the subjectivity associated with visual estimates). Selected stations (two to five) in both the PRC and Mongolia will be equipped with LIDAR equipment to give better assessment of the vertical profile of DSS events. Initial training and capacity building for a standardized monitoring and reporting operation would be a component in this phase. It is also proposed that outcomes of the DSS simulation and forecast at the national focal agencies be shared among the partner countries in a timely way as well. It is noted that this arrangement could give special benefits to Mongolia for its participation in the network, given its relatively less developed DSS assimilation and forecast capacity. A decentralized network is preferred with data sharing for the purpose of short-term forecasting.

- **Phase 2** (medium term) The focus is on *strengthening the DSS monitoring network.* Activities could include (i) expansion of the network by including about 30 additional monitoring stations to the network, and (ii) upgrading monitoring capacity of more stations in the network. Priority for network expansion should be given to help Mongolia build up its national DSS monitoring capacity as part of the longer term development. The main focus of technical upgrading at this phase will be provided for most of the network monitoring stations. Because PM_{10} data are available in real-time, such data are more useful for forecasting and early warning than data derived from TSP sampling. Technological progress in high-speed sampling and analysis may make TSP more useful in the future for forecasting and EW. The further development of sites to include LIDAR would be a feature of this phase. Selected stations along the chain of stations (including those in the DSS source areas), would be a high priority for upgrade. Intensified efforts for capacity building on application of the more sophisticated monitoring instrument and frequent exchange of experiences among experts in DSS modeling would be the main feature of the capacity building program during this phase.

- **Phase 3** (long term) The main focus of Phase 3 is to *improve DSS forecasting methods* to provide both short-term (early warning) and long-term (seasonal) predictions. Long-term forecasting will depend heavily on data derived from ground surface monitoring and on verification of prediction model output. It would also be a time to improve the overall capacity in Mongolia in the field of DSS forecasting through software development for modeling and simulation, training of personnel for monitoring stations, data processing and interpretation, etc. The possibility of getting sufficient external funding support for this aspect should be explored. . Based on the experiences of the first phases, the partner countries may consider expanding the regional cooperation by involving other relevant countries in the region (e.g. Kazakstan). The four partner countries may explore, once again at this stage, the necessity to set up a regional databank, which might provide a platform for training and exchange of experiences and technologies on DSS monitoring and early warning with an overall objective to have the partner countries reach a similar level in terms of national capacity to monitor DSS events, forecast DSS outbreaks (onset), and predict transport routes, transit times, likely duration, and geographic distribution..

Direction of Capacity Upgrading

The findings of scientific researches have made it possible to understand the relationship between the atmospheric visibility and dust concentration. In the course of constructing the regional network for DSS monitoring and early warning in Northeast Asia, one of the priorities is to upgrade the visibility meter (Transmissometers) based observation stations from manual operation to instrumental operation as the network standard. Efforts will then go into research on identification of the quantitative relationship between visibility and dust concentration. Such identification may provide a solid basis to link up the visibility based simulation with the dust concentration based simulation of DSS events. Along with upgrading the capacity of most of the network stations during Phase 2 of network development, the above efforts will provide the possibility of combining the visibility and dust concentration into an integrated and more powerful simulation and forecast system. The DSS visibility forecasting combined with the DSS concentration forecasting may constitute the groundwork for the future DSS forecasting to not only predict dust concentration but also compare it with the observed concentration from the network monitoring stations in near real-time.

The Proposed Network Monitoring Stations in the Region

After consultation with the various stakeholders, it was agreed that the following stations are proposed to comprise the base stations for the regional network in the DSS source areas as well as in the downstream areas:

In the PRC: It is proposed that a national DSS data center (located in CMA) be established jointly by CMA, SEPA and SFA. This national focal agency could manage the input from all the PRC government agencies whose data would contribute to DSS forecasting and early warning. This national focal agency will also coordinate the network monitoring stations in the PRC for their participation in the regional network. Consistent with the phased development approach, the network development in the PRC will be done in the following phases:

- In Phase 1, the national DSS data center should be established and a network of 25 identified monitoring stations with various monitoring capability should be integrated into this system (see Table 3.1). The communication network, and hardware and software components should be upgraded at these 25 stations so as to monitor DSS-related parameters in real-time. A distribution map of the 25 stations is shown in Figure 3.4.

- In Phase 2, an additional of 18 monitoring stations should be included in the regional network (Table 3.2) in line with the envisaged expansion and upgrading of the network. A total of 43 stations, plus the national DSS data center, would comprise the system of DSS network of monitoring stations for the PRC. The national DSS data center gathers and analyzes the real-time data collected by the system and provides the real-time information to its counterparts in the other partner countries. The national DSS data center is also prepared to share the outcome of its DSS simulation and forecast with its counterparts in the partner countries, if the partner countries could reach an agreement on such information sharing and exchange.

Selected stations with LIDAR capacity/potential would be included in the DSS monitoring network, but the time of their inclusion will be decided based on resources availability and agreement between the PRC and concerned parties.

Figure 3.4 Selected Monitoring Stations in the PRC for DSS Regional Network

Source: CMA

Table 3.1 Proposed Phase 1 Monitoring Stations for DSS Network in the PRC

	Site	Visibility	TSP	PM_{10}	LIDAR	Additional Capacity
1	Jiuquan	*	//	*		
2	Minxian	*	*	*		
3	Germud	*	*	*		
4	Lanzhou	*	*	//		
5	Yinchuan	*	*	//		
6	Houma	*	*	*		
7	Datong	*	*	*	*	o
8	Zhangjiakou	*	*	//		
9	Erlianhaote	*	//	*		
10	Huhehaote	*	*	//	//	
11	Neimeng-Zhurihe	*	*	*		
12	Dianjiang	*	*	*		
13	Nanyang	*	*	*		
14	Shenyang	*	*	//		
15	Changchun	*	*	//		
16	Beijing	*	//	//	//	
17	Qingdao	*	*	//		
18	Zhengzhou	*	*	*	*	o
19	Lianyungang	*	*	*		
20	Akesu	*	*	*		
21	Bayannuoergong	*	*	*	*	o
22	Xingzi	*	*	*		
23	Baicheng	*	*	*		
24	Donggang	*	*	*		
25	Suniteyouqi	*	*	*		

Note : // means existing instrumented capacity; * means adding needed equipment; o means with a plan for adding equipment in the future.

Table 3.2 Proposed Phase 2 Additional Stations for DSS Network in the PRC

No.	Site	Visibility	TSP	PM_{10}	LIDAR	Essential Meteorology Data
1	Xinjiang-Hetian	∗	//	∗		//
2	Xinjiang-Hami	∗	//	∗		//
3	Xinjiang-Kashi	∗	//	∗		//
4	Xinjiang-Wulumuqi	∗		//	∗	//
5	Xinjiang-Ruoqiang	∗		∗		//
6	Neimeng-Ejimaqi	∗		∗	∗	//
7	Neimeng-Xilinhaote	∗		∗		//
8	Neimeng-Chifeng	∗		//		//
9	Neimeng-Wulanhaote	∗		∗		//
10	Neimeng-Hailaer	∗		∗		//
11	Qinghai-Xining	∗		//		//
12	Qinghai-Waliguan	∗		∗	∗	//
13	Gansu-Zhangye	∗	//	∗	∗	//
14	Gansu-Xifeng	∗		∗		
15	Shandong-Jinan	∗		//		//
16	Liaoning-Dandong	∗		//		//
17	Jiangsu-Nanjing	∗		//		//
18	Jilin-Tumen	//		∗		//

Note : // means existing instrumented capacity; ∗ means currently non-instrumented observation but equipment for monitoring visibility is needed or means will be adding needed equipment; "empty cell" means no plan for adding equipment in the near future.

In Mongolia: Mongolia is the home site of over 30% of the DSS events experienced by the region. It's DSS monitoring infrastructure and capacity is relatively weak. This situation has provided a unique challenge and opportunity to improve DSS monitoring and early warning for the region as well as Mongolia---to strengthen DSS monitoring capacity in Mongolia would not only benefit Mongolia, but give considerable benefits to all the downstream partner countries through incorporating the monitoring data obtained at the origin of DSS.

On top of the list of needs is the establishment of a national network of DSS monitoring stations. Any new stations should be fully integrated into the system of the network monitoring stations. There is clear need to strengthen the monitoring data collection capacity in south Mongolia (see Box 3.1).

Over the medium term, Mongolia plans to establish a national DSS monitoring network consisting of 18 stations that are located in dry steppe, semi desert and desert areas (see Figure 3.5 and Table 3.3). The network monitoring stations are located along the dust path and windward side of the significant anthropogenic sources.

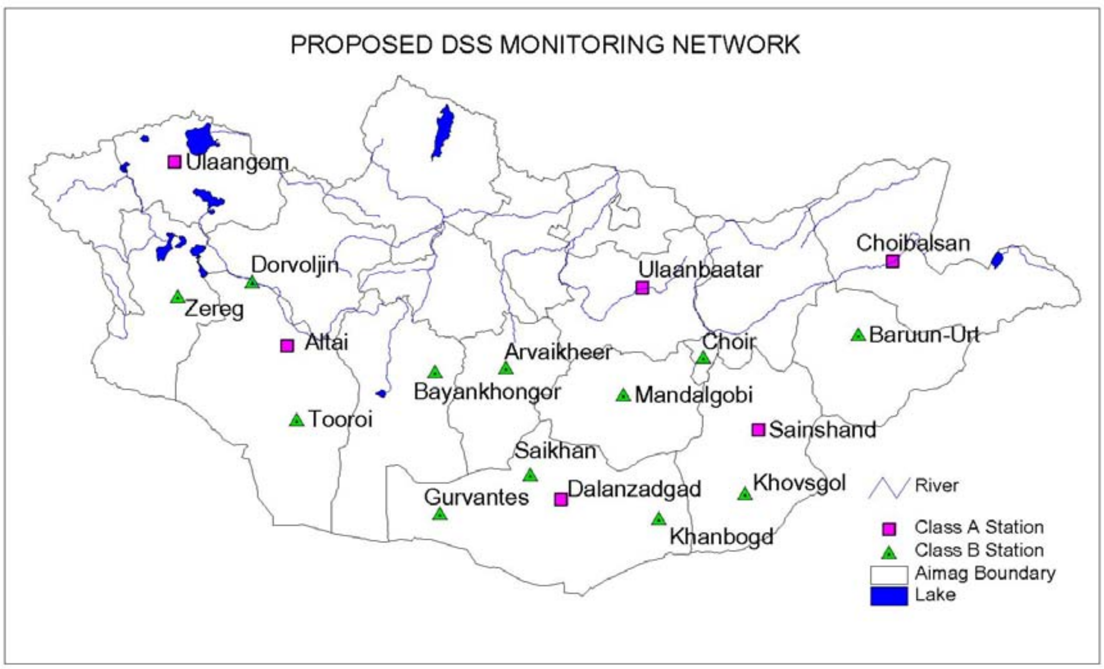
The selection of the network monitoring stations is based mainly on natural features of the area such as frequency of DSS occurrence, geographical location (intermountain corridors), and soil texture. In addition, the impact of industrial development such as mining (metal and coal) and exploration activities that can accelerate soil loosening and accumulate fine dust materials was considered. Of these 18 stations, 6 are to be designated as network monitoring stations for Phase 1 (Table 3.4) and the rest for Phase 2 (Table 3.5).

Box 3.1 Improving Present Monitoring Capacity of Mongolia

Requisites to improve current national capacity for monitoring and early warning of Mongolia are as follows:

1. Establishment of a national network for DSS monitoring and early warning involving all the major stakeholders.
2. Present monitoring and early warning system is limited to meteorological observation and weather forecasting. Improvement and upgrade of stations are warranted. Some meteorological stations located in the DSS area need to acquire new instruments for measuring DSS indicators. A minimum of three Class A DSS monitoring stations need to be established along the dust and sand sources area in the intermountain windy corridor.
3. There is an urgent need to develop the modeling and prediction system specialized for DSS forecasting with a capability to provide a 12-hour advance prediction for an early warning of a DSS event.
4. Necessary communication infrastructure in remote DSS source areas is needed to ensure real time data sharing and reporting.
4. Strengthen cooperation in the areas of data-sharing as well as in the exchange of the research results, experience, and technology with other partner countries.
5. Systematic training and development of human resources at all levels.

Figure 3.5 Location and Classification of the DSS Monitoring Sites in Mongolia



Source: Consultant Team

Table 3.3 List of Proposed DSS Monitoring Stations in Mongolia

	DSS Monitoring Stations and their Monitoring Program[1/]											
Aimag (province)	**Station Name**	**Class**	**Operator**	**Power supply**	**T,P,WS/D,Pr, Vis**	**Visibility**	**Soil moisture**	**TSP**	**PM_{10}**	**Surface condition**	**LIDAR**
Bayankhongor	Bayankhongor	B	WMO	E	+	+	+	+	+	+	
Gobi-Altai	Altai	B	WMO	E	+	+	+	+	+	+	
	Tooroi	B	NAMHEM	L	+	+	+		+	+	
Dornod	Choibalsan	B	WMO	E	+	+	+	+	+	+	
Dornogobi	Sain Shand	A	WMO	E	+	+	+	+	+	+	+
	Khuvsugul	B	NAMHEM	L	+	+	+		+	+	
Gobisumber	Choir	B	WMO	E	+	+	+	+	+	+	
Dundgobi	Mandalgobi	B	WMO	E	+	+	+	+	+	+	
Ovorhangai	Arvaikheer	B	WMO	E	+	+	+	+	+	+	
Omnogobi	Dalanzadgad	A	WMO	E	+	+	+	+	+	+	+
	Saikhan	B	NAMHEM	L	+	+	+	+	+	+	
	Gurbantes	B	NAMHEM	L	+	+	+		+	+	
	Khanbogd	B	NAMHEM	L	+	+	+	+	+	+	
Sukhbaatar	Baruun-Urt	B	WMO	E	+	+	+	+	+	+	
Uvs	Ulaangom	B	WMO	E	+	+	+	+	+	+	
Khovd	Zereg	B	NAMHEM	L	+	+	+		+	+	
Ulaanbaatar	Ulaanbaatar	A	WMO	E	+	+	+	+	+	+	+
Zavkhan	Durvuljin	B	NAMHEM	L	+	+	+		+	+	

[1/] + means programmed monitoring; L means power supply is limited while E means power supply is available.

Source: Compilation of Consultant Team

Table 3.4 Proposed Sites for DSS Monitoring in Mongolia for Phase 1

	Monitoring Site	Visibility	TSP	PM_{10}	LIDAR*	AWS
1	GobiAltai – Altai	+	+	+		o
2	Dornod – Choibalsan	+	+	+		o
3	Dornogobi – Sain Shand	+	+	+	+	o
4	Umnogobi – Dalanzadgad	+	+	+	+	o
5	Uvs – Ulaangom	+	+	+		o
6	Ulaanbaatar	+	+	+	+	o

Note : + means needed equipment; o means available equipment

* Proposed to be equipped by Japan under a cooperation agreement

Source: Consultant Team

Table 3.5 Proposed Sites for DSS Monitoring in Mongolia for Phase 2

	Monitoring Site	Visibility	TSP	PM_{10}	LIDAR	AWS
1	Bayankhongor – Bayankhongor	+	+	+		o
2	GobiAltai – Tooroi	+		+		+
3	Dornogobi – Khuvsugul	+		+		+
4	GobiSumber – Choir	+	+	+		o
5	Dundgobi – Mandalgobi	+	+	+		o
6	Uborkhangai – Arvaikheer	+	+	+		o
7	Umnogobi – Saikhan	+	+	+		+
8	Umnogobi – Gurbantes	+		+		+
9	Umnogobi – Khanbogd	+	+	+		+
10	Sukhbaatar - Baruun-Urt	+	+	+		0
11	Khovd – Zereg	+		+		+
12	Zavkhan – Durvuljin	+		+		+

Note : + needed equipment; o available equipment
Source: Consultant Team

In Japan and the Republic of Korea: As the downstream DSS countries, both Japan and the Republic of Korea have meteorological and DSS monitoring stations that are already equipped to play their part in the DSS regional network. Hence, these stations are listed to form part of the network for the first phase of network development while more stations are planned for inclusion in the future for the second phase.

Table 3.6 Proposed Sites for DSS Monitoring in Japan for Phase 1

	Monitoring Site	Class	Visibility	TSP	PM_{10}	LIDAR	AWS
1	Sapporo	A	o	o	o	o	o
2	Toyama	A	o	o	o	o	o
3	Tsukuba	A	o	o	o	o	o
4	Fukue	A	o	o	o	o	o
5	Nagasaki	A	o	o	o	o	o
6	Miyako	A	o	o	o	o	o
7	Matsue	A	o	o	o	(o)	o
8	Niigata, Maki	B	o	o	o		o
9	Tateyama (Toyama)	B	o	o	o		o
10	Inuyama	B	o	o	o		o
11	Fukuoka	B	o	o	o		o
12	Ryori	B	o			o	o

Note: o means available equipment; "empty cell" means not available.
Source: MOE of Japan

Table 3.7 Proposed Sites for DSS Monitoring in the Republic of Korea for Phase 1

	Monitoring Site	Class	Visibility	TSP	PM_{10}	LIDAR	AWS
1	Incheon – Incheon	A				o	o
2	Chungcheongnamdo – Gwangdeoksan	B		o	o		o
3	Incheon - Bakryengdo	B		o	o		o
4	Seol – Gwanaksan	B		o	o		o
5	Chungcheongnamdo – Anmyundo	A		o	o	o	o
6	Chungcheongbukdo – Chupungryeng	B		o	o		o
7	Jeollabukdo – Gunsan	B		o	o	o	o
8	Gwangjusi – Gwangju	B		o	o		o
9	Jeollanamdo – Heuksando	B		o	o		o
10	Jejudo-Gosan	B		o	o		o
11	Incheon – Gangwha	A		o	o	o	o
12	Chungcheongbukdo – Chunan	B		o	o		o

Note: o means available equipment; "empty cell" means not available.
Source: MOE and KMA

3.4 Technical Considerations

There is a need for a unified classification of DSS phenomenon for the proposed regional network. WMO has classified DSS weather into 11 categories, which could be distinguished by routine weather observation elements (wind and visibility) and they have been used in operational weather observation by its member countries. Its network covers the whole world and it is the single data source for monitoring DSS at a regional level in Northeast Asia. Therefore one of the possible way for the proposed regional network to classify DSS phenomenon is to follow the methodology based on wind and visibility data. In accordance with different characteristics of DSS and the weather observation acquired, DSS is mainly classified into the following four categories:

- Floating dust - widespread dust in suspension not raised by wind with horizontal visibility between 1 to 10 km.;
- Blowing sand - dust or sand raised by wind with horizontal visibility between 1 to 10 km.;
- Dust and Sand Storm - dust or sand raised by strong and turbulent wind with horizontal visibility less than 1 km.; and
- Severe Dust and Sand Storm - dust or sand raised by strong and turbulent wind with horizontal visibility less than 500 m.

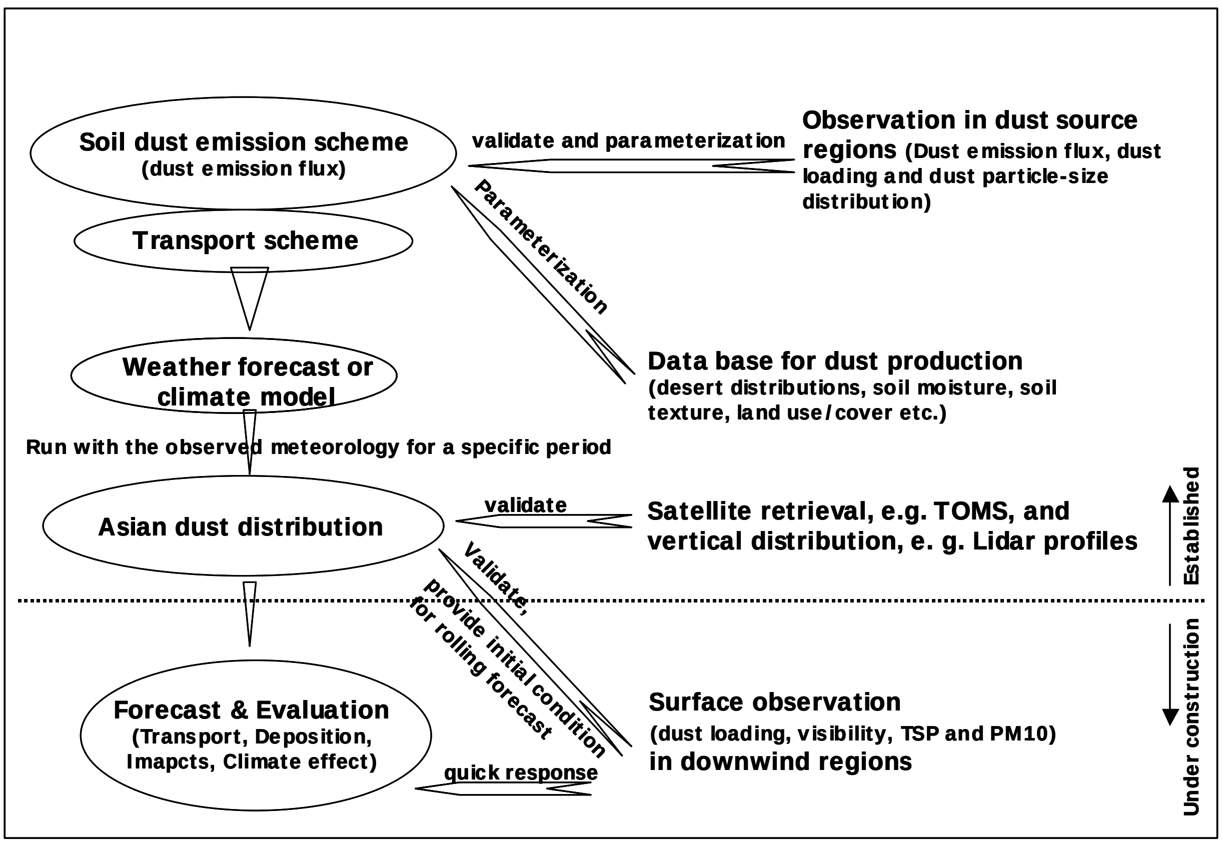
WMO criteria is proposed as a regional level classification of large scale DSS in Northeast Asia. This can be used till a new generation of dust concentration-based (e.g. PM_{10} and LIDAR) network monitoring stations has been established through technical upgrading.

There can be a local classification of DSS phenomenon based on dust or sand concentration. TSP and PM_{10} are the parameters that characterize the unique qualities and concentration of dust and sand in the air of a particular locality. It is impossible to classify the large-scale DSS phenomenon based on TSP or PM_{10} measurements without a regional monitoring network at the same instrumentation level in Northeast Asia. But dust concentration based classification can be established at local level based on TSP or PM_{10} data acquired at a specific locality. The partner countries can be encouraged to use concentration of suspended particles as a standard parameter to classify the DSS phenomenon at the local level since this will characterize the different particles suspended in the air and provide the basis to prepare local response. For this, more study is required.

3.4.1 Conceptual Framework for DSS Simulation and Forecasting

Figure 3.6 provides a conceptual framework for DSS simulation and forecasting, which forms the basis for early warning of DSS events. It is important to note that DSS simulation and forecast requires a huge amount of data obtained from different sources including remote sensing through satellites and sophisticated modeling capacity. As indicated in Figure 3.6, most of the basic infrastructures and database for DSS simulation and forecasting has already been established in the region, though at different levels in each partner country (except for Mongolia where the DSS simulation and forecasting capacity is yet to develop). As indicated in the lower part of the diagram, one important role of the proposed regional network is to establish and enhance the interaction between the forecast centers in the region and the network monitoring stations for more accurate prediction and early warning of DSS events.

Figure 3.6 A Conceptual Framework for DSS Simulation and Forecasting



This is because to accurately capture and predict the dust cycle associated with DSS events, the spatial and temporal distribution of dust loading derived from the simulation model need to be frequently validated with monitoring data gathered from ground observation through a system of the network monitoring stations scattered along the transportation routes of DSS from its origin to deposition. Continued validation of DSS movement at the ground level would allow the forecast centers in the region to have timely refinement of its forecast model through establishing a rolling simulation of a specific DSS phenomenon for more accurate prediction and early warning of the DSS event. The regional network can also enhance the development of DSS simulation and forecasting technology by promoting exchange of forecast outcomes and experiences among the forecast centers of the partner countries. This exchange will have special benefits for Mongolia where the simulation and forecasting capacity is less developed. An elaboration of DSS simulation and forecasting in the PRC is provided for reference in Box 3.2.

Box 3.2 DSS Simulation in the PRC

Scientists have conducted the model simulation of the Asian dust from 1960 to 2002. Initial parameters of the deserts in the PRC and Mongolia and other potential source areas are obtained through various sources including satellite images and WMO. Ground surface conditions in the PRC have been verified against surface observations. The combined data sets for the desert distribution/texture, land-use/roughness length, vertical flux size distribution and satellite observed soil moisture form a coherent input parameter set for the soil dust emission scheme which shows satisfactory results for simulations of the DSS events in recent years.

Comparisons between the model output and network monitoring observation under the ACE-Asia Experiment (the Asian Pacific Regional Aerosol Characterization Experiment) have shown that the model reproduces, with reasonable accuracy, the dust emission strength and hence the soil dust concentrations in the PRC and the areas downwind of the source regions. Based on all this work, a Numerical Weather Prediction (NWP) framework in the forecasting of DSS at the very-short and short ranges has already been set up at the China Meteorological Administration (CMA). The CMA has started providing early warning for DSS events through official public advisory since 2002.

3.4.2 Operational Mechanism

Operational Functions of a DSS Network

The setting up of the regional network and the associated national system for DSS monitoring and assessment will facilitate a deeper probe into causes of the DSS problem and, therefore, establish a scientifically justified perspective for policy making at the national and regional levels.

While it is a clear intention of the governments of the four partner countries to improve the level of regional cooperation on DSS, it is also clear that the mechanism and operation of data-sharing need to be worked out carefully. The main functions of a successful operational DSS network would be to:

- Clarify source areas, transport routes, and influence areas of DSS events. With access to the data accumulated for years, spatio-temporal distribution of DSS events, the physics of long distance transport of dust aerosols and the environmental impacts of each DSS will be clearly identified.

- Provide the scientific information for early forecasting and warning and for validation of models and simulations

To be effective for timely early warning, the DSS simulation and forecast models need a data collection and reporting system that can satisfy the following two key requirements:

- *Effective timeliness*: High-speed exchange of DSS monitoring data between the countries in the region and among the concerned agencies within an individual country.

The observational data should be transmitted to users within one hour, so that the data could be applied in producing DSS forecasting and early warning.

- *Maintained as an operational system:* The system should be kept running in a seamless, stable and reliable manner. Therefore, real time monitoring of its operation and emergency response capability is required. The response time should be limited to less than 30 minutes.

<u>Purpose of Data Sharing</u>

Real time data is essential for early warning services and would be used by modelers and forecasters at the forecasting center of each country (and probably by other relevant researchers as well). Timely receipt of real time data from the network monitoring stations would provide modelers and forecasters with the necessary information to make predictions about DSS paths, transit time, duration and severity as well as the geographic extent. It would also allow the rolling simulation at the capable forecast centers. By feeding back the forecast results to the network monitoring stations located at the DSS sources areas and along the transportation route, the regional network would not only allow for timely and improved model validation by ground observation, but also provide an opportunity for the forecast centers with more advanced simulation and forecasting capacity to benefit their counterparts through exchange of forecasting experiences, thus strengthening the forecasting capacity of the region as a whole.

After the DSS event has passed the archival data might be used as part of the national monitoring and evaluation effort to evaluate the accuracy of the simulation and forecasting model, and the success and effectiveness of the early warning attempt. They serve also as the database for designing more effective mitigation measures to prevent and control DSS.

<u>Mechanism for Data Sharing</u>

There exist a number of mechanisms for DSS data sharing among the partner countries (see Box 3.3 on Existing Mechanism for Data Sharing). They fall into the two types of data mechanism. Characteristics of the existing data sharing mechanisms are as follows:

(i) Data collection and transmission as part of the WMO agreement. This is a system of real time transmission of meteorological data from various monitoring stations in each member country to regional center for processing. Data provided in this system forms the basis for weather forecasts. The system has the capacity to handle large quantity of data needed for DSS simulation and has been working well at the regional level, but data transmitted in this system is generally not accessible to researchers who work outside the system.

(ii) Data collection and sharing under bilateral arrangement. Under these bilateral agreements, DSS data are collected with sophisticated instruments at several purpose-built or equipped monitoring stations. Data collected at these stations are transmitted to the host institutions, principally for research purposes. These stations have limited capacity to efficiently transfer large quantity of real-time data. Because of their recent establishment, these stations have no historical baseline data. Data from these stations may be of significant importance to scientific research on DSS phenomenon, but cannot be used as the basis for operational DSS forecasting and official early warning given the limitation noted.

Box 3.3 Existing Mechanisms for Cross Country Data Sharing

All of the partner countries are members of the World Meteorological Organization's (WMO) worldwide network. Selected monitoring stations in each country supply meteorological data at frequent intervals to the WMO centers. Data on visibility, wind direction and strength and other parameters of relevance to DSS are collected routinely as part of the WMO requirement using similar standards and indicators.This is an example of an "official" (government to government) data exchange mechanism.

The Meteorological Research Institute of Japan (JMRI) has carried out the Japan-China cooperative project ADEC in conjunction with Institutes of the Chinese Academy of Sciences. DSS monitoring stations have been set up in the DSS source areas in the western PRC and along the transport route of the dust aerosols on their way to Japan. The fully instrumented monitoring sites in the Taklamakan desert in Xinjiang provide data on the DSS outbreak and entrainment in eastward airflows. Transport and deposition are also analyzed. Numerical experiments using the Global Climate (dust forecast) Model (GCM) have also been carried out to assess the impact of dust aerosols on global climate. The monitoring is seasonal (not continuous throughout the year) and the data is not sent in real time.

The Sino-Japan Friendship Environmental Protection Center and National Institute for Environmental Studies (NIES) of the Ministry of Environment of Japan have undertaken joint research on DSS. The principal focus was on DSS transport and the environmental effect of DSS aerosols originating in the northern PRC. A DSS monitoring network was established in northeast PRC and Japan in February 2001. Six stations were established along a transect from Beijing to Erinhot - the designated source area. The sites were at Beijing, Zhangjiakou, Zhangbei, Huade, Sonid Youqi, and Erinhot over a distance of more than 1,000 km. In addition to the sites in the PRC, three sites were monitored in Japan[3]. The monitoring is continuous throughout the year and the data is sent through internet in real time basis.

The Korea-China Environmental Science and Technology Exchange Center was established in 1999 in the National Institute of Environmental Research (Seoul). The principal function is to facilitate exchange of environmental information (and personnel) and the promotion of joint research. KMA is cooperating with CMA on Asian Dust forecasting. Five DSS monitoring stations will be set up (three in eastern PRC and two in the Asian Dust path). These stations will be operated during the DSS season from February to May with the sharing of information and exchange of experts. Currently, the monitoring data is sent as an email attachment.

Note: This reiterates Section 2.5 on the existing bilateral initiatives on DSS monitoring.

To ensure effective data sharing for operational early warning of DSS in the region, two issues must be considered when designing the system: *firstly*, the collection of appropriate data from the network monitoring stations; and s*econdly,* the transmission of monitoring data among the partner countries within the region in real time.

In the immediate short term, it might be necessary to continue relying on the existing bilateral arrangements to ensure that relevant data are exchanged between the partner countries concerned. Given the limitation noted above, a more reliable data sharing mechanism for operational (rather than research oriented) DSS forecasting needs to be developed over time. First of all, each partner country should designate a national focal agency to coordinate DSS monitoring activities within the country and coordinate the country's participation in the regional network. Desirably, the regional network could establish a specialized communication system to allow for real time data sharing within the network. This does not appear to be a feasible solution. Apart from the exclusiveness of the system under MA, the communication system under WMO could be one of the solutions for real time communication.

[3] Mori, I. Nishikawa, M. Quan, H. Morita, M.(2002) Estimation of the concentration and chemical composition of kosa aerosols at their origin *Atmospheric Environment* 36: 4569-4575

Another option discussed is a kind of "passive data sharing." That is, each national focal agency collects the observation data from the network monitoring stations within the country and upload the data in real time on a specially designated section of its website for sharing with its counterparts in other partner countries through internet. This arrangement is simple, but may not be sufficient to meet the operational requirements of the forecast centers within the regional network for high speed transmission of the monitoring data needed for precise prediction of DSS events for early warning.

3.4.3 Hardware and Software Requirement

The hardware and software requirements for establishment of the proposed regional network are set out in Box 3.4, which are drawn up based on the needs of the PRC.

Box 3.4 Requirements for the DSS Forecasting and Early Warning Network: an Example from the PRC

1. Hardware:

Data Collection. For Phase 1, instruments for visibility are needed as all the nominated stations are not equipped. Also, 3 units of LIDAR and 17 units for PM_{10} monitoring are required. For Phase 2, the following are needed: 17 sets of the instrumented visibility, 12 units for PM_{10} measuring units, and 4 LIDAR.

Data Sharing and Transmission: If the data sharing and transmission is to be set up on the meteorological telecommunication system (MTS) or through internet on special pages on website of national focal agencies, it is not necessary to consider the cost for establishing a specialized communication infrastructure. But it is necessary to consider the investments for the terminal devices for data transmission and reception at each station, and for the high-speed international and/or national network telecommunication capacity in remote areas where the network monitoring stations are located, and for the network transmission devices and telecommunication consumables.

Data Processing and Storage: Mega-capacity data storage and processing system, including storage equipment, data processing computer and data dissemination server, would be needed at each national focal agency.

Simulation and Modeling: High-performance computer will be needed at the national forecast centers to handle the numerical DSS model for DSS simulation for forecasting and early warning.

2. Software

Numerical DSS Prediction Model: This should include model development, application, maintenance, refining and upgrading.

Data Processing and Assimilation: This should include the assimilation of surface and atmospheric monitoring data in different resolutions, the technique of processing DSS concentration observations and atmospheric optical observations, and the technique of assimilating and analyzing visibility and DSS concentration data.

Capacity Building: This should include the training of operational personnel at network monitoring stations and exchange of experiences between experts and technicians at the national forecast centers and academic circles involving DSS monitoring and early warning. This should also include the policy and operational coordination among the officials and policy makers responsible for regional cooperation on prevention and control of DSS in the partner countries.

3.5 Financial Implications

Establishing a regional DSS network in Northeast Asia will entail costs. Some of these costs will relate to the provision of equipment for data collection, handling, analysis and storage while others will be for data transmission/exchange. The partner countries are at different levels of socio-economic and technological development and vary in geographic and physical characteristics. Likewise, each country differs in their capacity to pay for system upgrades and network establishment and maintenance. These factors need to be considered carefully in any plan to develop a regional network for DSS monitoring and early warning. The cost implication for establishing and strengthening the regional DSS network is more focused on developing the DSS monitoring and early warning systems of the PRC and Mongolia as the DSS source areas. The DSS downstream partner countries of Japan and the Republic of Korea are already technologically more advance in their meteorological monitoring network and early warning system.

The financial implications of establishing a regional DSS network in Northeast Asia as presented in subsequent subsections are results of a preliminary estimation, which are subject to refinement and finalization as a next step of this study.

3.5.1 Development of the Regional Network for DSS in the PRC

Monitoring Station Costs in Phase 1

With improved economic conditions, issues on environment and ecology have been receiving more attention in the PRC. More money has been spent on DSS-related projects which include: (a) R&D projects, such as NWP (Numerical Weather Prediction) framework in the forecasting of DSS at the very-short and short ranges; (b) meteorological stations of CMA; and environmental stations of SEPA. As such, there are several existing independent systems relating to the DSS forecasting and early warning, which can be subject for selection and development of the regional network for DSS. However, there are two financial issues to be addressed in Phase 1. One is the fair and rational method of assessing cost recovery for the PRC contribution and the another is the estimation of incremental costs associated with equipping stations to a standard suitable for the regional network.

In Phase 1, the PRC will need some financial support from partner countries/international organizations to strengthen the existing 25 stations for the monitoring, forecasting, early warning, and data transmission in the DSS network in Northeast Asia. The incremental investment includes: (a) 25 units of visibility transmissometers; (b) 17 units for PM_{10} monitoring equipment; (c) 22 units of TSP monitoring equipment; (b) 3 units of LIDAR instruments, and (c) other investment such as human capacity building, cross-country communication for data-sharing, etc. These incremental costs are given in Table 3.8.

Monitoring Station Costs in Phase 2

In Phase 2, the number of the monitoring stations will increase to 43. This would mean an additional of 18 stations will become the part of regional network for DSS. The costs associated with this are set out in Table 3.8.

Table 3.8 Monitoring Station Costs in Phase 1 for the PRC

Cost Item	No. of Units	Unit Price ('000:US$)	Total Cost ('000: US$)
Visibility Transmissometers	25	25.0	625.0
TSP	22	17.0	374.0
PM_{10}	17	20.0	340.0
LIDAR[1]	3	176.0	528.0
		Total Equipment Cost	1,867.0
Installation cost including training(10% percent of equipment cost) and construction cost for LIDAR			486.7
Transportation cost (5%of total equipment cost)			93.4
Incremental operating cost[2] of monitoring stations for DSS based on two-year activity (2004-2005)			164.8
Total Cost			**2,611.9**

[1] Includes two parts equipment: Mie-LIDAR and its computer.
[2] Due to increase in equipment, the stations will incur more staff and related operating cost. According to the PRC Yearbook 2003, the average wage of staff and workers in 2002 in the PRC is RMB12,422 (about US$1,500), the average wage of staff and workers in the Geological Prospecting and Water Conservancy which is a sector similar to DSS monitoring is RMB12,303(about US$1,500). In addition, the employer will have to pay the welfare for the staff. It is difficult to arrive at an accurate cost but on the average, the estimated welfare payment per year is nearly equal to half of the wage.

Table 3.9 Monitoring Station Costs in Phase 2 for the PRC

Cost Item	No. of Units	Unit Price ('000:US$)	Total Cost ('000: US$)
Visibility Transmissometers	17	25.0	425.0
PM_{10}	12	20.0	240.0
LIDAR	4	176.0	704.0
		Total Equipment Cost	1,369.0
Transportation cost (5%of total equipment cost)			68.5
Installation cost including training(10% percent of equipment cost) and construction cost for LIDAR			536.9
Incremental operating cost of total monitoring stations for DSS based on 10-year activity			1,285.7
Total Cost			**3,260.1**

The National Data Center Development Cost

National Data Centers/Forecasting Centers should be strengthened for the operation of the network of prevention and control of DSS in Northeast Asia. The development cost for this facility consists of incremental telecommunication (operation and maintenance) cost, data storage system cost, high-quality working station cost and software cost (see Table 3.10). Any assistance in this regard will be welcome.

Table 3.10 National Data Center Development Cost for the PRC

Cost Item	Total Cost ('000: US$)
Incremental telecommunication operating and maintaining cost based on two-year activity	1,210.0
Data storage system	180.0
High-quality working station	578.0
Software cost based on two-year activity	337.0
Total	**2,305.0**

Remote Sensing Monitoring Cost Estimate

Ground surface conditions are important factors in DSS outbreaks. Hence, upgrading of the remote sensing capability of the PRC is important for monitoring the ground surface and for detecting the geographic extent and optical density of DSS events once break out occurs. The cost for such an upgrade of remote sensing capability is shown in Table 3.11.

Table 3.11 Remote Sensing Monitoring Cost for the PRC

Cost Item	Total Cost ('000: US$)
Large Capacity Computing Facilities	100.0
Depreciation of Computing Facilities	500.0
Equipment for data transfer	100.0
Total Cost of Equipment	700.0
Remote Sensing Image Processing Software	100.0
Depreciation of Image Processing Software	200.0
Other software	30.0
Model development for 10-years (@ US$100/year)	1,000.0
Remote sensing data cost for 10-years (@US$20/year)	200.0
New type Remote Sensing Image Processing Software and data cost	500.0
Total Cost of Software and Data	2,030.0
Operating cost : 10 staff for 10-years (@ US$40/year)	400.0
Total Cost	**3,130.0**

Notes: According to the PRC Yearbook 2003, the average wages of staff and workers of Meteorology, Seismology, Survey and Mapping technological supervision in 2002 are RMB16,130; RMB16,021; RMB16,868 and RMB16,478, respectively (or about US$2,000).

3.5.2 Development of the Regional Network for DSS in Mongolia

As previously indicated, there is no existing DSS monitoring network in Mongolia, therefore the following are assumed:

- all costs are preliminary estimates,
- international transportation cost (delivery) is assumed to be 5-15% of total equipment cost,
- installation cost includes training and consulting costs.

.Monitoring Station Cost for Phase 1

For three Class A stations and three Class B stations comprising the Phase 1 DSS regional network in Mongolia, total estimated cost is at US$2.9 million as shown in Table 3.12.

.Monitoring Station Cost for Phase 2

Table 3.13 presents the costs entailed for acquiring monitoring equipment in Phase 2 of developing the regional network for DSS in Mongolia. Some of the proposed sites will require continuous power supply. However, electricity supply cost is not included in the ground monitoring costing because this needs a detailed financial analysis and cost comparison.

Table 3.12 Monitoring Station Costs in Phase 1 for Mongolia

Cost Items	No. of Units	Unit Price ('000:US$)	Total Cost ('000:US$)
TSP	6	17.0	102.0
PM_{10}	6	20.0	120.0
Visibility sensors	6	16.0	96.0
Soil moisture sensors	6	5.0	30.0
LIDAR	3	176.0	528.0
		Sub-total	876.0
Installation cost including training (estimated at 20% of equipment cost)			175.2
Transportation cost - International transportation (15% of equipment cost) - Domestic transportation (by plane, car and train)			 131.4 50.0
Construction cost for LIDAR facility and ground monitoring station (3 x US$100,000) + (6 x US$30,000)			480.0
Import tax and custom clearance (20.75% of total cost of equipment)			181.8
Operating cost of six sites based on 10-year activity (including Administrative, Communication, Labor, Training, Maintenance, Spare parts etc.)			1,000.0
Total Cost			**2,894.4**

Table 3.13 Monitoring Stations Costs in Phase 2 for Mongolia

Cost Items	No. of Units	Unit Price ('000:US$)	Total Cost ('000:US$)
AWS	7	43.0	301.0
Visibility sensors	12	16.0	192.0
Soil moisture sensors	12	5.0	60.0
PM_{10}	12	20.0	240.0
TSP	7	17.0	119.0
		Sub-total	912.0
Installation cost including training (estimated at 30% of equipment cost)			273.6
Transportation cost - International transportation (15% of total cost) - Domestic transportation (by plane, car and train)			 136.8 100.0
Import tax and custom clearance (20.75% of total cost of equipment)			189.2
Total Cost			**1,611.6**

Remote Sensing Development

Like the PRC, Mongolia's remote sensing capability needs to be established and upgraded. The cost for such an upgrade is shown in Table 3.14.

Table 3.14 Cost to Establish and Upgrade Remote Sensing in Mongolia

Cost Item	Amount ('000: US$)
MODIS data receiving station	500.0
Installation cost including training (30% of station cost)	150.0
Transportation - International transportation (10% of MODIS cost) - Domestic transportation	 50.0 20.0
Import tax and custom clearance (20.75% of total cost of equipment)	103.8
MODIS data transaction cost for next 10 years	1,000.0
Sub-total	1,823.8
Operating cost based on 10-year activity (including Administrative, Communication, Labor, Training, Maintenance, Spare parts, etc.)	100.0
Total Cost	**1,923.8**

<u>Network System Development Cost</u>

The cost associated with developing and setting up the system for the network is shown in Table 3.15.

Table 3.15 Cost for the Development of Networking System in Mongolia

Cost Item	Amount ('000: US$)
Equipment cost - *YSAT stations at 5 remote stations (15.0 th. USD each)* - Central HUB - Message switching system - Data storage system (IBM Total Storage Enterprise Storage Server Model 800) - Internet Server (Sun Fire 4800 Server)	 75.0 1,000.0 500.0 500.0 100.0
Software cost	100.0
Sub-total	2,275.0
Installation cost including training (10% of total equipment price)	227.5
Transportation cost - International Transportation cost (5% of total equipment cost) - Domestic Transportation cost	 113.8 30.0
Data transaction cost based on 10 years (100,000 USD per year)	1,000.0
Operating cost based on 10-year activity	800.0
Grand total cost	**4,446.3**

The total project cost in the next 10 years for the improvement and operation of the regional network for DSS in Mongolia will be about US$11 million inclusive of the US$1 million telecommunications upgrade and improved computer capacity for storage and processing data. This cost, however, does not include the long-term operating cost, future equipment upgrading, and additional equipment purchase.

3.5.3 Funding

In order to foster regional cooperation in DSS monitoring, forecasting, and early warning on a sustainable financing mechanisms, a special fund should be raised to satisfy the operating cost of the DSS network. There are several potential sources identified for raising said funds. These are as follows:

- Contributions in cash or kind from network members and partners;
- Financial assistance from bilateral or multilateral donors such as GEF;
- Contributions from national governments;
- Contributions from regional, sub-regional and international institutions; and
- Donations from private sector.

The special fund could take the form of a Foundation or Trust Fund to which private sector, bilateral agencies, NGOs, etc. can contribute. It could be established off-shore and the funds adminstered by a Board.

Resources must be gathered at a scale to ensure an uninterrupted, smooth, and effective implementation of the various activities and program of the network. Whilst it is absolutely essential that the member countries make available funds from their own resources to the extent possible, it is also clear that external funding will have to be mobilized for various activities of the network.

Funding will be crucial at the initial network installation phase as financial support during the early stages can make an important contribution to ensuring broad initial participation and survival of the network through its difficult infancy period. Financial assistance from donor countries and international agencies can be focused on network-wide core programs or, alternatively, element-based projects. Collaboration between institutions in Asia and donor institutions should be encouraged whether in the form of formal partnership agreement or informal agreements.

Investments in appropriate technologies, particularly for electronic information exchange and electronic transfer of information will be crucial to the successful operation of the DSS network. It is estimated that the budget outlay for establishing and initially supporting the operations of the national data center and the DSS forecasting center and the cost of implementing Phases 1 and 2 of monitoring stations development will amount to US$22.2 million. It is likely that the four governments of the member countries will cover the cost for the national network coordination staff and other personnel and contribute to the operating expenses as well as shoulder a certain portion of the required equipment outlay. However, a considerable portion of the network budget will have to be sourced externally and this is where donor countries and agencies will play a key role in providing financial assistance. It should be noted that the budget estimate did not take into account the possible share of the operating cost to be met by the participating member countries either as in-kind contribution or inputted costs if the activities are spearheaded or undertaken in their respective countries.

CHAPTER 4 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

On the whole, the establishment of a regional network for DSS monitoring, forecasting, and early warning entails the introduction of a fundamental structure within the national level of the four partner countries (i.e., the PRC, Japan, the Republic of Korea, and Mongolia) as well as on the regional level. On the national level, the Meteorological Administration and Ministry of the Environment of each partner country should be the designated national focal point where all DSS-related data will flow and be shared on real time basis. Smooth collaboration with non-MA agencies will be encouraged and improved. On the regional level, a decentralized organizational set up is deemed practical since it allows various stakeholders in the region to participate under a formal operational structure of data sharing and reporting and under the coordination and supervision of partner countries' respective national focal agency.

During the course of this study, one major accomplishment toward the development of a monitoring indicator system for the regional network for DSS monitoring, forecasting, and early warning was the agreement among the four partner countries on the initial set of common monitoring data/indicators. The data set is comprised of: (a) instrument-measured visibility, (b) PM_{10} , and (c) LIDAR based observation data.

The review of current conditions of the four partner countries for DSS monitoring and early warning has revealed that the downstream countries of Japan and the Republic of Korea have better infrastructure and capacity for DSS monitoring and early warning. Therefore, development of the regional network at their end would entail more of the national and regional organizational arrangements to strengthen data sharing for all aspects of forecasting and early warning. The upstream countries of the PRC and Mongolia, on the other hand, are where most of the DSS events originate and occur. And yet, their infrastructure and capability (especially for Mongolia) are apparently insufficient. As such, the development plan for a Northeast Asian DSS regional network for the prevention and control of DSS initially focuses on improving and upgrading the network of monitoring stations as well as on capability building for DSS monitoring and early warning in these countries.

4.2 Recommendations

Speedy operationalization and quality performance of the network will depend on the level of skills the national coordinators possess and the efficacy of the communications between the national coordinators and the members, partners, and other stakeholders and the regional support structures including the UNEP, the UNESCAP, and others. The operationalization of the network would also depend on the commitment of the various country parties on the formulation of well-focused program of work. As such, the key elements of a program to implement the regional network for DSS are set out in Box 4.1 while Table 4.1 lists the recommendations for the overall phased development with the corresponding action plan involving all four partner countries within the purview of a regional network.

Preliminary discussions during meetings with scientists and administrators in each of the four partner countries formed the basis of the proposed action plan. Some actions have a suggested time-frame while others are a continuing concern. Some require considerable reorganization while others would be relatively simple to implement.

DSS forecasting and early warning system in source areas play an important role in coping with the disaster impact of DSS in advance. On the other hand, in downstream partner countries of DSS should assess the impact on air quality by DSS. Therefore, the predicting system for the concentration and deposition in PM_{10} in the Republic of Korea and Japan during DSS event or afterward should be implemented and developed in line with forecasting and early warning system.

Box 4.1 Key Elements of a Program to Implement the Regional Network for DSS

(a) Develop the framework for the conduct of assessment and monitoring of DSS related events (including early warning) at regional, sub-regional and national levels using in combination the various systems of information technologies and space-based technologies;
(b) Support a national focal point/agency to enhance and improve the linkage of national databases with regional and sub-regional databases applying digital and communication technology;
(c) Develop a regional framework for the conduct of joint or collaborative information gathering and database consolidation for scientific information on DSS related matters, including desertification control;
(d) Formulate programs that will provide for analysis and interpretation of data into usable form;
(e) Encourage the use of information generated by the network and devise systems for the transfer of this information to decision makers, and relevant end users (including citizens of affected areas); and
(f) Develop training and research programs for capacity building at the national level.

Table 4.1 Proposed Phased Development Program for a Regional Network for DSS

Phase	Recommended Projects	Action Plan
Phase 1 (6 – 12 mos.)	Establishment of Data Sharing Mechanism in Real Time for Short Term Forecasting	(a) Determine the national focal point/agency within each partner country's national DSS monitoring network; (b) Get agreement on the proposed hierarchy of monitoring stations to designate Class A and B stations and assess the cost of upgrading equipment and data transmission (where required). (c) Develop a set of common guidelines to govern the linkages among the national participating institutions and delineate the scope to which the DSS network can utilize the information. All national network members should bear the responsibility for providing their respective DSS monitoring and assessment information to the national focal point. (d) Hold a region-wide technical workshop regarding the construction of DSS network technologies to get agreement on which to use and how. Agree on the common language(s) to be used. (e) Conduct a survey within each partner country to determine the types and patterns of fields in the database to define the content and format of the information to be exchanged in the Meta databases with uniform criteria and formats for DSS monitoring and early warning. (f) Organize one Asian regional workshop with the objective of exchanging information and comparing notes. This workshop should be followed by a study tour of the PRC and Mongolia to allow participants to visit the field monitoring stations and view local conditions in the source areas.
	Enhance Scientific and Technological Cooperation and Exchange	(a) Organize an international symposium aimed at facilitating the exchange of ideas and experiences regarding monitoring and assessment and early warning. (b) Organize a study tour of selected country that is advanced in DSS monitoring modeling. The study tour participants should be relevant personnel of the network. (c) Capacity building such as training, dispatching of experts, or other activities (though already included in Phase 3 of the current phased development configuration) should be launched as soon as possible if and when resources become available.

Cont. Table 4.1

Phase	Project	Action Plan
Phase 1 (6 – 12 mos.)	Get Preliminary Agreement on Appropriate Indicator Systems for Northeast Asian Regional DSS Monitoring and Assessment	(a) Identify potential funding sources for national and international (incl. bilateral and multilateral) agencies and private sector. Look at innovative mechanism to raise and distribute funds (e.g., Trusts, Foundation, etc.) (b) Expand the network by identifying new sites and upgrading others. Install new dust monitoring equipment.
Phase 2 (3 years)	Expansion of the Regional Monitoring network	(a) Identify potential funding sources from national and international (including bilateral and multilateral) agencies and private sector. Identify mechanisms and manner to raise and distribute funds (e.g., Trusts, Foundation, etc.). (b) Expand the network by identifying new sites and upgrading others through the installation of new dust monitoring equipment.
Phase 3 (3-5 years)	Capacity Building	(a) Upgrade the forecasting technology and modeling capacity in all partner countries, especially in Mongolia. (b) Improve infrastructure and support facilities to support national DSS related activities (training courses, study tours, production of manuals, etc.). (c) Strengthen data management capacity and improve efficiency of network communication of the National DSS centers. Specific activities will include: i) increasing the response speed and information handling capacity of the web servers; ii) expanding data storage capacities of the database servers as well as increasing rate of e-connectivity; and iii) securing authorization from relevant authorities for the designated agency to take charge of the national network's day-to-day operation.

Getting the structure right includes training and other capacity building measures. As such, capacity building is an ongoing or continuing action found in all phases of developing the Northeast Asia DSS network. This includes training, experience sharing workshops, and field visits to the collection and monitoring sites. While the exchange of data and ideas through networking is an important element of the network, exchange visits will be crucial because there is simply no substitution for human interaction.

Training will be one of the crucial elements in view of the objective of building and enhancing institutional capacities at the national and regional levels for DSS monitoring and early warning. This will take the following forms:

- Human resources - There are a variety of effective training approaches, such as providing technicians for the necessary training and guidance on the spot in the participating countries and inviting trainees to the appropriate facility in one of the four partner countries for in-depth study or exchange of ideas regarding space based technologies, monitoring techniques, assessment methods modeling, and network and information management technologies.

- Equipment and technology for early warning and forecasting - To be able to identify the weak points in the delivery of services, the regional network (however configured) should be viewed as a process of data and information flow, through data capture, acquisition, processing, storage, and packaging. These are then disseminated to end–users, policy decision makers, private sector and the general public (in the case of impending hazards such as severe DSS events). All the data, information, institutional arrangements, human resources and technology) must be integrated to facilitate an efficient flow of information. This applies at all levels of operation (local, national, regional). Inevitably, equipment should be upgraded.

4.2.1 Implementation

As mentioned, the physical development of the monitoring network focuses on developing and improving the monitoring stations in the PRC and Mongolia. Table 4.2 presents the recommended phased development of the stations in these two partner countries with corresponding preliminary costs.

Table 4.2 Phased Development of Network Monitoring Stations in the PRC and Mongolia

Country	Phase[1]	No. of Stations Covered	Recommended Activities	Estimated Cost ('000 US$)
PRC	1	Initial 25	• Establish national focal agency and integrate identified monitoring station in the network. • Purchase and install needed hardware and software for identified stations for instrument-measured visibility, TSP, PM_{10} and LIDAR. • Upgrade communication network.	4,916.90
	2	Add'l. 18	• Expand network of monitoring stations. • Purchase and install needed hardware and software for	3,260.10
	3		• Introduce long term DSS forecasting capacity by remote sensing (annual trend).	3,130.00
Mongolia	1	Initial 6	• Establish a national focal point and integrate identified stations in the network. • Purchase and install AWS, TSP, PM_{10}, visibility sensors, soil moisture sensors, and LIDAR for identified stations. • Construct ground monitoring stations. • Establish and improve communication facilities/network.	8,340.90
	2	Add'l. 12	• Expand network of monitoring stations. • Purchase and install AWS, visibility sensors, soil moisture sensors, and PM_{10}	1,611.60
	3		• Capability building for DSS modeling, simulation and forecasting by remote sensing.	1,923.80

[1] Phase 1 – short term; Phase 2 – medium term; and Phase 3 – long term.

4.2.2 Financing Strategy

Some things could be done within 12 months. Others will take much longer. This will depend on raising the funds required, either through the various national governments' budgeting processes or through the raising of external funds. There are also constraints imposed by the need to proceed in an orderly fashion so that the upgrading and equipping of the monitoring stations can be in step. Data acquisition, data transmission, data processing, storage and retrieval, and dissemination have to be developed in ways that give maximum benefit and cost effectiveness.

In the proposed action plan for the first year, money should be spent in developing a set of common standards, conducting a survey, holding workshops, holding technical training courses and language training courses. Because there are many uncertainty factors in developing a set of common standards, it is impossible to give a relatively accurate cost estimate. For just the same reason, it is impossible to provide an accurate cost estimate of conducting a survey, holding workshops, holding technical training courses and language training courses. When the network is operational, the cost of organizing international workshops and the costs of developing and updating the standard operational manuals will become the part of the operating and maintenance cost.

According to sustainable financing principle, different source of money should be supplied to each budget line. Contributions from network members and partners, bilateral or multilateral donors, contributions from regional, subregional and international institutions, donations from private sector can be used to fund equipment and software for monitoring, early warning, and data transmission (perhaps through a Foundation or Trust Fund). Contributions from national governments and donations from private sector can be used to fund current operating investment. Contributions from network members and partners, bilateral or multilateral donors, contributions from regional, subregional and international institutions, donations from private sector can be used to fund operating cost arising from cooperation.

4.2.3 Cooperation with Other Regional and International Organizations

As a transboundary problem it is clear that government-to-government agreements could be put in place.

One of the important obligations of the Regional Network for DSS and its host institution(s) is to coordinate network-building efforts and provide specific technological assistance and guidance. Programs will be designed for promoting the role of science and technology in preventing and controlling DSS, on the one hand, and blending indigenous knowledge and modern science and technology, on the other, especially in the early warning system.

The launching of the proposed Regional Network for DSS would provide opportunities for members of the international community to put in concrete terms scientific cooperation against DSS in Northeast Asia. In particular, interested, affected, and developed country parties will be able to work more closely and effectively, within the framework of the regional network, with international regional and subregional organizations. Reference has already been made to the WMO network and to the Acid Deposition Monitoring Network in East Asia and the contributions that each of the partner countries makes now. Opportunities exist to further enhance these linkages and extend them to cooperation in the Asia-Pacific region (including Australia and other relevant countries), USA, and Central Asia. Close cooperation with existing networks and programs on long-range transboundary air pollution in Northeast Asia should be maintained.

APPENDIX 1

LIST OF PARTICIPATING PARTIES

1. Focal Points

GOVERNMENTS

Country	Office / Agency	Name / Designation[1]
People's Republic of China	International Department Ministry of Finance	Ms. Liu Fangyu Director, TA Division (Steering Committee Member)
	Department of Regional Economy State Development and Reform Commission	Mr. Yang Chaoguang Deputy Director General (Steering Committee Member)
Japan	Multilateral Cooperation Department Foreign Policy Bureau Ministry of Foreign Affairs	Mr. Hidenobu Sobashima Director, Global Environment Division (Steering Committee Member)
	Global Environment Bureau Ministry of Environment	Mr. Tokuya Wada / Ms. Keiko Segawa [2] Deputy Director, Global Environment Issues Division (Steering Committee Member)
Republic of Korea	Ministry of Environment	Mr. Won-min Kim Director, International Affairs Division (Steering Committee Member)
		Mr. Chi-ho Bai Deputy Director, International Affairs Division
		Mr. Jeong-Gyoo Park Deputy Director, International Cooperation Division, Korea Meteorological Administration
Mongolia	Department of Economic Cooperation, Management and Coordination Ministry of Finance and Economy	Mr. Khosbayar Amarsaikhan Director General (Steering Committee Member)
	Ministry of Nature and Environment	Ms. N. Oyundari Director, International Cooperation Department (Steering Committee Member)

[1] Designation in government agency represented. Steering committee members are also indicated.

[2] Ms. Segawa assumed the position of Mr. Wada during the course of the study.

INTERNATIONAL ORGANIZATIONS

Organization	Office	Name / Designation[1]
Asian Development Bank (ADB)	East and Central Asia Department	Mr. Adrian Ruthenberg Director, Operations Coordination Division
		Mr. Fei Yue Country Programming Specialist, Operations Coordination Division (Steering Committee Member)
		Ms. Carmela C. Espina Economics Officer
United Nations Convention to Combat Desertification (UNCCD)	Asia Regional Coordination Unit	Mr. U Wai Lin Regional Coordinator (Steering Committee Member)
		Mr. Yang Youlin Assistant Regional Coordinator
United Nations Environment Programme (UNEP)	Regional Office for Asia and the Pacific	Mr. Choei Konda Deputy Regional Coordinator (Steering Committee Member)
		Mr. Mylvakanam Iyngararasan Senior Programs Officer, Regional Resources Center for Asia and the Pacific
United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)	Environment and Natural Resources Development Division	Mr. M.A. Khan Chief, Environmental Section (Steering Committee Member)
		Mr. Il Chyun Kwak Environmental Affairs Officer

[1] Designation in organization represented. Steering committee members are also indicated.

2. Participants to Technical and Steering Committee Meetings and International Workshops

GOVERNMENTS

Country	Office / Agency	Name / Designation[1]
People's Republic of China	International Department Ministry of Finance	Mr. Huang Huiping Deputy Division DIrector
	Department of Regional Economy State Development and Reform Commission	Mr. Yang Chaoguang Deputy Director General (Steering Committee Member)
		Ms. Guo Xujie Senior Officer
	International Cooperation Department State Environment Protection Agency	Mr. Guo Jing Division Director
		Ms. Wang Yu
	National Bureau to Combat Desertification State Forestry Administration	Ms. Jia Xaioxia Deputy Division Director
		Ms. Li Mengxian Deputy Division Director
		Ms. Jian Tian Fa Deputy Division Director, Project Management Office
	China Meteorological Administration	Mr. Yu Jixin Director General, Department of Observation and Telecommunication
		Ms. Li Dongyan Deputy Director, Department of International Cooperation
	Development and Reform Commission of Inner Mongolia Autonomous Region	Mr. Li Xueyan Section Chief
Japan	Global Environment Bureau Ministry of Environment	Mr. Tokuya Wada / Ms. Keiko Segawa [2] Deputy Director, Global Environment Issues Division (Steering Committee Member)
	International Forestry Cooperation Office Forestry Agency	Mr. Masato Yoneda Deputy Director
		Mr. Kazutaka Okamoto Deputy Director
	Meteorological Research Institute	Dr. Masao Mikami Senior Researcher
	Environment Chemistry Division National Institute for Environmental Studies	Dr. Masataka Nishikawa Head
	Sino-Japan Friendship Center for Environmental Protection	Mr. Hideaki Koyanagi JICA Expert
	Overseas Environmental Cooperation Center	Mr. Mitsugu Saito Technical Manager

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APPENDIX 2

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[1] These experts were provided by their respective governments, as part of the in-kind contribution to the RETA 6068, to give technical advice and guidance to the consultant team.

APPENDIX 3

LOGICAL FRAMEWORK OF RETA 6068

Design Summary	Performance Indicators/Targets	Monitoring Mechanisms	Assumptions and Risks
Goal To reduce the frequency, severity, and damage of the transboundary environmental problem of dust and sandstorms (DSSs) in Northeast Asia through regional cooperation.	Reduced damage by introducing an effective regional monitoring and early warning network. Reduced frequency and severity by arresting the land degradation in the originating source areas of DSS in the People's Republic of China (PRC) and Mongolia.	Continued monitoring of DSS and the damage reports. Continued monitoring and regular report on land degradation and improvement in the originating source area.	The frequency, severity, and damage of DSS can be reduced through well planned and coordinated public intervention. Land degradation in the DSS originating area is one of the major causes of increased DSSs in the region.
Purpose To promote establishment of a regional cooperation mechanism for prevention and control of DSS in Northeast Asia to encourage and facilitate coordinated interventions of all the stakeholders on DSS at regional level.	To establish a regional cooperation mechanism that is supported with operational capacity to coordinate interventions on DSS and to mobilize support of stakeholders for combating DSS. To prepare a regional master plan for combating DSS that will be supported with the following: (i) a phased development program for establishing a regional monitoring and early warning network for DSS (ii) an investment strategy including recommendations for sustainable financing mechanism and identification of eight demonstration projects.	All the parties involved (i.e., the PRC, Japan, the Republic of Korea, and Mongolia and Asian Development Bank (ADB), United Nations Convention to Combat Desertification (UNCCD), United Nations Environment Program (UNEP), and United Nations Economic and Social Commission for Asia and Pacific (UNESCAP)) will establish a steering committee to provide overall guidance for project implementation. All the parties will also set up three technical committees to provide technical advice on specific technical issues during implementation of the technical assistance (TA).	All the four countries have the political will and policy commitment to addressing DSS through regional cooperation. All the four international institutions will cooperate with due diligence.
Outputs • An initial institutional framework for regional cooperation on DSS. • A regional master plan for regional cooperation on alleviating DSSs, which will be supported with, *inter alia*, the following: (i) a phased program to establish a well-functioning regional monitoring and early warning network for DSS, and (ii) an investment strategy including recommendations for sustainable financing mechanisms and identification of 8 demonstration projects, four in the PRC and four in Mongolia	The initial institutional framework will provide a forum and enabling mechanism for the major DSS stakeholders to coordinate their policy and intervention on DSS at a regional level. The master plan will be approved by the steering committee.	All the activities of the initial institutional framework will be under close monitoring of the major stakeholders through the steering committee. The master plan will be based on a comprehensive assessment of existing scientific findings and be developed in cooperation with the multiagency national working groups under the guidance of the national coordination agencies of PRC and Mongolia. The master plan will be reviewed by the technical committees concerned before being submitted to steering committee.	The steering committee can make decisions on policy and operational issues on behalf of the governments concerned. The technical committees concerned are capable of providing technical advice and guidance.
Activities 1. To establish (i) an initial institutional framework for regional cooperation on combating DSS; (ii) a regional data bank on DSS; and (iii) a website for the TA as part of the public awareness program.	The initial institutional framework and the web site for public awareness should be in operation within one month of approval of the technical assistance (TA). The detailed work program for all the activities should be available for review and endorsement by the technical committees concerned, and for review and consideration by the steering committee at the inception meeting	The work program will be reviewed by the technical committees and approved by the steering committee. Consultants are requested to submit weekly report to the project secretariat and ADB. Project secretariat will submit a monthly report to ADB, national coordination agencies, and the steering committee.	The governments will provide the consultants with access to the data and documents for their study. The project secretariat should be able to provide operational and administrative support to monitor and facilitate day to day operation of the field work.

Design Summary	Performance Indicators/Targets	Monitoring Mechanisms	Assumptions and Risks
2. To review and analyze: (i) existing scientific research findings on DSS and the existing national monitoring and forecasting systems for DSS in the region; (ii) existing national program/action programs on DSS and the national experiment/demonstration projects in PRC and Mongolia; (iii) best practices for alleviating DSSs; and (iv) initiatives from the private sector or non-government organizations. 3. To recommend a regional master plan for alleviating DSS through cooperation at regional level; the master plan should be supported with: (i) a phased program to establish a regional monitoring and early warning network for DSS, and (ii) an investment strategy including recommendations on sustainable financing mechanisms and identification of 8 demonstration projects, 4 in PRC and 4 in Mongolia	Findings of the review and analysis should be available for timely review by the technical committees concerned.	Project secretariat will circulate a newsletter for information dissemination and public awareness and supervision.	

APPENDIX 4

TECHNOLOGY AND PROCESSES FOR DUST AND SANDSTORM MONITORING, FORECASTING AND EARLY WARNING

1.1 MONITORING INDICATORS

What follows is an annotated list of indicators but it must be remembered that not all will be relevant to all situations. Some though have special value as input for modeling and forecasting. A basket of indicators is probably required to give the best outcome.

"Horizontal Visibility" can be considered as an effective indicator. This is because the visibility observation and analysis have been used in classifying and reporting [*Middleton and al*, 1986; *Natsagdorj et al.*, 2003] DSS in almost all the countries at least since the last 50 years. Another important thing is that the value of horizontal visibility has a relationship with surface dust concentration, and can then provide a proxy for dust distributions almost in real time. Rapid data access (four times each day) and an efficient communication system (e.g., GTS) exist in almost all the countries. This is very useful for validating the DSS FS output. WMO has been using visibility classifying the DSS until the present-day. The only problem for visibility network is that all the existing visibility data comes from the naked eye, not from an instrument.

"Total suspended particle (TSP)" is another proxy indicator for DSS FS & EWS. TSP is classed as a proxy indicator mainly because TSP is not a pure dust aerosol concentration indicator. TSP over continental Asia can actually be divided into five general categories: (1) soil dust aerosol and associated species (consisting of oxides of Al, Si, K, Ca, Ti and Fe, and trace elements), (2) particulate sulfates, (3) aerosol nitrates, (4) ammonium products, and (5) carbonaceous material [*Solomon et al.*, 1989; *Zhang et al.*, 2002; *Zhang et al.*, 2001]. One cannot be simply attribute the observed TSP to the dust contributions and the associated DSS event. The other four types of particulate contribute to the observed TSP. Another problem for TSP is that no real-time TSP data can be obtained by instruments at this moment. Once there is a DSS outbreak, a High Volume Air Sampler can be employed for TSP measurement and DSS sampling.

"Particulates with diameter smaller than 10 µm (PM_{10})" It has been listed as one of the indicators for air quality evaluation in every country; also it is a main indicator to estimate the impact of suspended particulate matter on human health. A major characteristic of DSS in North East Asia is its color. The color of PM_{10} sample collected from the middle and east of the PRC, the Republic of Korea, and Japan is darker than TSP sample. The color is a clue as to the source area. Currently, β-ray dust mass monitor is employed to PM_{10} measurement in PRC.

This indicator is also somewhat useful, but it is less important than TSP. It is not only because the contribution to the PM_{10} loading are from five types of particulate, but also because the soil dust particles associated with DSS include lots of particles with a diameter larger than 10 µm dust particles. This would give a gross underestimate, especially in severe or very severe DSS events. **But the PM_{10} data can be obtained in real-time in the proposed network stations, a merit over TSP**.

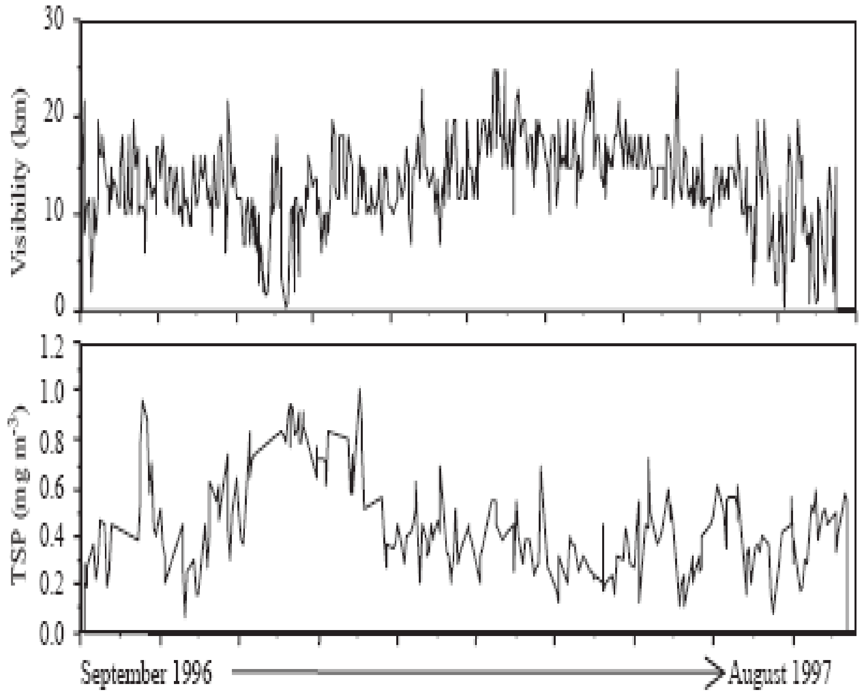


Figure A4.1 Time Series of TSP and Visibility (14:00 observation) in Xi'An from September 1996 to August 1997 [Zhang et al., 2002].

"Dust aerosol loading" can be considered as the best indicator for DSS regional monitoring and early warning network observations, because the higher dust concentration observed especially in depositional regions of DSS exhibits the transported dust associated with DSS from the source regions. If the spatial distribution of dust aerosol concentration predicted by FS can be compared and adjusted quickly and efficiently with an observed distributions of dust concentration from the regional network stations, a new initial condition will then be used into the rolling forecasting, which is extremely important for the accuracy in forecasting. Unfortunately no dust concentration data can be quickly and efficiently transferred to the existing DSS FS and cannot be established in the near future. This is mainly because to obtain the dust aerosol concentration, it takes several days or weeks to conduct the required chemical analysis.

The limitation of these two indicators is that there is no feasible way to get the data in real time. This limitation reduces their value in forecasting.

For the DSS source countries, the most frequently used indicators and technologies in DSS monitoring are meteorological data, soil and vegetation status, visibility and, where available, PM_{10}, TSP, and LIDAR although the last mentioned indicators are not very effective under conditions of severe DSS events. These air quality indicators form the core of monitoring programs in both Japan and the Republic of Korea. But knowing what data to collect is only the first step. Collecting it in a way that allows cross-region comparison is another.

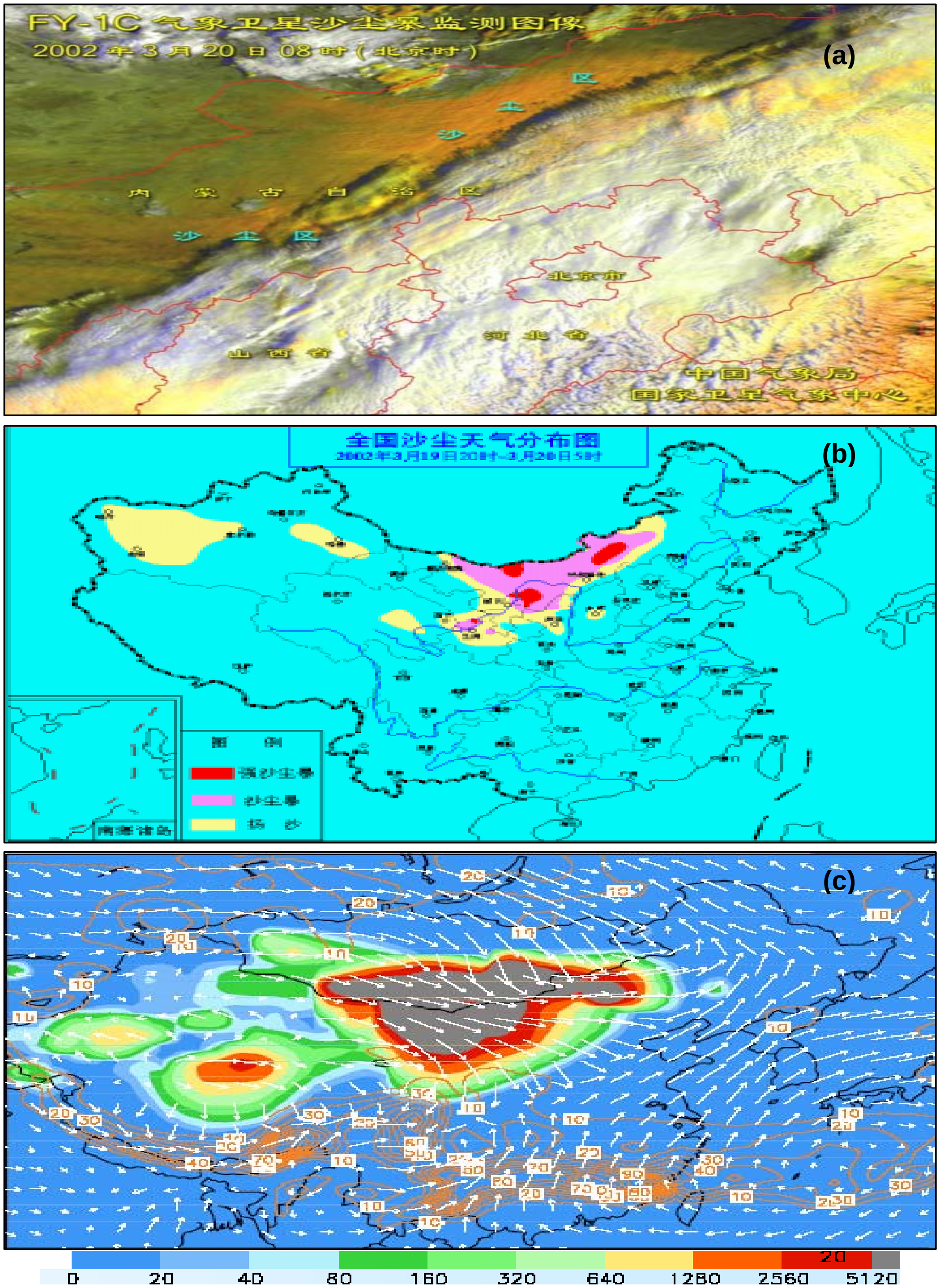


Figure A4.2 Spatial Distribution of DSS provided new dust initial condition for accurate forecasting. (a) DSS distribution retrieved from FY-IC satellite at CMA (08:00 BST, 20 March 2002; (b) DSS distribution reported on the basis of horizontal visibility in the PRC (20:00BTS, 19-March to 05:00, 20 March2002); (c) FS estimated surface concentration of dust aerosol (μg m^{-3}) and observed wind and rain (02:00 BST, 20 March 2002) in the PRC

So it is clear that because of the different needs in the DSS source areas and the DSS receiving areas and different ways to model DSS outbreaks, it is desirable to collect data from a basket of indicators (Table A4.1)

Table A4.1 Summary of the Data Required as Input for Various Models

Class of Indicator	Purpose & role	Specifications
Surface characteristics data	Very important as model inputs (Boundary conditions & fundamental data for dust emission estimate)	**Grid data:** 0.5 degree (or 50km) mesh at worst, ideally 0.1 degree (or 10km) mesh or finer
Point data (Monitoring data)	For **data assimilation**: Effective but not essential (does not necessarily improve the accuracy of forecasts)	**Temporally:** Need for real-time data **The number of sites:** The more, the better, but efficiency will change: (Ratio of number vs. efficiency) 1 -> 10 sites critical 10 -> 100 efficient 100 -> 1000 less efficient
	For each model **validation**, and for model **developments** of forecasting, early warning and assessment of likely impact of taking a remedial measure such as afforestation; very important	**Temporally:** No need of real-time data (monthly OK) **The number of sites:** Even a small number is useful: 10-20 in PRC, 5-10 in Mongolia would be enough for the first step

Point data (monitoring data)

Measurements	Priority	For validation and model improvement	For assimilation
LIDAR	High	Direct comparison is impossible (Needs conversion between concentrations and extinction coefficient) *Can get vertical profiles	Not directly available
Horizontal velocity	Medium	Useful to validate meteorological model simulations	Available (For meteorological model)
Visibility	Low	Direct comparison is impossible (Needs conversion between concentrations and visibility)	Not directly available

Surface characteristics data

Landuse/Vegetation	All of these are essential data for accurate simulation of DSS
Soil texture	
Soil moisture status Snow cover	

The scope of other indicators that should be considered in DSS monitoring in the future is set out below as follows:

(a) Meteorological
- Wind velocity, direction
- Air turbidity
- Visibility
- Atmospheric stability parameters
- Snow coverage

(b) Soil
- Texture
- Moisture
- Temperature
- Bare soil

(c) Vegetation Coverage

(d) Relief
- Slope
- Aspect
- Elevation

(e) Socio-economic
- Unpaved road network
- Open mining area

1.2 GROUND SURFACE MONITORING: ITS ROLE AND EFFECTIVENESS

Dust and sandstorms are atmospheric phenomena and are often classified as hazardous weather events. However, they are ground-initiated and ground-generated in source regions, ground-enhanced along their transport path. They are air-driven storms but it is the interaction between the atmosphere and the ground surface that is the key to DSS outbreak and impacts. The ground surface conditions and the ecological environmental of the source regions and along the transport route are very important.

Remote sensing has value in DSS monitoring in two main ways:

- Real-time monitoring in spatial distribution of DSS by remote sensing
- Ground surface conditions and ecological environmental assessment in the source regions and depositional regions by remote sensing

Low-resolution remote sensing data can be used to retrieve the spatial distribution of DSS, aerosol optical depth and aerosol index when a DSS event occurs. The satellite data and models that have potential for DSS monitoring are shown in Table A4.2.

The monitoring should focus on the source region, the transport path and the deposition areas. Low resolution remote sensing data can be used to identify the outbreak, extent, density, and visibility during the DSS events.

1.3 REMOTE SENSING FOR DSS REAL TIME MONITORING

Remote sensing has an important role for ground surface conditions and ecological conditions assessment in the source regions and along the transport path. Tables A4.2 to A4.4 show the attributes of the various satellites in common use.

Remote sensing has great potential for DSS monitoring but DSS events are not stationary and change is rapid. For real-time monitoring at regional scale, high resolution satellite data will not fit the purpose due to the narrow swath width (60-180km) and low temporal resolution (16 -26 days). Also high-resolution data is expensive. High resolution data can be used in limited key DSS source areas, where DSS occurs more frequently and has more serious effect.

Table A4.2 Satellite Data and Models for DSS Monitoring

Satellite	GMS/VISSR	NOAA AVHRR	MODIS
Frequency of visit	Hourly	Twice a day	Twice a day
Resolution	5 km	1.1km	250m, 500m, 1km
Swath (coverage)	1/3 of the earth surface	2000km	2330km
Selected wavelength	Visible, infrared	1.6µm 11µm 12µm	1.628-1.652µm 3.66-3.84µm 10.78µm 11.28µm
Selected bands	All bands	Channel 3A, 4 and 5	Channel 6, 20, 31, 32
Models for best observation	No	$NDDI = a \bullet e^{(b \bullet v_{ch3})} \bullet (ch4 - ch5) / ch4$	Not available, can use same model as NOAA data
Data cost	Free, material cost	Free, material cost	Free, material cost
Station cost (RMB)	200,000	200,000	3,000,000
Output	Hourly monitoring	Daily Monitoring 1. Comparable dust intensity index 2. Visibility 3. Monitoring the source, transportation, diffusion and deposit of dust sandstorms 4. Albedo* 5. Optical Depth**	Daily Monitoring 1. Comparable dust intensity index 2. Visibility 3. .Monitoring the source, transportation, diffusion and deposit of dust sandstorms 4. Albedo* 5. Optical Depth**
Comments	Limited by cloud cover	Limited by cloud cover	Limited by cloud cover

* Albedo: Percentage of light reflectivity (radiance), white =100% Albedo

** The optical depth model is available but the model validation is a difficult to conduct. It needs highly restricted conditions. The model is ready to serve the research purpose but cannot meet the requirements in operation. It is a valuable parameter for DSS monitoring, but it is not sufficiently precise for quantitative analysis. It needs further research and supporting instruments.

Table A4.3 List of DSS Indicators Derived from Satellite

Satellite name	DSS indicators	Usage status
NOAA	Vegetation cover Land surface temperature Wind DSS location, movement Land cover type	operational
MODIS	Land cover type Aerosol thickness, size distribution	experimental
SeaWifs	Aerosol thickness, size distribution	experimental
Landsat	Vegetation cover Sandy sources Relief Land cover type	operational
SPOT	Vegetation cover Land cover type Sandy sources Relief	operational

Table A4.4 Remote Sensing for Ground Surface Conditions Monitoring (an Example from PRC)

Satellite	NOAA AVHRR	MODIS	SPOT VEGETATION	SPOT	LANDSAT TM
Frequency of visit	Twice a day	Twice a day	One day globe coverage	1-4 days	16 days
Resolution	1.1km	250m, 500m, 1km	1.15km	2.5m, 5m, 10m, 20m	15m, 30m
Swath	2000km	2330km	2250km	60km*60km,	180km*180km
Vegetation coverage monitoring	Band 2,1	Band 2, 1 NDVI VI IR/R SQRT IR/R TNDVI	Provide one day synthesis vegetation index image and 10 day synthesis vegetation index image	Band 3,2 NDVI VI IR/R SQRT IR/R TNDVI	*NDVI=(IR-R)/(IR+R)=* *(TM4-TM3)/(TM4+TM3)* *VI=IR-R=TM4-TM3* *IR/R=TM4/TM3* *SQRT IR/R=* $\sqrt{TM4/TM3}$ *TNDVI=* $\sqrt{\frac{TM4-TM3}{TM4+TM3}+0.5}$
Selected bands for soil moisture	4, 5	4,5,6,7,8,9	SWIR band: Leaf surface water content	No	Band 6
Selected bands for snow cover	4, 5	MODIS Standard Snow Products MOD10 MOD33	All bands	All bands	All bands
Cost estimation	Free, material cost	300RMB/orbit	Annual fee 110,000 RMB	12000RMB/scene	5000 RMB/scene
Comments	Last winter snow cover monitoring is the most Important for DSS monitoring	Regular monitoring from summer to next spring	VEGETATION NDVI data can be downloaded from www.vgt.vito.be	5 years monitoring circle, focus on source region	5 years monitoring circle, focus on source region

Notes: **VI**: Vegetation Index. VI>1, is the boundary of vegetation or non vegetation. **NDVI**: Normalized Difference Vegetation Index. NDVI>0.15, is the boundary of vegetation or non vegetation. This is a more precise and commonly used indicator for vegetation. **TNDVI**: Transformed Normalized Difference Vegetation Index. If this model is used, then no negative value will appear in the image no matter whether there is vegetation or other targets in the image with higher reflectivity on red band than Infrared band. The input for these models must be the reflectivity, not the digital number of the images.

A framework of how remote sensing technology might be integrated into DSS Monitoring and Early Warning in PRC is shown in Figure A4.3.

For DSS monitoring purposes the most suitable remote sensing satellites are:

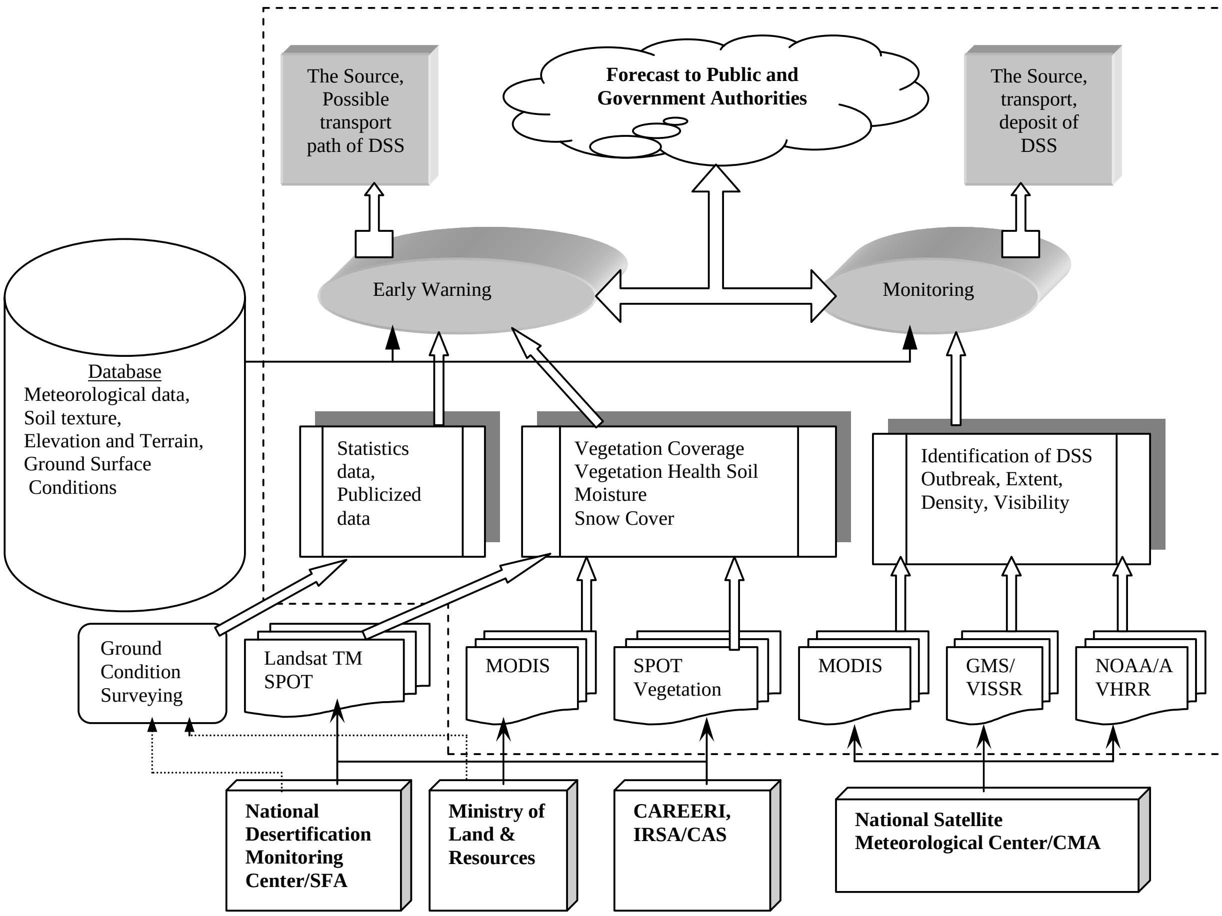
1. NOAA. AVHRR data successfully has been used for environmental studies and monitoring at the regional scale. The advantage of NOAA data is its availability at every 6 hour interval and at 5 bands 0.58 - 0.68, 0.725-1.1, 3.55-3.93, 10.3-11.3, 11.5-12.5 mkm over the large area. Also NOAA data is cheap and is very useful for long term monitoring. All participating countries have a NOAA receiving station.

2. MODIS provide comprehensive coverage in spectral and spatial contexts in comparison with NOAA data. Spatial resolution of 250, 500 and 1000 m in 36

wavebands in the spectral range from 0.4 to 14 mkm. Temporal resolution is 1-2 days.

Another suitable tool for DSS is the Microwave sensor. Microwave RS has one very good advantage of cloud transparency observation. In most of cases DSS especially those caused by cyclone, coincides with cloud. This sensor gives us the possibility to monitor even in the case of cloud cover. Microwave RS has been successfully used for soil moisture and precipitation monitoring, both important indicators of DSS.

Figure A4.3 Framework on Remote Sensing for DSS Monitoring and Early Warning (an Example from PRC)



Geostationary satellites that provide data every 30 minutes have been mostly used for weather forecasting. Also, combined and integrated use of multi-sensors of different satellites could be useful.

- Using GMS satellite data, every hour monitoring during the DSS season, principally from February to June[1].
- Using NOAA AVHRR satellite data for DSS, soil moisture, vegetation monitoring, and every day monitoring during the DSS season, principally from February to June.
- Using SPOT VEGETATION for vegetation monitoring, every ten days during non DSS season, every one day during DSS season, principally from February to June.
- Using MODIS for vegetation monitoring and soil moisture monitoring every day during the DSS season, principally from February to June.

The assessment should forecast the source region, the possible transport path and the deposition areas before the DSS outbreak. The statistical data and the data from the ground condition surveying results (not the original surveying data, database, detailed maps) should delineate the areas with poor ecological environment and those with poor vegetation coverage. Using such a database, and statistical data from ground surveys even low-resolution remote sensing data at regular (10 days intervals) can monitor vegetation cover and vigor in the potential DSS outbreak areas and along the likely transport path. In addition, soil moisture status, snow cover and other surface characteristics of value to modelers can be used to support the early warning efforts.

The framework of remote sensing technology for ground surface conditions and ecological environment assessment is shown in Figure 4.3 The satellite data used for DSS monitoring and their functions in DSS monitoring and the ground surface conditions and the ecological environment assessment of the source region and transport path are shown in Table A4.4 and Box A4.1.

Box A4.1 Suggested Applications for Remote Sensing in DSS Forecasting and Early Warning

- Use NOAA AVHRR satellite data for soil moisture, snow cover monitoring before the DSS season from September to February.
- Use MODIS for vegetation monitoring, soil moisture estimation, snow cover monitoring regularly before the DSS season from September to February.
- Use SPOT VEGETATION for vegetation coverage, health condition monitoring, every ten days during non DSS season, from September to February.
- Use Landsat TM or SPOT images for vegetation monitoring and ecological environment assessment only in sensitive source regions and along the transport path. It should be conducted on a 5-year cycle, mainly relying on the project results and output of SFA and Ministry of Land Resources.
- Use elevation data or topographical map to delineate the possible transport path and store in the database.

[1] Sometimes DSS occur at other seasons. Less frequent monitoring occurs over the whole year.

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The regional master plan is composed of three volumes, namely: Volume 1: A Master Plan for Regional Cooperation for the Prevention and Control of Dust and Sandstorms; Volume 2: Establishment of a Regional Monitoring and Early Warning Network for Dust and Sandstorms in Northeast Asia; and Volume 3: An Investment Strategy for Dust and Sandstorms Prevention and Control through Demonstration Projects.

This report has been prepared by a team of consultants engaged by ADB in cooperation with national experts from Japan and the Republic of Korea under the technical guidance and supervision of a Technical Committee chaired by the UNESCAP. Finally, this report was reviewed and cleared by members of the Steering Committee. Appendix 1 lists the participating parties, consultants and national experts for this undertaking.

ABBREVIATIONS AND ACRONYMS

A$	Australian Dollar
ADB	Asian Development Bank
ADEC	Aeolian Dust Experiment on Climate Change Impact
AVHRR	Advanced Very High Resolution Radiometer
AWS	Automatic Weather System
CAA	Civil Aviation Authority
CAREERI	Cold and Arid Regions Environment and Engineering Research Institute
CAS	Chinese Academy of Sciences
CMA	China Meteorological Administration
DPRK	Democratic People's Republic of Korea
DSS	dust and sandstorm
GEF	Global Environment Facility
GMS	Geostationary Meteorological Organization
GTS	Global Meteorological Telecommunication System
JMA	Japan Meteorological Agency
KEI	Korea Environment Institute
KMA	Korea Meteorological Administration
LIDAR	Light Detection & Ranging instrument
MA	Meteorological Agency
MODIS	Moderate Resolution Imaging Spectroradiometer
mu	Chinese land area measurement (15 mu = 1 ha)
NAMHEM	National Agency for Meteorology, Hydrology, & Environmental Monitoring (Mongolia)
NIER	National Institute of Environmental Research (the Republic of Korea)
NIES	National Institute for Environmental Studies (Japan)
NOAA	National Oceanic & Aeronautical Administration (USA)
NWP	Numerical Weather Prediction
PM_{10}	Particulate Matter of < 10µ
PRC	People's Republic of China
R&D	Research and Development
RETA	Regional Technical Assistance
RMB/CNY	Chinese currency; yuan
KOR	Republic of Korea
SEPA	State Environment Protection Administration (the PRC)
SFA	State Forestry Administration (the PRC)
TA	Technical Assistance
TM	Thematic mapper (satellite mounted)
TOMS	Total Ozone Mapping Spectrometer
TSP	Total Suspended Particles
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Programme
UNESCAP	United Nations Economic and Social Commission for Asia and Pacific
US$	US dollar
WMO	World Meteorological Organization

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EXECUTIVE SUMMARY

1. INTRODUCTION

Dust and sandstorms (DSS) are natural phenomena that have occurred for thousands years in the Northeast Asia Region. During the past 50 years, however, the frequency has increased, geographic coverage has expanded, and damage intensity has accelerated. Now, DSS are considered to be among the most serious environmental problems in the region as a disastrous hazard. It causes considerable hardship, loss of income, disrupts communications, affects people's health and, in extreme cases, leads to human casualties and destruction of livestock and crops over large areas in the affected countries.

The Technical Assistance on the *Prevention and Control of Dust and Sandstorms in Northeast Asia* was implemented in the context of the ongoing joint efforts of the major DSS stakeholders in the region, including the four partner governments of the People's Republic of China, Japan, the Republic of Korea and Mongolia; and four international institutions, namely: the Asian Development Bank (ADB), United Nations Economic and Social Commission for Asia and Pacific (UNESCAP), United Nations Convention to Combat Desertification Secretariat (UNCCD), and United Nations Environment Programme (UNEP). The key activities under the TA fall into two major components; one for initiating an institutional framework for regional cooperation on DSS and the other for developing an investment strategy for prevention and control of DSS as part of the master plan for regional cooperation on alleviating DSS.

This report contains the outcome of the study on "an investment strategy for DSS prevention and control through demonstration projects." It focuses on sustainable financing mechanisms and identification of nine priority focus areas for demonstration projects (four in PRC, four in Mongolia, and one cross-border area straddling the PRC and Mongolia) to promote and disseminate the best practices in addressing the causes of DSS. The report has been prepared by a team of consultants in cooperation with national experts under the technical guidance and supervision of the Technical Committee chaired by UNESCAP and reviewed by the participating parties at the Steering Committee.

2. RATIONALE

DSS has an enormous damaging effect on the environment, economy, and society in the countries of the Northeast Asian region. The cost of damages is, by and large, a function of the intensity of DSS events as well as the values at risk. Direct damage cost caused by DSS include loss of crops and livestock, loss of topsoil, damage to property, industries and businesses, critical facilities and infrastructure, disruption to transportation systems, road accidents, and closures of schools and services. Indirect damage cost of DSS include: increased medical costs, impact on human health, costs of cleaning residential and commercial buildings, repair and reconstruction costs, and wear and tear on machinery and equipment due to DSS. Chinese researchers[1] estimated that land degradation costs their nation approximately US$6.7 billion each year, and the indirect costs of damages are 4.5 times that of the direct costs. The costs of damages associated with DSS in PRC alone are estimated to range from US$70 million to US$239 million per year.

[1] Lu Qi and Wu Bo, 2002 Population, Resources and Environment in China 12(2): 29-33

Stepping up DSS prevention and control is justified, given the enormous damage costs by DSS and the urgent need to reduce the frequency and severity of DSS. The benefits of anti-DSS efforts include the reduction in economic losses and the restoration of damaged ecosystems. Above all, the most important benefits are the higher standards of living for millions of people in the DSS source areas and pathways as well as the improved public health and safety in all DSS-affected areas. First and foremost, the impact of DSS on human health is of great concern in DSS source areas as well as along the DSS transport routes downwind. Given the high population density of metropolitan centers, health concern with DSS is particularly high.

3. LESSONS LEARNED

Mongolia and the PRC have formulated their respective National Action Programs to combat desertification. Due to political commitment and increase in budgetary allocations to desertification control on the part of the central government in each country and technical and financial assistance from a number of donor agencies, some best practices and mitigation approaches have emerged, and a few lessons have been learned as follows:

- The realization that DSS is non-point source and serious transboundary environmental problem, which requires an integrated regional approach. Moreover, a coordinated regional approach is needed in tandem with national initiatives.
- There is need to undertake interventions and remedial actions on a scale that is commensurate with the scale of the DSS–source areas.
- A cross-sectoral approach in combating desertification is more likely to achieve desired results. Likewise, undertaking one activity in isolation (e.g., only the planting of trees) will not solve the DSS problem.
- It is essential for all stakeholders (particularly the local community in the source areas) to work together for DSS reduction. Varying responsibilities are required from the national government, local governments, and local communities.
- It is possible to develop packages of measures that can be applied at reasonable cost over large areas.

4. INVESTMENT STRATEGY FOR DEMONSTRATION PROJECTS

In the context of existing international, regional and national frameworks for the control of land degradation, environmental protection, and sustainable development at large, an investment strategy for DSS prevention and control is being proposed. The strategy aims at safeguarding the environmental, economic and social sustainability of the Northeast Asian region at a broad level, and envisages improving the health, safety and welfare of the peoples in DSS source areas, pathways and impacted downwind locations. The goals, priorities and scope of investment strategy have been proposed taking into consideration:

- Feasibility;
- Affordability;
- Sustainability;
- Novel approaches and methodologies; and
- Ongoing policy/institutional initiatives.

The situation in PRC and in Mongolia is somewhat different. Therefore, the investment component of the strategy for each country will be quite different. PRC is a partner with ADB/GEF under Operational Program 12 (OP 12) of GEF. Over the next 10 years US$1.5 billion will be spent on projects aimed principally at combating land degradation and alleviating poverty. The aims of this effort are complementary with the aims of the DSS prevention and control proposal. Therefore, PRC should align and tailor its program of evaluating the actions/measures to prevent and control DSS in line with the projects being developed under GEF's OP-12. Moreover, the resolution of *cross boundary issues* requires further international cooperation to augment the bilateral programs and partnerships.

Interventions and actions under the investment strategy to be undertaken on a scale that is commensurate with the size of the DSS source areas and values at risk in DSS-impacted areas. A package that comprises a hierarchy of measures at national/provincial and local levels needs to be designed as follows:

- administrative and policy measures that are applicable over an entire administrative unit and may require action at national or provincial level; and
- measures restricted to specific sites.

Elements of the package in the first category may include the revision of legislative, policy and administrative regulations to relieve the pressures that cause land degradation, technical measures for revegetation of degraded lands using methods such as grassland fencing and exclusion of grazing, and capacity building, training and extension services. Many of the technical approaches are proven to be effective in reducing DSS, but the optimum combination of elements needs to be determined. In the second category measures will be unique to specific field sites although some of these may be applied across a range of ecological conditions.

4.1 Selection of Demonstration Sites

In tackling the identified anthropogenic factors in DSS source areas, initially, attention will need to be given to focus areas and, in the interests of cost effectiveness, a demonstration project approach is recommended. The rationale for adopting a demonstration project approach in focus areas is threefold. *First*, the projects are relevant to government mandates, and they can be aligned with existing and emerging priorities of the government and responsive to other related issues, such as public health and safety. *Second*, they can be designed and programmed to suit diverse local conditions, operational requirements and the availability of financial resources and implementation capacities. *Third*, they help provide value adding and generating results within a reasonable timeframe - the demonstration sites will serve as a test bed for evaluating the appropriateness of the technical measures, innovative trials, and institutional arrangements and policies.

The choice of the focus areas for the demonstration projects is the responsibility of the respective governments in PRC and Mongolia. The selection of these areas should follow a set of criteria as outlined Table E4.1.

The respective governments of the PRC and of Mongolia have nominated four focus areas within their territory and one cross-border area. Each area is in a known DSS source area and/or in the pathway of DSS and all are characterized by poor ecological conditions due to a combination of natural and human-induced causes. The bio-physical, ecological, and socio-economic profile of each focus area has been described in Appendices 2 to 5 of the report. The focus areas were selected on the basis that they were representative of different ecosystems and as such presented an array of land uses, population densities, household livelihood strategies. Some actions/measures will be unique to some focus areas but others could be evaluated across a range of ecosystems. There is also a hierarchy of actions/measures. At the level of the province or *aimag* in Mongolia, there may be administrative or policy measures that apply over the whole administrative unit, whilst some actions/measures will be restricted to a specific site. Some sites will be large (10,000 ha for some rangeland components) but others such as alternative energy (wind and solar) may occupy <1 ha.

Table E4.1 Criteria for Selecting Demonstration Project Sites

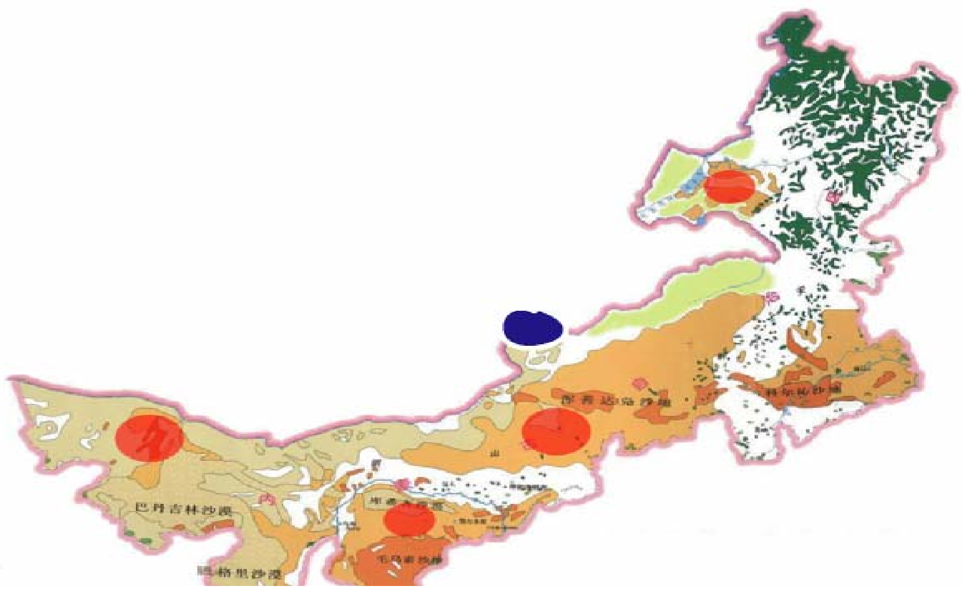
	Criteria
General	• Criteria should be general enough to be used for future project development. • A guiding principle is that land in the process of degradation should be included in the chosen sites. • The project design should entail a comprehensive and integrated approach. • The demonstration projects should have synergy with ongoing work undertaken by local government and communities. • Local stakeholders should be involved in site selection and project implementation, that is, using a bottom up approach. • The recommended sites should be incorporated into each country's NAP. Alternatively, the recommended demonstration projects could be associated with key areas of provincial-level projects that tackle the same issues. • Local experiences and achievements in both technical and policy aspects of land management will be especially valuable in selection and design of the demonstration projects. • These sites must be located in DSS source areas or along the pathways and have an acceptable level of accessibility to the site from abroad. • The demonstration sites should be representative of different natural conditions
Additional	• State of land degradation should be substantial in extent and quantifiable by appropriate indicators that enable scientists to determine the original vegetation level. • Land degradation should be caused by human activity. • Land degradation is currently contributing to the increase of DSS events • Appropriate monitoring is possible to evaluate the effectiveness of DSS measures.
Specific	Scope - size of a project site generally greater than 10,000 ha. - components to be tested and demonstrated should be site specific. - focus areas should have a range of land forms, types and uses. - duration should be minimum of 5 years. Purpose - environmental - economic (cost effective) - sociological - replicable - contributing to poverty reduction.

4.2 Proposed Focus Areas for Demonstration Projects in the PRC

Although DSS are known to originate in several places in the western and northern PRC, it was the decision of the PRC government to concentrate the choice of focus area for each demonstration project within the Inner Mongolia Autonomous Region. The four focus areas for the demonstration projects (Alashan, Ordos Plateau, Xilingol and Hulunbuir) are located along a 1,500 km west-east transect that samples the various environments in the DSS source areas. These areas represent four important grassland ecozones, namely, Hulunbuir for mountainous meadow grasslands, Xilingol for typical grasslands, Ordos for dry grasslands, and Alashan for desert grasslands. The focus areas are those that are the degraded rangelands but are reversible, given appropriate measures and timely treatment. In the west, the Alashan area is arid (annual rainfall range of 40-200 mm). In the Ordos area (annual rainfall range of 190-300 mm), there is a mosaic of sandy land from source-bordering dunes along the Yellow River system, sand plains on the margins of the various deserts, and Loessal hills. In Xilingol (annual rainfall of >350 mm), there are plains with loess under a layer of sand. The grasslands of Hulunbuir are on rolling plains and the annual rainfall is > 300 mm. The soil is underlain with deep sand of the Quaternary age. Figure E4.1

shows the location of the PRC focus areas including the area for the cross-border demonstration project.

Figure E4.1 Map of Focus Areas in Inner Mongolia Autonomous Region, the PRC



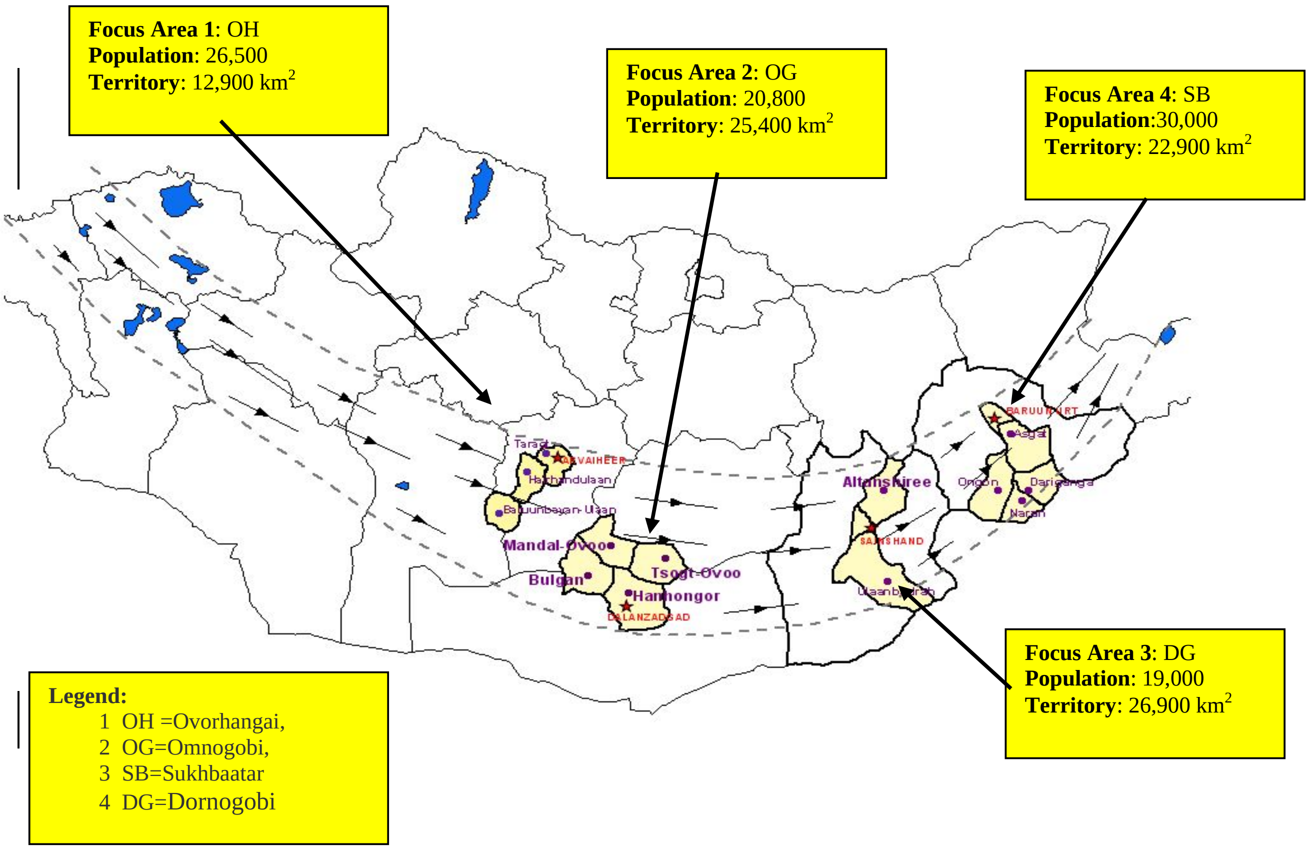
Legend:

- 🔴 Four focus areas in the PRC from west to east are Alashan, Ordos, Xilingol, and Hulunbuir
- 🔵 Cross-border focus area at Erinhot on the PRC side

4.3.3 Proposed Focus Areas for Demonstration Projects in Mongolia

Four focus areas were selected in Mongolia after discussions with the government officials, scientists in research institutes, and after field visits. Each of the focus areas occupies several local administrative areas and each covers a significant range of physical and human resources. The locations, administrative boundaries and some relevant data on DSS are shown in Figure E4.2.

Figure E4.2 Location of Focus Areas in Mongolia (including DSS path)



4.3.4 Proposed Cross-Border Demonstration Focus Area of Erinhot-Zamiin Uud

The proposed focus area for the cross-border or sub-regional demonstration project is in the border region near Erinhot on the PRC side and Zamiin Uud on the Mongolian side (or the Erinhot-Zamiin Uud Focus Area).

Zamiin Uud focus area is located in Dornogobi *aimag*. It has a size of 12,900 km^2 and covers the entire territory of one *soum* (Zamiin Uud) It experiences the same severe climate as Erinhot and lies on the same substrate. Both communities face problems on lack of both surface and ground water. The particular challenge that the geographic location, climate, and general lack of natural resources poses have been addressed in different ways by the people on each side of the border. In PRC, much emphasis has been placed on ameliorating the environment through a combination of measures. The banning of grazing within a 10-km radius of the city center, planting of wind breaks and other protection forestry, and innovative uses of waste water (including sewerage) are some of the measures implemented. Technology transfer may be possible so that the Mongolian side can benefit from the lessons learned and techniques perfected by the PRC side.

There is a clear need for involvement in this subregional project by experts from the four partner countries. Potentially, the joint cross-border site should be an especially useful way to validate the ideas and approaches of many stakeholders. A training center should be established to facilitate exchange of technical know-how among the four partner countries. Likewise, a hi-tech plant nursery and plant propagation facility should be constructed.

Mongolia recommended that attention be also given to fostering ecotourism with strict environmental safeguard controls in the Gobi regions on the Mongolian side as a means to provide alternative livelihood.

4.4 Proposed Activities and Investment Requirements

4.4.1 Project Activities in Focus Areas of the PRC

Table E4.2 sets out a summary of the major proposed actions/measures for each of the Focus areas in PRC.

Table E4.2 Summary of Proposed Actions for Focus Areas in the PRC

Items \ Sites		Alashan	Ordos	Xilingol	Hulunbuir
Combating land degradation to prevent and control DSS	Prevention	Cropland conversion to forest/ grassland		Documentation of protection measures	
	Rehabilitation	Rangeland management	• Airseeding • Enclosure	Rangeland management	• Rangeland management • Enclosure
	Development	• Desert-based industries • Alternative energy sources	• Desert-based industries • Ecotourism[1]	• Artificial grassland management	• Artificial and natural grassland management • Alternative energy sources
Capacity Building to implement measures for DSS prevention and control		• Training Center for alternative skills • Capacity building for local government	Capacity building of local government	• Training Center for alternative skills • Capacity building for local government	• Training Base for grassland management • Capacity building for local government
Poverty Alleviation to reduce pressure on land and reduce dust entrainment		Solar/wind-power energy[2]	Better practices for fodder plantations	Better practices for fodder plantations	• Better practices for fodder plantations • Solar/wind power energy[2]
Social Development to improve livelihoods, reduce dependence on farming and animal husbandry, improve infrastructure		Develop off-rangeland skills		Develop off-rangeland skills	

[1] Ecotourism should be dealt within the environmental carrying capacity of the area with strict environmental safeguard controls.

[2] Introduction of renewable energy and other fuel-efficient cooking methods can reduce pressure on woody plants that should be left in place to stabilize the soil surface.

Based on the proposed actions/measures or project activities intended for each focus area in PRC, an indicative cost and corresponding coverage is shown in Table E4.3.

Table E4.3 Indicative Costs and Coverage of Project Activities in the PRC

Area	Activity	Cost US$ Million	Coverage
Alashan	Rangeland Management	2	50,000 ha (includes training, capacity building, production of manuals, video and posters)
	Private Sector Desert-based Industries	1	10,000 ha
	Alternative Energy Sources	5 – 10	5,000 -10,000 ha
	Skills Training for Alternative Livelihood	3	500 persons (includes establishment, equipment and staffing)
	Capacity Building for Local Government	1	100-150 cadre over 5 years
	Sub-total	**12.0 – 17.0**	
Ordos Plateau	Capacity Building for Local Government	1	100–150 cadre over 5 years
	Desert-based Industries (Development Models)	20	50,000 – 100,000 ha
	Air Seeding Techniques	1	100,000 ha
	Fencing Techniques	-	-
	Artificial Grassland and Shrub Plantation	0.2	2,000 ha
	Sub-total	**22.2**	
Xilingol	Integrated Package for Area Protection	0.5	25,000 ha
	Capacity Building of Local Government	1	100-150 cadre over 5 years
	Skills Training for Resettled Herders	3	500 persons
	Artificial Grassland and Shrub Plantation	0.2	2,000 ha
	Rangeland Management	2	50,000 ha
	Sub-total	**6.7**	
Hulunbuir	Rangeland Management	2	50,000 ha (includes training, capacity building, production of manuals, video and posters)
	Artificial Grassland	0.2	2,000 ha
	Planting Chinese Pine	0.5	10,000 ha
	Alternative Energy Sources	10	5,000-10,000 ha
	Capacity Building for Local Government	1	100-150 cadre over 5 years
	Fencing Techniques	-	-
	Awareness Campaign	2	100,000 ha
	Sub-total	**15.7**	

4.4.2 Project Activities in Focus Areas of Mongolia

Table E4.4 sets out a summary of the major proposed actions/measures for each of the focus areas in Mongolia.

Table E4.4 Summary of Proposed Actions for Focus Areas in Mongolia

Items \ Sites		Ovorhangai	Omnogobi	Sukhbaatar	Dornogobi
Combating land degradation to prevent and control DSS	Prevention		Plant trees to stabilize sand movement around *soums*	• Strengthen Darganga Natural Park • Plant trees to stabilize sand movement	Windbreaks along roads and railways
	Rehabilitation	• Rangeland management • Enclosure	Rangeland management	Rangeland management	Rangeland management
	Development	• Develop ecologically responsible mining • Renewable energy sources	Renewable energy sources		
Capacity Building to implement measures for DSS prevention and control		Capacity building of local government	Capacity building of local government	• Capacity building of local government • Awareness campaign	Capacity building for local government
Poverty Alleviation to reduce pressure on land and reduce dust entrainment		Renewable energy use			Strengthen environment sound poverty reduction policies and programs
Social Development to improve livelihoods, reduce dependence on animal husbandry, improve infrastructure			Develop Alternative Energy		Infrastructure and technology development

Based on the proposed actions/measures or project activities intended for each focus area in Mongolia, an indicative cost and corresponding coverage is set out in Table E4.5.

Table E4.5 Indicative Costs and Coverage of Project Activities in Mongolia

Area	Activity	Cost US$ Million	Coverage
Ovorhangai	Use of environment friendly technology for gold mining	0.7	100,000 ha per year
	Rangeland Management	1	100,000 ha. (includes training, capacity building, production of manuals, video and posters)
	Use of renewable energy resources	1 – 1.5	50 households per year
	Capacity building of local govt.	1	100-150 cadre over 5 years
	Artificial grassland plantation	0.2	
	Sub-total	**3.9 – 4.4**	
Omnogobi	Rangeland Mgt.	1	100,000 ha (includes training, capacity building, production of manuals, video and posters)
	Tree planting	1	100,000 ha
	Use of renewable energy sources	1 – 1.5	50 households/year
	Capacity building of local govt.	1	50-100 cadre over 5 years
	Sub-total	**4.0 – 4.5**	
Sukhbaatar	Strengthen Darganga Natural Park	0.3	20,000 per year
	Rangeland Mgt.	1	100,000 ha (includes training, capacity building, production of manuals, video and posters)
	Plant Trees to Stop Sand Movement	0.6	50,000 ha
	Capacity building of local govt.	1	50-100 cadre over 5 years
	Awareness campaign	0.5	100,000 ha
	Sub-total	**3.4**	
Dornogobi	Windbreaks along roads and railways	0.5	253 ha per year
	Rangeland Mgt.	1	100,000 ha (includes training, capacity building, production of manuals, video and posters)
	Capacity building of local govt.	1	50-100 cadre over 5 years
	Strengthen of poverty-environment policies	1	Shainshand *soum* center
	Sub-total	**3.5**	

4.4.3 Project Activities in the Cross-Border Focus Area

The proposed major project activities for the cross-border focus area of Erinhot-Zamiin Uud are given in Table E4.6.

Table E4.6 Summary of Proposed Actions for Cross-border Focus Area in Erinhot-Zamiin Uud

Items \ Sites		Erinhot-Zamiin Uud
Combating land degradation to prevent and control DSS	Prevention	• Rangeland and livestock management • Windbreak, shelterbelt along the road and rail link from Ulaanbaatar to Zamiin Uud.
	Rehabilitation	Revegetation and tree planting
	Development	• Waste water re-use; Model forest planting with waste water irrigation • Alternative energy
Capacity Building to implement measures for DSS prevention and control		Training center for traditional and hi-tech nursery facility; training of local government officials
Poverty Alleviation to reduce pressure on land and reduce dust entrainment		Ecotourism[1/]
Social Development to improve livelihoods, reduce dependence on farming and animal husbandry, improve infrastructure		Awareness campaign for stakeholders

[1] Ecotourism should be dealt within the environmental carrying capacity of the area with strict environmental safeguard controls.

Table E4.7 Indicative Costs and Coverage of Project Activities in Cross-border Area of Erinhot-Zamiin Uud

Area	Activity	Cost US$ Million	Coverage
Erinhot – Zamiin Uud	Hi-tech nursery and plant propagation facility	0.5	Area size variable; training of 100 technicians per year.
	Establish international training center	0.5	200 persons per year
	Use of waste water	0.2	Erinhot City
	Alternative energy sources	0.6	100 local herders per year
	Ecotourism [1/]	1.0	Area of a *soum*
	Rangeland/livestock management	2.0	100 households
	Windbreaks/shelter belt	0.2	500 ha
	Sub-total	**5.0**	

1/ Rationale for this is that as a cross-border focus area on the transcontinental railway, there is a steady stream of visitors seeking to experience the Gobi desert and the herders' lifestyle. Income generation from this source can reduce pressure on grazing lands.

4.5 Financing Plans

The scale of the demonstration projects is flexible and can be tailored to the available funds. Preliminary estimates for each focus area range from US$ 3 million to over US$22 million but not all of the money needs to available at one time. Some of the proposed project components can be packaged and funded as stand-alone measures and some are candidates for private sector partnerships. Among the donor community there may be project components that more closely fit their current aid program. A possibility is to establish a regional fund dedicated to prevention and control of DSS, which could receive contributions from the participating countries (including private corporations, international agencies or organizations). Government donations to the fund could be used as the seed money and could serve as a vehicle to mobilize additional funding support from other sources, public or private.

Every demonstration project has its special capital costs. A major element of each site must be the installation of appropriate monitoring systems whose intent is to measure any reduction in frequency and intensity of DSS that can be attributed to the intervention being tested. The monitoring system will vary between sites but an extra 1% can be added to the cost estimates to provide for it.

There are a few possible funding sources for DSS investments, to wit:

- **Internal sources.** There is budget allocation for environment management in different levels of the national government but not much is available for DSS investment in the PRC and Mongolia. Likewise, internal resources can be tapped from the domestic private sector, communities, and small stakeholders of the project area.

- **Bilateral Channels.** The bilateral donors such as Japan typically concentrate on funding pre-project activities and pilot project. Bilateral assistance is most often given as grants. The bilateral support from donors has an important role in insuring that the projects are well documented and well structured through support for feasibility studies and pilot projects. Without the combination of bilateral assistance for feasibility studies and pilot projects with international financing of subsequent larger scale implementation many projects with important environmental benefits would not be implemented or their scope would be significantly reduced.

- **International Financing Institutions.** Apart from bilateral donors, a number of the international financial institutions are active in connection with the financing of environmental projects in the region. The most important actors are the Asian Development Bank (ADB), the World Bank, and the European Union. There is a well-developed cooperation between the Government of Mongolia and the international financial institutions. The large international financing institutions such as the World Bank and ADB typically provide long-term loans financing large-scale investment projects. However, governments are cautious on increasing their foreign debt and are least likely to borrow funds for the purpose of combating DSS.

- **Global Environment Facility.** GEF considers DSS as a subset of land degradation. However, there is a hope that GEF would consider Mongolia's case for funding because Mongolia has never received any financing from GEF for OP 15[2]. Everybody agrees that land degradation is becoming worse and worse in Mongolia. The PRC, on the other hand, is already a partner of GEF OP 12[3] on Land Degradation in Dryland Ecosystems.

- **Private Sector Involvement.** It should be expected that the opportunities for mobilizing additional resources for environmental investments through involvement of the private sector in a Public-Private Partnership. It should increasingly be tested in both DSS affected countries and source countries in the coming years. The Government of Mongolia will be following these developments and seek to contribute constructively to ensure that such new cooperation models are implemented in a way

[2] GEF's Operational Program on Sustainable Land Management, which includes creating appropriate enabling environment, institutional strengthening, and investments.

[3] GEF's Operational Program on Integrated Ecosystem Management.

that secures the public interest. The need to mobilize additional resources for investments in DSS prevention and mitigation leads governments and international financing institutions to consider new forms of cooperation where the private sector is involved in a Public-Private Partnership. In conclusion, both the PRC and Mongolia should mobilize significant internal and external resources for investments, which are necessary for mitigating DSS impacts in the region. .

Since a phased approach is more viable to implement, the financing plan should strictly stick to the phased approach. The project should have three phases for the next 10 years (see Table E4.8).

Table E4.8 Phases of DSS Prevention and Control Program

Phases and Proposed Activities	Funding Needed (US$ 000)	Funding Sources[1/]
Phase I. 2006-2007		
1. Feasibility studies	1,000	GIC, BS, PS
2. Capacity building	8,000	
3. Institutional development and policy framework	500	
4. Public awareness	500	
Subtotal	10,000	
Phase II. 2008-2010		
1. Implementation of pilot projects (Zamiin-Uud and Erinhot)	5,000	GEF, GIC, PS, BS
2. Monitoring (equipment)	1,600	
Subtotal	17,600	
Phase III. 2010-2015		
1. Implementation of projects in three dust source areas based on the feasibility studies and lessons learnt from pilot projects. .	24,000	GEF, GIC, PS, BS
2. Monitoring (equipment)	240	
Subtotal	24,240	
Grand Total	**40,840**	

1/ GIC – Government in-kind contribution; GEF – Global Environment Facility; BS – Bilateral sources; PS – Private Sector.

As part of the regional master plan to combat DSS there is a need to replicate and expand the treated area. The “package” of measures/actions that are proven to reduce the frequency and severity of DSS should be scaled up to involve an area more commensurate with the size of DSS source area.

CHAPTER 1 INTRODUCTION

1.1 Background and Objectives of the Project

Dust and sandstorm (DSS) is the generic term for a serious environmental phenomenon that involves strong winds that blow a large quantity of dust and fine sand particles away from the ground and carry them over a long distance with significant environmental impacts along the way. In the realm of DSS in the Northeast Asian region, the People's Republic of China (PRC), Japan, the Republic of Korea , and Mongolia form a single ecological community due to their geographic proximity and climatic contiguity. The major sources of DSS in the region are believed to be the desert and semi-desert areas of the PRC and Mongolia. Both Japan and the Republic of Korea are the recipients of this dust. To address the long range transboundary environmental problem of DSS, a regional cooperation mechanism must be established among the countries in the region. .

At the request of the governments of the People's Republic of China (PRC) and Mongolia, the Asian Development Bank (ADB), United Nations Economic and Social Commission for Asia and Pacific (UNESCAP), United Nations Convention to Combat Desertification Secretariat (UNCCD), and United Nations Environment Programme (UNEP), initiated their own projects for the prevention and control of DSS in Northeast Asia. ADB prepared the project concept for a regional technical assistance (TA) in early May 2002 and the three agencies of the United Nations made a project proposal to seek support from the Global Environment Facility (GEF) to address the same environmental problem in the region.

It was proposed by the governments of the four countries that ADB, UNESCAP, UNCCD, and UNEP jointly develop an expanded TA to integrate the support from the international community, maximize the effects of the undertaking, and promote regional cooperation on DSS to be co-financed by ADB (Japan Special Fund) and GEF.

The TA commenced in March 2003. The key activities under the TA fall into two major components; one for establishing a regional network for monitoring and early warning of DSS in Northeast Asia, and the other for developing an investment strategy for prevention and control of DSS as part of the regional master plan for alleviating DSS.

The first component focused on the *establishment of a regional network for monitoring, early warning and forecasting of DSS.* The objective of the second component, on the other hand, is to outline *an investment strategy and financing plan to support and sustain activities geared to preventing and controlling DSS*. Hence, the specific focus of this second component is on sustainable financing mechanisms and identification of nine priority demonstration projects (four projects in the PRC, four in Mongolia, and one cross border project) to promote and disseminate the best practices in addressing the causes of DSS.

The activities of the second component of the TA include: (i) identification and promotion of best practices for alleviating DSS; (ii) exploration of initiatives from the private sector or nongovernmental organizations; and (iii) the identification and formulation of project components that are of potential interest to the donor community with the incorporation of financial assistance in cost recovery issues where external loans are to be considered as part of the remediation package.

1.2 Rationale for the Prevention and Control of DSS in Northeast Asia

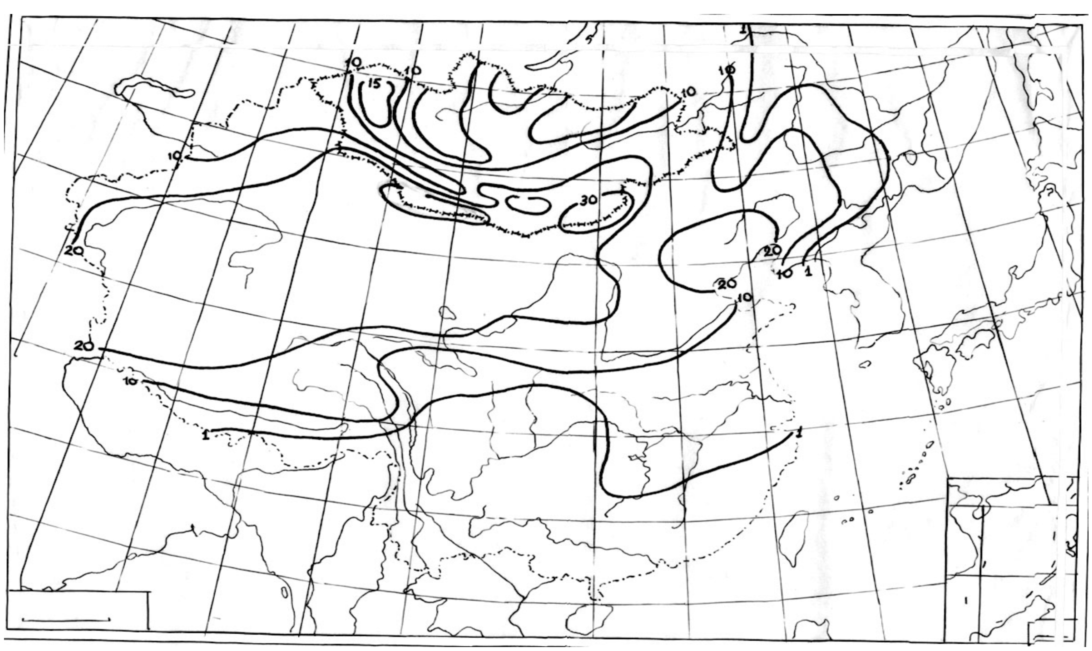
DSS is a transboundary environmental issue of a non-point origin, which has raised serious concerns in Northeast Asia. Catastrophic DSS in the region in recent years have resulted in enormous damage to rural communities in DSS source areas and along the transport route of the DSS. Industries, businesses as well as residents in urban centers downwind, such as in Beijing and Tianjin of the PRC, and even in Seoul and Tokyo, are also affected according to their proximity to the DSS source.

Severe DSS events are more frequent now than a decade ago[1] and the number of dusty days/year (as defined by the various WMO criteria) is as high as 60-80 in many places in Mongolia. The number of dusty days has been increasing. In Mongolia, for example, the number of dusty days was about 15 days in the 1960's and about 50 days in the 1980's; posting a threefold increase.[2]

Figure 1.1 gives the average number of days of severe dust storms in Central Asia. It shows that the highest frequency of occurrence of 30 days/year is in the south Gobi region of Mongolia with parts of the northern PRC also experiencing a high frequency of 20 days/year.

There was a severe DSS event in April 20, 2000, which covered a large area in the PRC (12 provinces, 2.5 million square km were affected by the DSS). Particulate matter, as assessed by TSP, was well above the PRC's air quality standards such that 8 mid-sized cites registered a 5 grade on the pollution measuring scale, and 11 cities had 3 grade pollution. Other serious DSS have occurred in recent years that led to many human casualties, large scale losses of livestock, complete destruction of crops, etc[3]

Figure 1.1 Average Number of Days of Severe Dust Storms in the Region



The implementation of DSS prevention and control activities is perceived to result not only in the net improvement of the quality of life experienced by the people in the DSS affected areas in Northeast Asia—the source areas, the areas along the dust transport routes, and

[1] Beijing has experienced many more severe DSS events in recent years (up to 23 times in 2002)
[2] D., Dagvadorj, L. Natsagdorj. D.Gomgluudev, and P.Natsagdorj 1999. Climate Change and its Trend in Mongolia (Scientific Report of Institute of Meteorology and Hydrology , 1999), Ulaanbaatar, No.20, pp.115-133.
[3] Yang Youlin, Victor Squires and Lu Qi (eds).2002. Global Alarm: Dust and Sand Storms from the World's Drylands. UN, 356 pp

the dust destination areas but also safeguard the life and property of people in source areas in particular.

1.2.1 DSS Source Areas

Satellite imagery and ground based observations confirm that the major DSS sources are the sandy land in the desert margins and in the transition zones between pastoralism and agricultural cropland in the northwestern, northern and northeastern areas of the PRC and in the southern and western parts of Mongolia (see Figures 1.2 to 1.4).

Many meteorological stations have been set up in China and these play an important role in monitoring weather conditions that are implicated in DSS. The PRC has 3,000 sites for meteorological observation, and 118 of these are situated in Inner Mongolia. In recent years meteorological data have been supplemented by satellite imagery and by data on soil surface conditions obtained from a network of over 60 monitoring stations.

The northern part of the west League of Alashan is the area where DSS occurs most frequently. Another major source is the Hunshdak sandlands located in southwest region of Xilingol League. Both Alashan and Xilingol are, thus, the natural candidates for the demonstration projects

The situation in Mongolia is also clear. Mongolian scientists derived the number of dusty days per year from the sum of the number of days with dust storms and drifting dust obtained from 34 meteorological stations in Mongolia from 1960 to 1999[4]. The trend is upward in the period 2000-2004, perhaps as a result of a prolonged drought and the increased grazing pressure on semi arid grazing lands.

Box 1.1: Sandstorm in PRC (Source Area and Route)

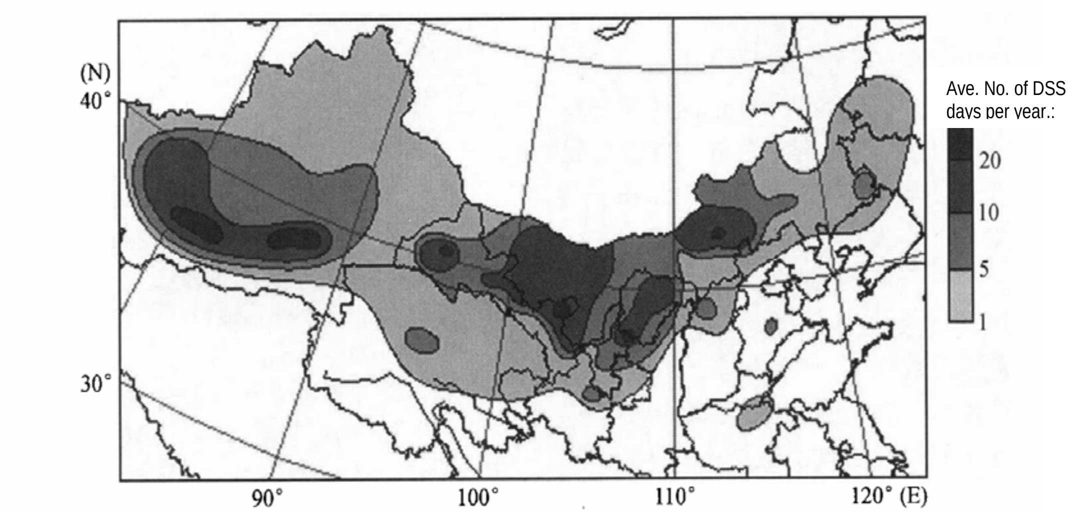
Source areas: Based on the studies of sandstorm data from China Meteorological Administration, it has been found that there are four high frequently sandstorm centers and origin regions in the PRC. They are 1) Taklimakan Desert and its nearby in south Xinjiang Basin. 2) Alxa and Minqin in Hexi Corridor of Gansu Province. 3) North of Yingshan in Inner Mongolia (Zhurihe in Central Inner Mongolia) and Otingtag Sandy Land and their nearby regions. 4) Yanchi in Ningxia, Yulin in Shaanxi and their nearby region along the Great Wall in Mu Us Sandy Land.

Route of dust and sandstorm in the PRC: According the analysis of satellite images, there are three major tracks of DSS in China. The first one is the west track, which passes over the Pamir and then enters into south Xinjiang Basin and then moves eastward, affecting Qinghai and Gansu The second one is northwest route, which travels through north Xinjiang and western region of Mongolia and then enters PRC, affecting northwest parts of PRC Provinces. The third one is the northern route, which comes from Baikal or central and east Mongolia and then enters into PRC.

Sources: Wang Tao et al., 2001, The Situation of Dust Storm and its Strategy in North China, China Science (B),5;
Zhou Zijinag, et al, 2001, Blowing Sand and Sandstorm in China in recent 45 years, Quaternary Science, Vol. 21 No.1, P9-17;
Zhang Qingyang, et al, 2002, Preliminary Study on Sand-Dust Storm Disasters and Countermeasures in China, Chinese Geographical Science, Vol.12, No.1, P: 9-13.

[4] D., Dagvadorj, L., Natsagdorj. D., Gomgluudev, Natsagdorj, P.,1999. Climate change and its trend in Mongolia. Scientific report of Institute of Meteorology an Hydrology et al., 1999), Ulaanbaatar, No.20, pp.115-133).

Figure 1.2 Yearly Average DSS Days in the PRC, 1952 to 2002



Note: DSS days are higher in the western and northern PRC

Figure 1.3 DSS Tracks from Mongolia and the Northern PRC

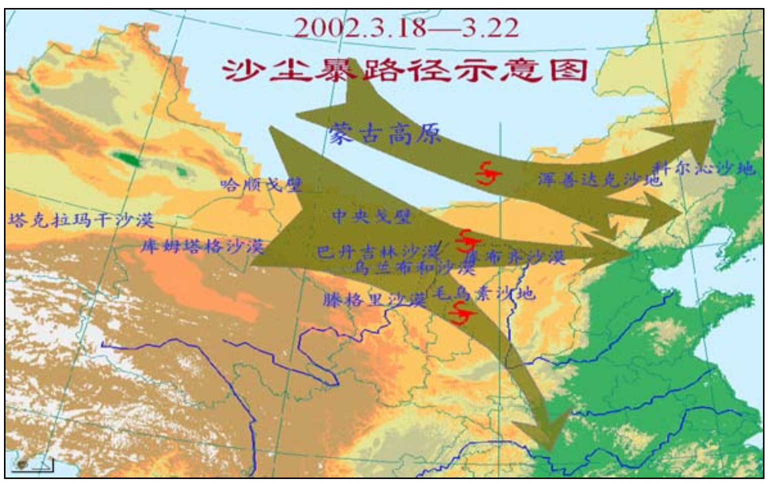
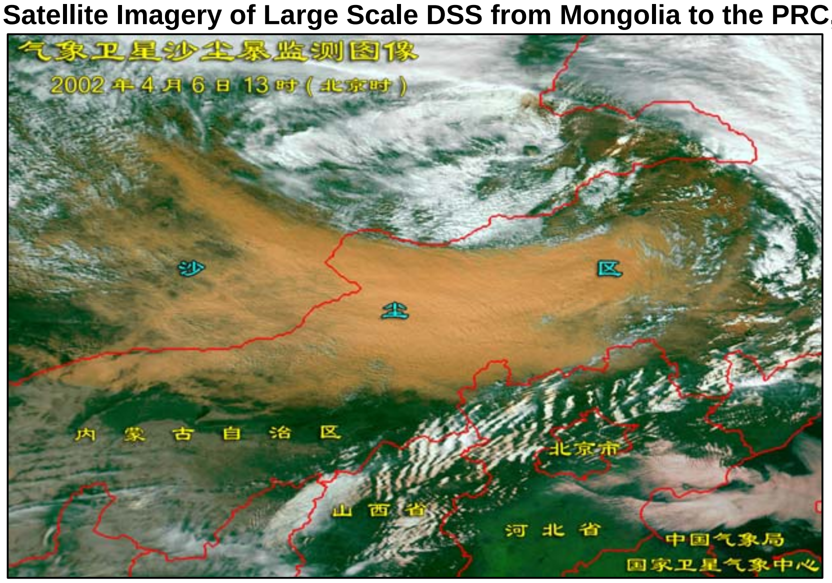


Figure 1.4 Satellite Imagery of Large Scale DSS from Mongolia to the PRC, April 2002



1.2.2 Direct Cost of Damages by DSS

Each of the four partner countries (i.e., the PRC, Japan, the Republic of Korea and Mongolia) has a different perspective of DSS and its significance. Each assesses the cost of damage by DSS in a different way. There are varying areas of concern about DSS in each of the four partner countries (such as damage to life and property, health concerns, and air quality) but there is also an area of common concern.

Principal direct damages of DSS include the following:

(i) Loss of crops and livestock. Severe DSS events lead to the total destruction of crops over the affected area and the widespread loss of livestock.

(ii) Property damage. Houses, power transmission towers, railway lines, roads, canals are damaged.

(iii) Loss of topsoil. According to an estimate made by the World Watch Institute, the Earth's continents lose as much as 24 billion tons of fertile topsoil every year, especially in the developing countries. UNCCD estimates that one third of the earth's surface is threatened by desertification, affecting more than four billion hectares. Since 1990, some six million hectares of productive land have been lost annually due to land degradation. UNEP estimates that desertification has caused income losses worldwide in the amount of US$42 billion per year.[5]

(iv) Damage to industries and businesses, including retail sales. DSS also poses a serious threat to industries, such as tourism, retail sales and even high-tech manufacturing.[6]

(v) Damage to critical facilities and infrastructure, e.g. roads, railway, irrigation canals, and power lines.

(vi) Disruption to transportation systems, including diversion and cancellation of flights.

(vii) Road accidents caused by dust storms.[7] In many parts of the northern PRC, DSS causes thick blankets of sand to blow across the road surface, creating a tremendous road hazard.[8]

(viii) Closures of schools, businesses and services, and absenteeism from work.

[5] "Ten years on: UN marks World Day to Combat Desertification," UNCCD, http://www.unccd.int/publicinfo/menu.php

[6] According to Howard French in his 14 April 2002 New York Times report "China's growing deserts are suffocating Korea," semiconductor manufacturers, which are highly sensitive to contaminants, have reportedly had to change their sophisticated air filters much more frequently and require workers to take longer showers before beginning assembly work. Workers are also being discouraged from entering and exiting the factories any more than is strictly necessary. Meanwhile, Hyundai Motor has reportedly begun to wrap new cars in plastic sheeting before export to protect them from the yellow dust.

[7] Mike Young and Peter Williams of CSIRO estimated that, based on four major dust storms, there had been an additional 12 motor accidents (per storm) brought about by drivers not fully appreciating the risks of driving in highly dusty conditions with poor visibility. For details, see "Australian dust storms stir up illness," by Lucy Chubb, Environmental News Network, July 20, 2000.

[8] "Grapes of Wrath in Inner Mongolia," a May 2001 report from US Embassy in Beijing.

Scientists from the PRC[9] estimated that land degradation costs the nation US$6.7 billion a year and affects the livelihood of 400 million people. The cost of the damage (or damage cost) by DSS in different parts of the Northeast Asian region varies significantly from one event to another, largely due to:

- wind speed and direction,
- topography of sites,
- vegetation types, and
- moisture conditions along the DSS transport route.

In terms of an individual DSS event, intensity is an important measure of DSS behavior, and damage cost is, by and large, a function of the intensity of DSS.

Box 1.2 Cost of Damage by a Single Severe DSS Event in Mongolia

The DSS on March 18, 2002 started at 10:05 in the eastern part of Mongolia and lasted till 19:45 of March 21, 2002. Its path was wide covering 67% of the total territory of Mongolia (95 *soums*/districts) and it was felt by different areas for 30 minutes to 68 hours, depending on their location on the DSS path. Wind speed exceed 20 m/sec (up to 38 m/sec in some places). The DSS left 3 people and 53,000 animals dead, 83 houses damaged, 24 communication lines and 6 power towers destroyed. The top soil of some parts of the central regions was blown away. **The direct economic loss was more than US $2 million.**

1.2.3 Indirect Costs of Damages by DSS

The indirect costs of damages by DSS are believed to be in the neighborhood of 4.5 times more that of the direct costs. Indirect damage costs of DSS include, the increased medical aid and costs that arise from the effect of DSS on public health, the costs of cleaning residential and commercial buildings, the repair and reconstruction costs, the wear and tear on machinery and equipment due to DSS, and so on.

First and foremost, the impact of DSS on human health is of great concern in DSS source areas as well as along the DSS transport routes downwind. Given the high population density of metropolitan centers, health concern is particularly high. On DSS days, clinics often overflow with patients suffering from respiratory ailments.[10] It is reported that, in Seoul, the number of deaths on “yellow sand days” is higher than the daily average on non-yellow-dust days. In particular, deaths due to cardiovascular and respiratory problems rise dramatically.[11]

There is a lack of definitive studies regarding the damage costs of dust storms to public health. In Australia, researchers argue that as much as 20% of the asthma problems in the State of South Australia (an area of over 1 million km^2) may be attributable to wind borne dust. One estimate of the cost of dust related asthma came up with a ballpark amount of about A$20 million a year (approximately US$15 million) in the State of South Australia and a range between A$10 million (US$7.6 million) and A$50 million (US$38 million) due to losses chiefly associated with absenteeism from work and school. However, two scientists of CSIRO (Australia), who conducted the research, warned that the estimated annual damage

[9] Lu Qi and Wu Bo, 2002 Population, Resources and Environment in China 12(2): 29-33
[10] “Sand smothers Mongolia to Korea,” http://www.cnn.com/2002/WORLD/asiapcf/east/04/08/skorea.sand/index.html
[11] One study concluded that, from March to May, 1995-1998, the death rate among Seoul residents on yellow sand days was 1.7% higher than on normal days (for details, see *Urban Air Quality Management and Practice in Asian Cities* – 3.10 Seoul, pp.50-51).

to public health may be revised downward to A$3 million (US$2.3 million) should the direct link between DSS and asthma fail to be confirmed.[12]

DSS gives rise to huge cleaning costs, for instance, the need to clean the glass of residential and commercial buildings, remove dusts inside houses, and so on.[13] In addition, wear and tear on machinery and equipment represent a significant damage cost to industries.

Finally, the need for shelters and the nuisance that DSS creates for rural and urban residents constitute considerable indirect damage as well, but it may not be quantified easily in economic terms.

1.2.4 Benefits of DSS Prevention and Control

In spite of the difficulty to quantify the monetary consequences of actions designed to mitigate DSS impact, there is a wide range of benefits from DSS prevention and control, including the reduction in economic losses, made possible with the improvement in the accuracy of prediction and monitoring. The reduction of property damage is an obvious benefit of DSS prevention and control programs. To evaluate this benefit in monetary terms, one must first identify the property that would be affected, as a consequence of DSS control efforts.

A second major benefit of DSS prevention and control activities is the protection of natural resources. Evaluation of this benefit entails a two-step process. The research must first identify the resources that would have been affected as a consequence of DSS prevention and control efforts. Then a monetary value needs to be established on the resource damage that would be averted.

There are many indirect benefits that result from DSS control. DSS events diminish air, soil, and water quality, and disrupt human activities. Prevention and control measures aimed at stabilizing sandy land will contribute to a reduction in the frequency and intensity of DSS events. Certainly, it is a challenge to express these benefits in monetary terms. Improved public health and safety is, perhaps, the most important benefit of DSS prevention and control. But, it is a challenging task to determine how many lives can be saved and how many hospital visits can be avoided as a result of specific DSS prevention and control activities.

The ecological functions such as landscape, recreation, carbon sequestration, soil erosion prevention not only benefit the local residents but also society at large. In the context of the Northeast Asian region, the eastern provinces in the PRC stand to benefit from DSS prevention and control efforts in the upstream areas in southern Mongolia and northwestern and the northern PRC, and even countries downstream, like the Republic of Korea and Japan, are beneficiaries.

In like manner, it is not easy to measure the value of DSS prevention and control. Surrogate measures are sometimes used to assess the performance of emergency response systems such as those of the fire and police departments and ambulance services. A reduction in response time will lead to an overall improvement in public health and safety (Martell and Boychuk 1997). Similarly, greater accuracy in forecasting and longer lead time that decision makers can gain will help draw up better plans to cope with disastrous DSS occurrence and,

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[12] "Costing dust – How much does wind erosion cost the people of South Australia?" 1999. Also see "Public health impact of wind erosion," notes put together by Harry Butler (butler@usq.edu.au), http://www.sci.usq.edu.au/staff/butler/research/dust/html, dated 26 September 2000.

[13] "The Electricity Trust of South Australia found it necessary to clean transformers after severe dust storms because of the risk of power leakage and failures." Article by Lucy Chubb, titled "Australian dust storms stir up illness," Environmental News Network, July 20, 2000.

hence, mitigate the damage. The benefits, which need to be quantified, that may be of concern to DSS prevention and control managers are as follows (a preliminary and partial list):

- Dust uplift
- Aquatic and terrestrial wildlife habitat;
- Biodiversity;
- Carbon sequestration;
- Cultural and social activities;
- Ecosystem health;
- Hydrological functioning;
- Natural resources, such as timber;
- Property;
- Public health and safety;
- Recreation and tourism activities;
- Soil conservation;
- Systems infrastructure; and
- Transportation and communications.

The benefits of DSS prevention and control is the quality of life “with” DSS prevention and control less the quality of life “without” DSS prevention and control. More concrete measurement for assessing the impact of DSS prevention and control includes things like the effect on the gross domestic product (GDP) of the countries in the Northeast Asian region. Specifically, the value of DSS prevention and control is the GDP “with” DSS prevention and control less the GDP “without” DSS prevention and control. It must be noted that this approach ignores many important “quality of life” issues that are not currently included in GDP calculations. Therefore, it is important to correctly account for all effects of DSS prevention and control activities. For instance, DSS control expenditures might increase the GDP while the DSS events themselves may result in a reduction in GDP (such as those brought about by school and mill closures, airport shut downs, and so forth).

1.3 Developing an Investment Strategy

DSS prevention and control is a common thread running through the many regional efforts to protect the environment in the interests of promoting the welfare of citizens in respective countries. Transboundary environmental issues were first dealt with on a bilateral basis, in the Northeast Asian region but bilateral cooperation quickly turned into a regional effort to solve issues such as DSS.

The investment strategy is proposed in the context of the international, regional, and national frameworks for the control of land degradation, with particular emphasis on:

- goals
- priorities
- scope
- feasibility
- affordability
- effectiveness
- sustainability
- novel approaches and methodologies
- policy/institutional initiatives

The situation in the PRC and in Mongolia is totally different. The investment strategy for each country will be quite different (see chapter 5). The PRC is a partner with ADB/GEF under OP 12[14]. Over the next 10 years, US$1.5 billion will be spent on projects aimed principally at combating land degradation and alleviating poverty. There is insufficient difference between the aims of this effort and the aims of the DSS prevention and control proposal to warrant GEF funding a special DSS control program. The PRC should tailor its program of evaluating the actions/measures to prevent and control DSS to the projects being developed under GEF's OP 12. But the resolution of *cross boundary issues* requires further international cooperation to augment the bilateral programs and partnerships.

1.3.1 Risk Management

There is a high degree of uncertainty, which makes it impossible to transform DSS prevention and control plans into precise, deterministic predictions concerning the social and economic impacts of DSS control programs. The issue of risk must be considered. Risk arises in DSS prevention and control because the probability of a DSS event varies from season to season, depending on the weather, wind, moisture, terrain and a host of other factors within a region. The probabilities of DSS events of a different size, in different climatic conditions, on different terrain, and under different land use situations can be worked out, based on existing knowledge about probability distributions of DSS events. However, in policy making and day-to-day management, a more practical approach is often used, that is, to simplify some of these factors by classifying the DSS loss and cost data by size, behavior, and so on.

Concerning DSS prevention and control, the timing, location and movement of DSS are highly uncertain, and this means that potential damages have these characteristics as well. However, given the current state of knowledge and technology, the protection of human life and property can be achieved through the mitigation of DSS impacts, although it is not possible to significantly influence the movement of DSS.

It is important to assess the benefits of reducing DSS risk. A dust storm risk can be expressed in several ways. One way is to express it as the average area affected per year. The principal drawback of this method is that it tends to give rise to a great deal of dispersion. Another way is to construct a risk index, based on expert opinions.

1.3.2 Applying the "Least Cost-Plus-Loss" Principle

There is a body of literature on natural resource damage assessment (see Morey et al. 2002).[15] There is a method known as the Least Cost-Plus-Loss,[16] which provides one option to analyze the cost effectiveness of interventions to deal with the uncertainties and widespreading damages associated with disastrous phenomena like DSS. The method pertains to setting the fire management program level in a region such that expected costs (fire prevention and fire-fighting costs) and losses are minimized. The criteria have two main components; economic efficiency and risk. Efficiency of a prevention program is measured by the net results accomplished, i.e., the reductions in losses rather than net revenue. The theory states that as prevention costs are increased, damage plus fighting costs decrease at

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[14] ADB/GEF Partnership on Land Degradation in Dry Ecosystems in the PRC which targets land degradation where the objective of land degradation control overlaps with the core GEF concerns (biodiversity, climate change and international waters).

[15] Morey, Breffle, Rowe, and Waldman. 2002. Estimating Recreational Trout Fishing Damage in Montana's Clark Fork River Basin: Summary of a Natural Resource Damage Assessment. *Journal of Environmental Economics and Management.* The article discussed the mining wastes caused significant reductions in trout stocks in a 145-mile stretch of Montana's Silver Bow Creek and Clark Fork River. To estimate economic damages from decreases in catch rates, the authors developed and estimated an individual-based utility-theoretic model of where and how often an angler would fish as a function of travel costs, catch rates, and other influential characteristics of the sites and individuals.

[16] The Least Cost-Plus-Loss model concerns only costs and does not estimate benefit. It must be recognized that decreased damage is not the only benefit of DSS prevention and control.

a decreasing rate. A prevention program is considered optimal at the level where total expenditures are minimized. Using the concepts of marginal analysis, at this point, marginal damage is equal to marginal cost (Cooper and Ashley-Jones 1987).

Policy makers are ultimately interested in measures that reflect the total cost of the DSS prevention and control program as well as the net damage incurred. This so-called “cost plus loss” measure indicates the total cost of the DSS prevention and control program plus the net loss due to DSS. The objective is to minimize cost plus loss. As discussed earlier, the true impact of DSS includes its impact on public health and safety, property, and other values.

In terms of a DSS damage function, while the number of DSS events can be hardly reduced, it may be possible to reduce the intensity of DSS, on the one hand, and mitigate the destructive impact, on the other hand. Research is required to investigate the dependencies underlying the relationships among the variables concerned. Simulation techniques may be employed to reconstruct hypothetical DSS events and determine the impact of different levels of prevention and control programs on the resources.

Note that DSS is, partially, a function of human settlement and activities in dust source areas. As the distribution of human settlement is not uniform, the value of assets at risk is not uniform. In general, the spatial distribution of “assets at risk” is highly correlated with population and, therefore, assets concentrate largely in urban centers. This enables the employment of some type of “gravity model”. It means that efforts need to be focused on areas where assets at risk are more numerous and valuable, and where the incidence of DSS is higher. However, it is a challenging task to enumerate and value a highly heterogeneous set of assets at risk.

1.3.3 Selecting DSS Prevention and Control Budget Levels

The economics of DSS prevention and control is about allocating expenditures to various DSS prevention and control activities, aiming at relating the overall level of DSS prevention and control to the potential benefits that would arise from the chosen prevention and control efforts. The basic principle of wildland fire economics is known as the “least cost-plus-loss” (LCPL) model, as explained in section 1.3.2. This model maybe amenable to an economic analysis of the problem of DSS prevention and control. The basic idea is that when money is spent on DSS prevention and control, a decrease in DSS losses is expected. Economic theory suggests that there will be decreasing marginal returns to scale so that eventually each additional DSS prevention and control dollar spent would produce less and less reduction in DSS damage on the areas affected. From the viewpoint of economic efficiency, the method that should be used involves setting the DSS prevention and control program level in a given sub-national region, or nation, or the Northeast Asian region such that expected costs (both prevention and control costs) and losses are minimized.

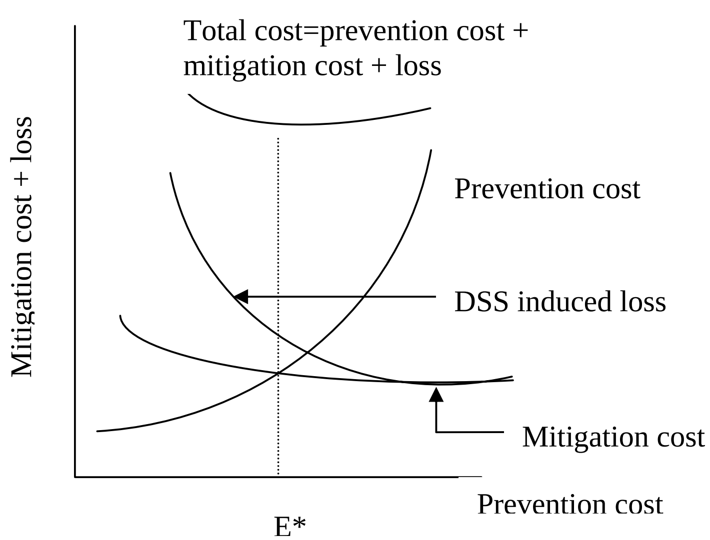
The LCPL model can be illustrated graphically as shown in Figure 1.5. The horizontal axis is E, or the amount of money that is spent on DSS prevention and control, that is, the expenditures on DSS conditions ameliorating activities (CAA). The vertical axis is represented by L(E), which is the sum of the cost incurred on DSS impact mitigating activities (IMA) and DSS losses; note that L(E) is a function of E.

Since E should be viewed as a cost as well, the total cost of DSS prevention and control as well as the DSS damage may be expressed as:

$$T(E) = L(E) + E \quad (1)$$

Equation 1 refers to the total cost plus loss incurred per year if E dollars are spent on DSS prevention and control. The DSS prevention and control agency should select a value of E, denoted by E*, that will minimize T(E). Note that E* is the point where the tangent to T(E) is horizontal (see Figure1.5).

Figure 1.5 The Least Cost-Plus-Loss Model



The LCPL principle states that as prevention and control costs (or the costs of CAA) are increased, DSS damage plus impact mitigating costs (or the costs of IMA) decrease at a decreasing rate. With total expenditures being simply the sum of these two, the optimal DSS prevention and control program should be operated at such a level that the total cost of operations plus DSS losses are minimized, i.e., minimizing the costs of CAA and IMA plus DSS losses. As funds are required for a wide variety of DSS prevention and control and impact mitigation activities, the LCPL model can be expanded to account for this.

When assessing damage and considering options, it is particularly helpful to be able to examine the effects of proposed programs, in a “with project” and “without project” fashion. From the perspective of a DSS prevention and control manager, the question is to decide how much should be spent on DSS prevention and control efforts, or allocate DSS prevention and control budgets to various activities comprising a DSS prevention and control program. Hence, a multi-stage sequential process for developing a DSS economics analysis system will include: (1) selecting an alternative, (2) acquiring resources, (3) allocating the required resources, (4) using the resources, (5) generating outputs, and (6) evaluating the outcomes.

Stepping up the activities for prevention and control is justified given the damage cost of DSS, and the need to reduce the frequency and severity of DSS. Table 1.1 sets out some of the benefits of implementing various measures in the DSS source areas

Table 1.1 Expected Benefits from the Prevention and Control of DSS

Actions/Interventions	Expected Benefits for Recipient Areas[1]	Expected Benefits for Source Areas in the PRC and Mongolia
Sandy land stabilization	Indirect benefit	Considerable benefit to local people in DSS source areas. Saves lives and property as well as protects livestock, cropland, and rangeland.
Dust abatement, prevent uplift and entrainment	Considerable benefit in terms of health, safety, better air quality and prevention of property damage.	Considerable benefit in terms of health, safety, better air quality and prevention of property damage.
Revegetation of bare land	Useful in so far as it prevents dust uplift.	Useful in so far as it prevents dust uplift and reduces DSS severity
Reform of policy and administrative measures to reduce pressure on land users that encourage poor land use practices	Indirect	Potential benefit as the enabling environment is improved and perverse incentives are removed that foster land use practices contributing to DSS outbreaks
Better inter-sectoral coordination	Indirect	Any prevention and control measures will be enhanced if there is an integrated effort
Alternative energy sources, Fuel efficient cooking [2]	Indirect	Solving fuelwood problem will relieve pressure on rangelands and lead to more stable ecosystems
Improved rangeland management, grazing control,	Rangelands are known sources of DSS. Any increase in vegetation cover will reduce DSS.	Rangelands are known sources of DSS. Any increase in vegetation cover will reduce DSS.
Poverty reduction and alternative livelihoods	Reduce frequency and severity of DSS if successful.	There would be fewer people engaged in poor land use practices that contribute to dust uplift and blowing sand.
Development of desert industries including herbal medicines, paper making, animal husbandry and tourism.	Indirect	Enhance partnerships with the private sector, job creation, alternative livelihoods and alleviate poverty. Less pressure on DSS source areas would contribute to less frequency of DSS.
Building green belts, including protection forestry along rail and road routes.	Indirect	Reduce wind velocity, reduce DSS hazard, and protect infrastructure.
Capacity building in technical areas and in participatory approaches to DSS prevention and control.	Greater capacity will lead to more efficient and effective programs to combat DSS.	Legacy of better trained local cadre of officials and technicians.
Improved cropping practices to protect soil during DSS season.	Reduce dust uplift and transport.	Reduce dust uplift and transport as well as reduce loss of soil fertility.
More effective rehabilitation of mine sites and prospect survey sites	Less dust.	Less dust and ecological restoration.

[1] Principally the Republic of Korea and Japan but also includes the eastern seaboard of the PRC.
[2] Solar stoves/kettles can reduce need for fuelwoods; fuel–efficient stoves, use of bottled gas and other measures can have a similar effect.

CHAPTER 2 REVIEW OF MAJOR MITIGATING MEASURES TO COMBAT DESERTIFICATION FOR DSS CONTROL

2.1 General

Although the accurate quantitative relation between DSS and land degradation is yet to be examined and established through continued study, it is generally believed that the rapid and massive land degradation (including desertification) in DSS originating source areas over the past few decades has contributed to the increased intensity, severity, and frequency of DSS in Northeast Asia. Rehabilitation of vegetation cover has been considered as one major means to combat DSS.

The governments of the PRC and Mongolia have formulated comprehensive programs to combat land degradation, which serve as their main thrust to alleviate DSS. With support from the UNESCAP, the UNCCD, and the UNEP, Mongolia and the PRC have developed their national action programs to combat desertification. It is generally believed that there is link between desertification defined as “land degradation in drylands” and DSS.

The Government of the PRC attaches great importance to desertification control. As early as the 1950s, as a priority task the government organized people to harness the areas affected seriously by desertification, including the effects of wind erosion, water erosion and soil salinization. The PRC has, over the past four decades, gained headway and experience in development of techniques for desertification control, using silvicultural techniques on sand fixation, control and improvement of secondary salinized soil, sand fixation along railways and highways, and building shelterbelts in desert margins.

Progress in Mongolia has been hampered by a lack of funding and trained personnel but some gains have been made[1].

2.2 DSS Mitigation Measures in the PRC

The Government of the PRC and its people has made great efforts to fight the adverse effects of desertification. As early as the 1950s, the government organized desert investigation and scientific studies on the desertified land and has given priority to fix the shifting sand and combating desertification in the seriously affected regions. From the early 1970’s, the PRC has initiated and implemented successively such major ecological development programs on the basis of achievement of traditional technologies, practical techniques, know-how, and acceptable experiences. Examples are the *Green Great Wall* Project (otherwise known as “Three-North Shelterbelt” Program covering the northwest, central north and northeast areas of the PRC), *National Key Project to Prevention and Control of Sandification*, the *Coastal Shelterbelt* Program, the *Plain Farmland Protective Shelterbelt* Program, and the *National Program of Shelterbelt Development along the Middle Reach of the Yellow River*.

As a result of these measures, the forest coverage in the PRC has increased from 8% in the 1950s to 18.2% in 2002. The National Program to Combat Desertification and "the Three-North Shelterbelt” Program have brought more than 16 million hectares of farmland and 10 million hectares of rangeland under effective protection. Now, 795 counties in the plain areas have reached afforestation and the ecosystems and environment have been improved to a certain extent.

[1] "Basic Policy Guidelines of the Government of Mongolia related to DSS and Desertification Control and Environment” (National Report, 1991)

In early 2002, the Government of the PRC announced a 10-year program with a total investment of RMB54 billion (about US$6.5 billion) to address the DSS concern in five provinces in the northern PRC. With support from ADB, the Government of the PRC also established a partnership with GEF for an overall program on land degradation in dryland ecosystems. This will provide US$1.5 billion over 10 years. However, the linkage of these national initiatives to the regional concern on transboundary DSS is yet to be established through cooperation beyond national borders. Without an effective policy and coordination at the regional level, the impact and effectiveness of the national initiatives as a means to combat DSS will be limited.

The PRC has actively pursued measures and approaches to control sand encroachment on agricultural and grazing land as well as measures in water and soil conservation. Many of these measures have been so successful that they have been adopted the world over. Major measures are explained below.

The PRC will set up 30 desertification and DSS monitoring stations for the purpose of monitoring land cover, sandy land dynamics, and effectiveness of implementing national projects. Currently, the PRC is using 540 meteorological stations[2] for monitoring and forecasting DSS occurrence. Agencies involved in the DSS related activities in the PRC include the China Meteorological Administration (CMA); State Environmental Protection Administration (SEPA); State Forestry Administration (SFA); Ministry of Water Resources; Chinese Academy of Sciences (CAS); National Development and Reform Commission; Ministry of Science and Technology; and Ministry of Land Resources.

In order to combat the increasingly severe problem of land degradation, and also to respond to the increasing public demand for a better ecological environment, the PRC has invested more and more resources in the battle against land degradation. From the first half of the 1990s to the start of the 21st century, total investment in land degradation control programs has increased ten-fold. The most significant increase in investment has been within the forestry sector. There was a big increase in central government investment, through the launching of six key forestry ecological projects.

PRC prepared a National Action Plan to Combat Desertification (NAP). The NAP is a key instrument of planning and budgetary authorization of public investment projects and programs. The NAP has a time horizon of 2001-2050, with implementation spread over three phases; 2001-2010, 2011-2030 and 2031-2050. A key objective of the NAP in its first phase is to control 22 million hectares of desertified land by various means by 2010. Essentially it boils down to a combination of

(i) direct interventions to check the spread of desertification and contain and prevent wind and water erosion (shelter belts, wind breaks, soil conservation, and control of water run-off in catchment areas); and

(ii) community level participatory for local area development projects, which draw on local knowledge and resources to promote sustainable agriculture, natural resource management, prudent exploitation of common property resources, and non-farm alternative income generating activities.

The SFA has been the lead agency within the PRC in the development and promotion of anti-desertification projects and the NAP. The development approach pursued has primarily focused on combating water and wind erosion through vegetative means, notably:

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[2] The PRC has established a National DSS data center. It is located in CMA with support from SEPA and SFA. This center manages the input from all the PRC government agencies whose data can contribute to DSS forecasting and monitoring.

1) a ban on logging in natural forest areas;
2) reforestation of hillsides and waste lands;
3) establishment of windbreaks/shelterbelts to control wind erosion;
4) closure of degraded grasslands and forest areas to allow for natural vegetative recovery;
5) replacement of annual crop production in desertification prone, semi arid, environments with perennial tree crops and/or improved pastures; and
6) sand dune stabilization through a mixture of revegetation with trees, shrubs and grasses (including aerial seeding) and/or use of branches, twigs, crop residues and other dead material pushed into the sand to form a lattice square grid. In places such measures have been very successful but they can come at a high cost, particularly where afforestation in semi-arid/arid climates requires the installation and use of irrigation.

The pilot program on conversion of farmland to forest and grassland (*Grain for Green program)* was launched in 2000 in 188 counties in 17 provinces. In 2001, this was expanded to 224 counties in 20 provinces. The aim of the program is to return low yielding farmland to forests and grasses. To date, the central government has spent some US$900 million on the project, leading to the conversion of some 1.2 million hectares of farmland. In addition, over one million hectares of barren land have also been planted with trees. For 2002, there were plans to convert a further 2.2 million hectares of low yield farmland to forest and grassland and to plant more than 2.6 million hectares of barren land.

The government plans to reward farmers who convert farmland in this way. Depending on the type of land, farmers receive 1,500 - 2,250 kg of grain /ha/yr. The government also gives them seeds and saplings free of charge, and annual living expenses of US$40 per hectare. Farmers are reportedly very happy as in a normal year their average yields may be as low as 750 kg/ha whereas they are receiving free 1,500 kg/ha (*China Daily* 12 March 2002).

The continued success of this program depends on the central government being prepared to continue providing the free grain and annual living allowance indefinitely. Given that this is a high cost approach, it may be difficult to sustain this for more than a few years. Should the subsidy stop, there is a very real risk that farmers will have little option but to revert to the growing of annual crops to meet their short-term livelihood needs, thereby undoing the ecological gains.

The Ministry of Agriculture has a parallel program aimed at revegetating degraded grasslands by replanting grasses and shrubs.

2.3 DSS Mitigation Measures in Mongolia

Basic policies set forth in the document entitled "Basic Policy Guidelines of the Government of Mongolia" related to DSS and desertification control and environment are as follows (National Report, 1991):

- Cultivation of additional land is to be avoided through measures to increase the productivity of land already under cultivation and to restore fallow and eroded lands to full productivity. Pasture land productivity is also to be increased through fertilization and reintroduction of traditional forms of animal husbandry which made effective use of pasture resources.

- Pasturelands degraded by geological exploration, road construction, defense programs and other activities are to be restored. A balance between forest use and reforestation is to be achieved. Reforestation of multipurpose trees is to be carried out simultaneously with timber harvest. Green areas in urban settlements and forest belts between cultivated fields are to be developed.

- A program for preservation of the Gobi region is to be carried out including plantation of forests and revegetation of river banks.
- A program for reducing the rate of desertification and for drought amelioration will be introduced including research into cloud seeding.
- Monitoring systems are to be developed and programs including the establishment of an Institute of Ecology and a Gobi Desert Research Center, are to be instituted to monitor environmental conditions and assess long term climate change trends and to predict their influence on human living conditions and health.
- All efforts by individuals, private or state enterprises and domestic or foreign organizations aimed at restoration of soil or water resources reintroduction of wildlife enrichment of natural resources (e.g. through reforestation) recycling of wastes and introduction of waste minimization and other environmentally sound technologies are to be encouraged.
- The economic system established by the government will be adjusted to the natural environment and will ensure that demands on the natural environment will not exceed normal environmental tolerance levels.

Also, policies related to environment and DSS control has been included in the Mongolian Action Programme for the 21st Century (MAP 21), the National Environmental Action Plan, and National Desertification Action Programmes.

The Government of Mongolia has developed a “Gobi Regional Development Plan” but no specific program on prevention and control of DSS is in place as of the present. However, the National Action Plan (NAP) to combat desertification includes measures that will contribute to achieving this. Implementing the NAP is a priority of the Mongolian government.

2.4 Effectiveness of the Current Mitigation Measures

In the PRC, especially in the “Three-North” regions, active efforts have been made and effective achievements have been obtained in some areas by adopting various countermeasures and approaches to combat desertification since early 1950’s.

Notwithstanding the success stories, the area of land in the PRC that is degrading is increasing year by year during 1995 to 2000 (and at an accelerating rate). The frequency of DSS is increasing, especially the incidence of severe DSS events.

The cost effectiveness, replicability, sustainability and technical ease of implementing the interventions and control measures has yet to be demonstrated on a scale that is commensurate with the area of land that needs to be treated in the DSS source areas. The analysis presented here indicates that the process will be long and costly. But the damage cost of DSS is high. To do nothing is not an option.

Box 2.1 A Case Study of DSS Prevention and Control from Yulin Prefecture, Shaanxi

Yulin Prefecture of Shaanxi Province is an example of efforts to prevent and control DSS at the sub-regional level. The prefecture is located in the northwest PRC, and on the south edge of the Mu Us Sandy Land. The desert area, about 24,400 km^2 accounts for 56% of the total land territory of the prefecture. There are seven counties with a combined population of 1.1 million.

About 1,500 years ago, Yulin was covered with dense forests and grasses. Gradually, due to the wars in past dynasties and irrational economic development activities in the past 50 years, vegetation coverage has been seriously damaged and the environment has deteriorated. By the early 1950, the forest and rangeland has completely disappeared and much arable land has been turned into wasteland. Hundreds of thousands of farms and a lot of villages have been buried by shifting sands. The disasters of shifting sands and frequent winds have resulted in huge damage to the production of local crop-farming and animal husbandry.

From mid-1950's, the people of Yulin have been organized on a large scale to fight sand movement and prevailing wind with practical techniques, traditional knowledge and know-how and positive help of preferential government policy. After more than 40 years of efforts, the micro-climate and ecology, environment and productive conditions in Yulin have been obviously improved. Natural calamity decreases year by year. The annual incidence of sandstorm has declined from about 70 days in 1950's to nearly 20 days in 1990's. The height of sand dunes has been decreased by one third. The annual spreading speed of dune movement has dropped from 5-7 m/year to 0-1 m/year. The average sand silt discharge from blowing sands to the existing rivers in the prefecture has been decreased up to 51%. Similar examples can be found in all affected areas in arid, semi-arid, and dry sub-humid areas at different scales in the PRC. The efficiency of the application of traditional knowledge, practical techniques and know-how for combating desertification and controlling DSS is remarkable and there is great potential in applying them to future efforts to combat desertification and prevent and control DSS.

Source: Dr Lu Qi, Chinese Academy of Forestry, Beijing.

From the extensive catalogue of experience with technologies and know-how accumulated over the past decades, it should be possible to develop packages that can be applied at reasonable cost over large areas. To do this soon enough and to reduce the hazard that DSS represent will require further effort from the governments in the DSS source areas and considerable support from the partner countries in Northeast Asia and the international donor community

The lessons from past national programs and projects include:

- The realization that DSS is non-point source and serious transboundary environmental problem, which requires an integrated regional approach. Moreover, a coordinated regional approach is needed in tandem with national initiatives.
- There is need to undertake interventions and remedial actions on a scale that is commensurate with the scale of the DSS –source areas.
- A cross-sectoral and integrated ecosystem management approach in combating desertification is more likely to achieve desired results.
- It is essential for all stakeholders to work together for DSS reduction. Varying responsibilities are required from the national government, local governments, and local communities.
- It should be possible to develop packages of measures that can be applied at reasonable cost over large areas.

Table 2.1 gives a summary of some successful measures in the north of the PRC to control desertification with an indication of their applicability and limitations and a measure of their cost and effectiveness.

Table 2.1 Review of Available Desertification Control Technologies in the Northern and Western PRC

No.	Technique / Methods	Sites Where Applicable	Limitations / Benefits	Relative Cost Effectiveness	Overall Rating[1]
	Biological Methods				
1	Shelterbelt networks to protect farmland	- Within farmland - Along banks of canal	- Only a few tree species suitable - Long-horned beetle damaged - High consumption of water - Good protection results - Making micro-climate for crops - Supplying timber	- Relatively expensive - Simple management - Resulting in yield reduction in the marginal field.	4 Effectiveness 4 Durability 4 Maintenance
2	Sand fixation forest for fixing mobile send dunes	2/3 of leeward side of mobile dunes from bottom	- Hard condition for shrubs to survive - Labor intensive - Long life (20-40 years) - Fixing sand dunes	- Cheap - Relatively easy to Maintain	4 Effectiveness 4 Durability 3 Maintenance
3	Wind break forest	Between farmland and sand dunes	- Labor intensive - High consumption of water - Good ecological & economic benefits	- Relatively Cheap - More effort to maintain	4 Effectiveness 4 Durability 2 Maintenance
4	Enclosure for grazing land and forest	Desert grassland Forest area	- Increasing biodiversity - Few labor requirement	- Cheap - Easy to Maintain	4 Effectiveness 4 Maintenance
5	Air seeding for grazing land and afforestation	Loess plateau Desert grazing land	- Must have aircraft - Relatively high concentration of rainfall - Efficient for making grazing land and afforestation	- Cheap in large area - Low labor cost	4 Effectiveness 4 Durability 3 Maintenance
6	Blocking in front and pulling from behind	Dune chains	- Labor intensive - Reduce sand blown off - Stabilizing mobile dune	- Relatively expensive	4 Effectiveness 4 Durability 3 Maintenance
7	Grass Kulum to block wind and sand and to create pasture	Pasture land	- Labor intensive	- More effort to maintain	4 Effectiveness 3 Durability 2 Maintenance
8	Integrated management of small watershed with planting	Loess plateau	- Labor intensive - Can cause blow out - Long life - High social value as it provides cash to local people	- Relatively expensive - More effort to maintain	4 Effectiveness 4 Durability 2 Maintenance
9	Combating soil secondary salinization with vegetation	Mis-managed irrigation areas Lower reach of river	- Labor intensive - Few species - Improving soil	- Costly - More effort to maintain	2 Effectiveness 4 Durability 2 Maintenance
10	Combating industrial-mining induced desertification with vegetation	Mining area	- Labor intensive - High consumption of water - Good ecological & economic benefits	- More effort to maintain - Costly	2 Effectiveness 4 Durability 2 Maintenance
	Engineering Methods				
11	Clay sand barriers	2/3 of leeward side of mobile dunes from bottom	- Must have clay - Labor intensive - Preventing Rain water from infiltration (crust on surface) - Long life	- Costly	4 Effectiveness 4 Durability 4 Maintenance
12	Straw checkerboard	2/3 of leeward side of mobile dunes from bottom	- Must have local supply of straw - Labor intensive - short life (2-4 year)	- Cheap - Low labor cost because of low cost of rural labor	4 Effectiveness 2 Durability 3 Maintenance

[1] Subjective rating is based on the results from consultations with local community and used a scale of 1 (lowest) to 5 (highest)

Source: Compilation of Consultant Team.

Cont. Table 2.1

No.	Technique / Methods	Sites Where Applicable	Limitations / Benefits	Relative Cost Effectiveness	Overall Rating[1]
	Engineering Measures Combined with Biological Methods				
13	Straw or clay sand barriers combining with vegetation	2/3 of leeward side of mobile dunes from bottom	- Must have local supply - Labor intensive	- Relatively Cheap - Easy to Maintain	5 Effectiveness 5 Durability 4 Maintenance
14	Building farmland by leveling sand dune with water	Sand dune	- Must have water - Less Labor requirement - Good results	- Cheap - Easy to Maintain	5 Effectiveness 4 Durability 4 Maintenance
15	Building water conservation project, reclaiming barren land, and improving soil to form new oases	Intermountain basins surrounded by snow-capped peaks	- Must have water - Labor intensive - Long life - High social value as it provides cash to local people	- Relatively expensive - Low labor cost because of low cost of rural labor	4 Effectiveness 4 Durability 3 Maintenance
	Chemical Methods				
16	Covering sand dune with pitch or making sand barren with asphalt felt	Sand dune	- Must have chemical materials - Labor intensive - Changing soil surface - Long life	- Expensive - Easy to Maintain	4 Effectiveness 4 Durability 4 Maintenance
17	Chemical materials (plastic film, dry water or soil moisture protector) to protect or supply water	Arid areas	- Must have chemical materials - Labor intensive - short life - Good results	- Expensive	4 Effectiveness 1 Durability 2 Maintenance

[1] Subjective ating is based on the results from consultations with local community and used a scale of 1 (lowest) to 5 (highest)

Source: Compilation of Consultant Team.

2.5 Financing Mechanism for Current DSS Mitigation Efforts in the PRC

Projects initiated by the central government of the PRC play an important role in the strategy to prevent and control DSS. More money is now spent in prevention and control of DSS. In Ordos Plateau (one of the focus areas), there was US$60 million invested in forestry construction from 2000 to 2002, more than the total investment from 1950 to 2000. Since 1998, the central government of the PRC has initiated six main ecological improvement projects, such as

- Natural Forest Protection Program,
- Returning cultivated lands to forests or pasture (*Grain for Green program),*
- Treatment of the DSS source areas that threaten Beijing and Tianjin Districts,
- Water and soil conservation in key areas,
- Phase 4 of “Three-North” forest shelterbelt system development,
- Protection and improvement of natural grasslands.

Almost all of the key projects are related to the prevention and control of DSS, but only *Treatment of the DSS source areas that threaten Beijing and Tianjin Districts*, and *Phase 4 of “Three-North” forest shelterbelt system development* has the single aim of DSS prevention through controlling land degradation. According to the plan, from 2000 to 2010, the central government will allocate a huge amount of money to curb the country’s land degradation with over US$700 million going to Beijing and its surrounding areas.

Table 2.2 National Key Projects Implemented in Focus Areas of the PRC

Focus Area	National Projects	Funding Source	Total Budget (US$ mil)
Alashan	• Natural Forest Protection Program • Returning cultivated lands to forests or pasture • Phase 4 of "Three-North" forest shelterbelt system development	Central govt Local govt	60 10
Hulunbuir	• Natural Forest Protection Program • Returning cultivated lands to forests or pasture, • Phase 4 of "Three-North" forest shelterbelt system development, • Water and soil conservation in key areas, • Returning grazing-lands to grasslands • Protection and improvement of natural grasslands	Central govt. Local govt	40 20
Xilingol	Treatment of the DSS source areas that threaten Beijing and Tianjin Districts.	Central govt. Local govt.	72 28

Ordinarily, the financial resources for implementing the key projects in the PRC come from three channels:

- National budget,
- Funds raised by local governments,
- Loans from the four state-owned commercial Banks on "reduced interest rate" – with the interest payable by central and local governments[3].

Since 1998, the central government of the PRC has been carrying out an active fiscal policy and the state has borrowed money for the key projects, or gone into deficit spending.

Besides the national resources used in key projects and other investment, foreign capital and donations also play an important role in prevention and control of DSS. The important foreign aid to the PRC has been oriented mostly towards projects that reinforce economic structures and services, which received 61% of allocated resources. The productive sectors received 8.2% and agriculture, which is part of this sector, a modest 4.9%.

Table 2.3 State Budget Appropriation Investment in Ecological Project of Inner Mongolia Autonomous Region

Year	Amount of Budget Appropriation (US$ million)
1999	207
2000	213
2001	244

[3] Until 2001, the loans from the four state-owned commercial banks used in forestry development and prevention of desertification were on a "subsidized interest rate" basis. But in July 7, 1999 People's Bank of China made a new ruling. Special "reduced interest rate" loans could be retained until the end of 2000 but from 2001, the decision whether the bank lends the special loan should be decided upon using commercial rules.

The planning for DSS prevention and mitigation projects by the banners (i.e., counties in Inner Mongolia Autonomous Region) and prefectures in the focus areas of the PRC are actually found in their respective 10th Five-Year Plan and 11th Five-Year Plan covering a period of 10 years from 2001 to 2010. The same plans were used as the platform for the proposed demonstration projects in the focus areas of the PRC. Reference for the projects derived from these plans are shown in Tables 2.4 to 2.8.

In Hunlunbir, Xilingol and Alashan, although the projects involve different banners, they have the same content of investment. The capital cost of the demonstration project in Hulunbir is US$14,164.380, in Xilingol US$14,755.760, in Ordos US$36,833.630, in Alashan US$5,492.900. Other investment and project management cost are US$10,200,000. So the total cost of the demonstration projects is US$ 81,446,670.

Table 2.4 DSS Prevention and Mitigation Plan Cost for Hulunbuir

Project Elements		Quantity		Investment	
		Unit	Amount	Unit price (US$)	Amount required1/ (US$ 000)
Training center for farmers and herders		Site	1	121,951 /site	122
Stabilizing sandy land using physical measures		Ha	3333.33	402.44 /ha	1,341
Stabilizing sandy land using biological measures	Grazing ban	Ha	13333.33	14.63/ha	1,951
	Scots pine planting (3-year-old seedlings)	ha	4,000	573.16/ha	2,293
	Shrubs planting (direct seeding, *Hedysarum* spp., *Caragana* spp.)	ha	5333.33	182.93/ha	976
Shelterbelts surrounding urban centers and Pasture shelterbelts		ha	4,000	463.41 /ha	1,854
Model households for sustainable grassland management	Grazing by rotation	ha	333.33	18.29/ha	6
	Livestock improvement			2439.02	2
	Stall and shed building	m^2	200	18.29/m^2	4
	Wind and solar power	set	1	1219.51	1
	Feed processing facility	set	1	4878.05	5
	Sub-total	households	300	18292.68/ household	5,488
Monitoring	Equipment, manpower				140
Grand total for Hulunbuir					**14,164**

1/ May not add up due to rounding off.

Table 2.5 DSS Prevention and Mitigation Plan Cost for Xilingol

Project Elements		Quantity		Investment	
		Unit	Amount	Unit price (000 $)	Amount required1/ (US$ '000)
Sand barriers		ha	2667	402.44 /ha	1,073
Tree planting		ha	13333	182.93/ha	2,439
Containerized seedlings growing		Seedling	20,000,000	0.04/plant	732
Closures		ha	33333	91.46/ha	3,049
Resettlement of displaced herders and farmers		Household	600	1219.51 /household	732
Demonstration households for agro-pastoral, integrated, stall-feeding activities	Wind and solar power	Household	1	1219.51/ household	0.01
	Stall-feeding	M^2	200	18.29/ M^2	0.03
	Fencing and grazing by rotation	ha	333	18.29/ha	0.05
	Forage processing equipment	Household	300	4878.05/ household	0.04
	Well digging and water supply	Well	1	2439.02/well	0.02
	High-yield forage plots	ha	0.67	1097.56/ha	0,06
	Livestock breeding and improvement	Household	1	2926.83/ household	0.24
	Sub-total	Household	300	21951.22	6,585
Monitoring	Equipment, manpower				146
Grand total for Xilingol					**14,756**

1/ May not add up due to rounding off.

Table 2.6 DSS Prevention and Mitigation Project Cost for Ordos

Project elements		Quantity		Investment	
		Unit	Amount	Unit price (US$)	Amount required [1/] (US$ '000)
Dalate Banner					
Stabilizing sandy land using multi-layered sand barriers		ha	2666.67	475.61/ha	1,268
Stabilizing sandy land using physical measures		ha	1333.33	402.44/ha	537
Artificial and mechanized tree planting		ha	13333.33	274.39/ha	3,659
Introduction of tree planting machinery		set	50	6097.56/set	305
Feed processing plant		plant	2	146341.46 /plant	293
Containerized seedling production facilities (annual production capacity of 30 million seedlings)		facility	5	34146.34 /facility	171
Family based eco-pasture and livestock farm in sandy areas		household	100	24390.24 /household	2,439
Monitoring (equipment and manpower)					867
Total for Dalate					**9,341**
Hangjin Banner					
Sandy barriers		ha	2000	402.44/ha	805
Afforestation by aerial seeding		ha	13333.33	128.05/ha	1,707
Family based eco-pasture and livestock farm	Feed processing equipment	set	1	4878.05/set	5
	Breeding livestock	head	2 dairy cows, 20 sheep		5
	Stall and shed establishment	m^2	200	18.29/ m^2	4
	Well digging	well	1	1219.51/well	1
	Greenhouse	m^2	400	18.29/ m^2	7
	Silos facility	m^3	150	16.26/ m^3	2
	Forage plots	ha	0.20 –0.33		0.5
	Shelterbelts	ha	1.33	548.78	0.7
	Sub-total	household	150	25609.76/household	3,841.46
Mongolian willow (*Salix mongolica*) chip mill		mill	3	73170.73 /mill	220
Mechanized tree planting		ha	6666.67	182.93/ha	1,220
Monitoring (equipment and manpower)					779
Total for Hangjin`					**8,572**
Ertok Banner					
Training center		site	1	121951.22 /site	122
Family based eco-pasture and livestock farm		household	150	24390.24/household	3,659
Small-scale feed processing plant		plant	2	146341.46 /plant	293
Sand barriers		ha	30,000	402.44/ha	805
Planting by aerial seeding		ha	200,000	128.05/ha	1,707
Mechanized tree planting		ha	100,000	182.93/ha	1,220
Mongolian willow processing mill		mill	2	73170.73 /mill	146
Monitoring (equipment, manpower)					795
Total for Ertok					**8,746**
Grand total for Ordos					**36,834**

1/ May not add up due to rounding off.

Table 2.7 DSS Prevention and Mitigation Project Cost for Alashan

Project elements	Quantity		Investment	
	Unit	Amount	Unit price (US$)	Required[1/] (US$ 000)
Resettlement for ecological restoration (experimenting various measures including insurance schemes and development approaches)	Person	800.00	1,219.51 /person	976
Technical and professional training for farmers and herders	Person	2,500.00	36.59 /person	91
Grazing ban	ha	133,333.33	14.63/ha	1,951
Planting by aerial seeding (fringes of deserts)	ha	6,666.67	164.63/mu	1,098
Sandy barriers (fringes of deserts)	ha	2.000.00	439.02/mu	878
Monitoring (equipment and manpower)				499
Grand total for Alashan				**5,493**

1/ May not add up due to rounding off.

Table 2.8 Other Investment and Project Management for DSS Prevention and Mitigation Plan in Inner Mongolia Autonomous Region

Elements	Investment required (US$ 000)
Capacity building	8,000
Institutional development and policy framework	500
Public awareness	500
Project management	1,200
Total	**10,200**

Table 2.9 Total Cost of DSS Prevention and Mitigation Plan in Inner Mongolia Autonomous Region

Elements	Capital cost estimate (US$ 000)
Hulunbir	14,164.38
Xilingol	14,755.76
Ordos	36,833.63
Alashan	5,492.90
Other investment	10,200.00
Grand Total	**81,446.67**

New laws such as the "*Law on Desertification Prevention and Treatment*" (January 2002) and policies such as "*China adopts preferential policies on west development*" (State council circular, November, 2000) are issued in order to stipulate the responsibility of government at all levels and to encourage private sector to take part in the prevention and control DSS. According to the "*Law on Desertification Prevention and Treatment*", government at all levels are responsible for the control of desertification and the central government should increase investment and create more favorable policies.

The main contents of favorable policies include the recognition that central government is responsible for providing the majority of grain and seedling subsidies and cash subsidies pertaining to the implementation of state-approved projects that:

- convert cultivated land to forest and grassland;
- protect natural forests; and
- prevent and eliminate land degradation.

The central government will provide proper compensation for losses of local financial revenue incurred by the implementation of projects that convert cultivated land to forestry and grassland and protect natural forests.

The government encourages afforesting activities and cultivating grass on barren mountain tops and unproductive land and converting cultivated mountain slopes to forest land and grassland in the western region. The government allows those economic entities or individuals engaged in afforestation and grass planting to own the wood and grass in question and hold land use rights over such areas. Any economic entity or individual may apply to afforest these areas to protect the environment and improve the ecosystem and to use these state-owned barren mountains and land in accordance with the law. The only conditions are that sufficient amount of capital should be invested in the project and afforestation should be successfully completed. As long as these conditions are met, any party may purchase the right to use state-owned land at a reduced rate.

Such land use rights will remain in effect for 50 to 70 years and the concerned party can apply to have those rights renewed at the end of the 50 years. These rights can be inherited or transferred. In the event that the state reclaims those land use rights for development purposes, the affected party will receive compensation in accordance with the law. No felling of trees is allowed in forested areas that have been converted from cultivated land under state grain subsidies. The overall amount of agricultural land should be carefully maintained to preserve national food security. There should be a balance between the area of agricultural land lost to other purposes and the amount of reclaimed agricultural land.

DSS is not only a national problem, but also a regional problem. Countries and international institutions in the region realized this (Box 2.2).

2.6 Financing Mechanism for Current DSS Mitigation Efforts in Mongolia

The national budget of Mongolia provides a limited amount of funding on an annual basis for its NAP-related activities. Disbursements from the national budget for activities to aid the implementation of the NAP are increasing annually.

In 1998, the Fund for Environmental Protection was set up. About 35 million Tugrugs (Tgs) have been allocated to small- to medium-sized projects related to the NAP.[4] However, in spit of some 300% increase in the national budget allocations to environmental protection during the past five years, the total amount of money spent in the environmental sector in 2002 was less than 1% of the country's GDP. Of the total 2.3 billion Tgs that was allocated for environmental protection, 44% of the budget went to desertification monitoring activities while 40.5% was spent on nature protection and 15.3% went to staff costs.

Non-budget funds for the environmental sector are made up of donations and grants from international organizations, foreign aid and private donors. Of the total external assistance, 21% was spent on biodiversity conservation, 21% on monitoring, 17.6% on Protected Areas Management, 8.2% on forest protection, and 5% on reducing water pollution.

[4] US$1 = 1,180 Tgs

Box 2.2 Examples of Foreign Investment and Bilateral Aid to the PRC to Combat DSS

(a) From 2001 to 2004, 3,600 million Japanese Yen loan from the Japan Bank for International Cooperation (JBIC) has been invested in ecological shelterbelt development along the Yellow River in Inner Mongolia Autonomous Region. The period of the Japanese Yen loan is 40 years and can be extended to 50 years.

(b) Sino-German Government Cooperation Program of Desertification Land Treatment in Inner Mongolia. The main content of the program is tree planting and combating desertification. According to the agreement between the PRC and Germany, the total investment of this program is 113.70million RMB; Germany made a donation of 16 million Mark (equals to 72 million RMB); the supplement to projects from the PRC side is 33.34 million RMB; free-labor input by the local farmers and herdsmen is regarded as the PRC investment of 8.36 million RMB.

(c) Sino-Australian Grassland Protection Technological Cooperation Program has been implemented in Inner Mongolia Autonomous Region. According to the agreement between the PRC and Australian government, the total investment of this program is RMB 68 million (US$8.3 million); Australia made a donation of A$5 million (RMB 40 million); the supplement from the PRC side is RMB 28 million. Besides the direct investment, this program supplies loans to herdsmen. As of year 2000, the total loan is RMB 3.758 million. Reportedly, 1334 participating households raised their income by RMB 1,000 per year.

(d) Sino-Korea Government Cooperation Program of Combating Desertification Forestation Project. The main components of this program are: 1) the rehabilitation of the upper stream watersheds of Miyun reservoir in Beijing from 2001 to 2003, and 2) the forestation project on the desertification prevention in five areas of the western PRC from 2002 to 2005. According to the agreement between the PRC and the Republic of Korea, the total investment of this program is US$ 12.3 million; the Republic of Korea made a contribution of US& 6.3 million, whereas the supplement to projects from the PRC is US$ 6 million as in-kind contribution. Total forestation area will be around 9,500 hectares.

(Note: US$ 1= RMB 8.2)

CHAPTER 3 PROJECT REQUIREMENTS FOR THE PREVENTION AND CONTROL OF DSS IN NORTHEAST ASIA

3.1 Project Needs and Approaches

The DSS in Northeast Asia is a case for investment in measures to prevent or reduce DSS occurrences originating from sandy dust source areas. Governments in the Northeast Asian region need to develop and implement new initiatives to better manage DSS hazards and mitigate the impacts. To achieve this objective, there is a need to continue the development of technologically feasible and financially affordable plans, with a focus on the end result of joint efforts. For any new initiatives to work, there is a need to develop a new strategy with policies and practices that reflect the economic realities of the country concerned. Tangible benefits to residents and communities in DSS source areas must be produced.

It is necessary to undertake preventative measures and upgrade national DSS response capability. In particular, there is a need for: (i) a new paradigm for DSS prevention and control, treating DSS as a transboundary environmental problem; and (ii) greater participation by individuals, households, communities, the private sector, civil groups, academia, as well as agencies of various levels of government and international organizations, based on mutually accepted responsibility and shared interests.

As a result of the increase in DSS events of greater intensities in recent years, there is a recognized need for programs and actions that are built on experiences of past and current measures to address DSS concerns. Likewise, there is an urgent need for new and innovative approaches to DSS prevention and control as well as investment in human resources and infrastructure.

The development of a Northeast Asian regional DSS control strategy also presents an opportunity to support complementary priorities and initiatives, including the strengthening of community foundations in the DSS source areas.

As has been agreed upon during the First International Workshop on Investment Strategy under this project held in Ulaanbaatar, 11-12 May 2004, the general principles of the investment strategy for DSS prevention and control in the Northeast Asian region are twofold: (1) demonstration projects will be used as the main vehicle for attaining the objective of reducing the intensity of DSS and mitigating the impact. Demonstration sites will be selected in the context of regional cooperation and transboundary nature of the DSS issue; and (2) the demonstration projects will be viewed as a first step of continuing efforts and there will be scope for expansion and replication.

It is expected that after the confirmation of the focus areas, the actual selection of sites for the various approved actions/measures will occur. A participatory approach should be used to select the sites and verify the likely benefits of suggested actions/measures to be evaluated. Local stakeholder involvement in the identification of best practices and in site selection for demonstration projects is essential.

3.1.1 Participatory Approach and Community Involvement

The strategy to prevent and control DSS will depend on the recognition that it is a transboundary problem affecting several countries in the Northeast Asian region but that the regional challenge requires a local solution. Such solutions should build on local resource potential of rural communities and their traditional knowledge and know-how, combined with the application of advanced technologies. The emphasis on these local areas' development projects should be participatory and inclusive, aimed at internalizing DSS control measures and promoting sustainable cultural practices.

Assessment of natural disaster risks is usually approached from a technical or expert perspective. Public or community input on how the risks are identified and perceived is often excluded until the implementation phases of management schemes. Communities are at the interface between the environment and society where environmental disturbances and risks are keenly experienced. Traditional, technical risk assessments do not incorporate community risk perceptions. Conventional wisdom held the view that bio-physical vulnerability constituted the major risk context and, as a result, any action taken by an affected community was merely in response to the risk factors. New research findings recognize the need to expand the scope of the risk context to include socio-economic vulnerability. Conceptually, the linkages between the risk context and community action in response to risk explicitly include: community risk perception, experience, and the capacity to cope with the hazard factors and consequences (Flint 2004).

Another important factor in this regional approach to prevention and control of DSS is that the stakeholders include those people in the downwind (receiving areas). They reside at a long distance from the proposed demonstration projects. A way must be found to involve them in the final design of the demonstration and in the specification of the monitoring system.

Participatory approaches to working with communities to solve land degradation and DSS prevention and control provide development teams with a set of methods/tools which empower members of a community to share their experience, and particularly their knowledge, in assessing conditions and developing solutions. The development process therefore becomes community owned and community driven. The solutions derived often use local knowledge that is far better suited, less demanding of resources, than any that may be imposed from the outside.

Participatory approaches are most commonly used to assess needs and prioritize solutions and as a means of sensitizing people to situations. The participatory process ensures that the communities are enabled to recognize and explain the problems they experience, and to take ownership of the solutions offered. Participatory, people centered and process-oriented approaches recognize local knowledge and the value of traditional resource management systems.

The involvement of women in participatory approaches is essential. Women have relatively greater responsibility for family and community welfare, including being the primary decision makers on issues concerning health, education, and household finances. However women are often left out of participatory approaches to development. Experience has shown that unless specific steps are taken to ensure that women participate as decision-makers and benefit from donor activities, they usually do not.

Communities that participate in donor projects need to be fully informed about the purposes of the project, and the project benefits, costs, resources, process of implementation and impact on the community. A good communication strategy not only engages community participation, it can assist in reducing corruption or the perception of it. Donors need to communicate their position on corruption and suggest ways to deal with it if it is suspected.

Failures of past interventions have necessitated the introduction of new approaches to preventing and controlling DSS whose guiding philosophy is to allow solutions to *evolve* rather than impose them from outside. There is a clear need to bridge the gap between production and income objectives of the land users on the one hand, and the long-term objective of preserving natural resources on the other.

In rural development and about applying principles of local participation, two important points need to be stressed right up front. First, there is the institutional aspects of participation. Local participation cannot really be expected to take place without recognition of what the existing institutions are and how accessible they are to local peoples. And second, the agenda of local people has actually in many cases moved beyond participation; instead the issue has become governance.

It may be difficult to recognize local institutions. This could be called a “problem of visibility”. Many totally fail to recognize that there are local institutions in areas that have been managing natural resources for generations. They are simply invisible.. And of course local people in a sense conspired in this invisibility: they did not talk about these institutions because they did not think that this was part of what controlling DSS and land degradation was about. Participatory approaches try to re-open negotiations about land management issues with people who are already managing their own resources and offer to assist them in doing that better in the face of the changed (and changing) circumstances.

The following five principles relate to “partnerships” (a crucial aspect of participatory approaches) in rural development of which prevention and control of DSS is one aspect.

- People will participate only if there is a purpose and reason to do so
- Flexibility should be built into the process to incorporate feedback and changes
- Equal access to relevant information and the opportunity to participate effectively must be available to all parties – and this also means acknowledging that not all participants can readily afford the time and expense.
- Diverse stakeholders are accountable for their constituencies, and must provide timely feedback and reporting related to the outcome of the process.
- Commitment to implementation and effective monitoring is essential.

3.1.2 Technical Approach

Components of the package include technical measures, capacity building and policy/administrative initiatives. Many of the technical approaches are proven but the optimum combination of elements needs to be further refined. The main emphasis in the demonstration sites is on “value adding” and this will be done through supplementary activities that specifically target DSS (as opposed to controlling sand dunes or desertification in general). The design of the proposed demonstration projects should emphasize the “how to” aspects but have a considerable element of “additionality” to the national programs in the PRC and Mongolia.

The key characteristics are:

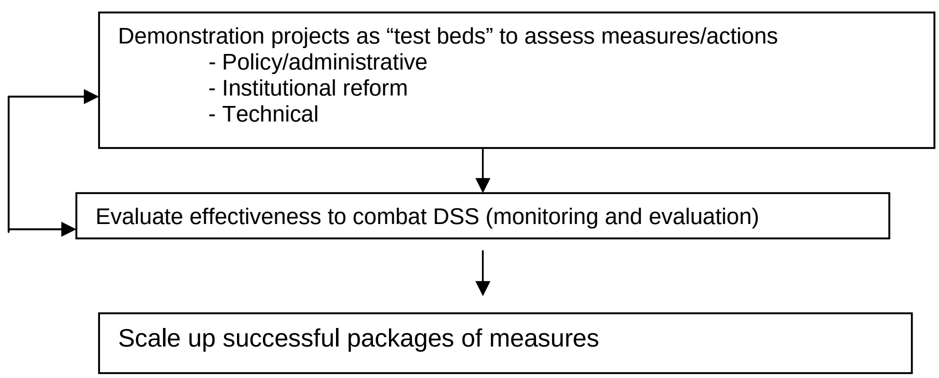
1. An integrated approach to preventing and controlling DSS in well defined and verified DSS source areas.
2. Revegetation of degraded lands using best practice approaches, including such interventions as grassland fencing, exclusion of grazing, improved tillage methods for both dryland and irrigated croplands, etc.
3. Revision of legal, policy and administrative regulations (where appropriate) to relieve the pressures that cause land users to degrade the land under contract to them. This will involve much more dialogue with herders/farmers and other land users (a participatory approach).
4. Training and capacity building, including production of manuals, guidelines, exchange visits, etc.

3.2 Development of Demonstration Sites

The choice of the focus areas for the demonstration projects is the responsibility of the respective governments in the PRC and Mongolia. The selection of these areas should follow a set of criteria as outlined in the Table 3.1.

The respective governments in the PRC and in Mongolia have nominated four focus areas within their territory and one cross-border site. Each is in a known DSS source area and/or in the pathway of DSS and all are characterized by poor ecological conditions due to a combination of natural and human-induced causes. The bio-physical, ecological and socio-economic profile of each focus area has been described in the appendices of this report. The focus areas were selected on the basis that they were representative of different ecosystems and as such presented an array of land uses, population densities, household livelihood strategies. Some actions/measures will be unique to some focus areas but others could be evaluated across a range of ecosystems. There is also a hierarchy of actions/measures. At the level of the prefectures (in Inner Mongolia Autonomous Region) or *aimag* (province) in Mongolia, there may be administrative or policy measures that apply over the whole administrative unit, whilst some actions/measures will be restricted to a specific site. Some sites will be large (10,000 ha for some rangeland components) but others such as alternative energy (wind and solar) may occupy <1 ha.

The purpose and role of the demonstration projects is summarized below.



The success of the regional effort to prevent and control DSS will depend on the successful implementation of the demonstration and the careful monitoring to ensure that the package of actions/measures that are tried actually reduce the frequency and/or severity of DSS. Real solution to DSS is to reduce the constant pressure on the land by addressing the underlying causes of DSS.

Table 3.1 Criteria for Selecting Demonstration Project Sites

	Criteria
General	• Criteria should be general enough to be used for future project development. • A guiding principle is that land in the process of degradation should be included in the chosen sites. • The project design should entail a comprehensive, integrated approach. • The demonstration projects should have synergy with ongoing work undertaken by local government and communities. • Local stakeholders should be involved in site selection and project implementation, that is, using a bottom up approach. • The recommended sites should be incorporated into each country's NAP. Alternatively, the recommended demonstration projects could be associated with key areas of provincial-level projects that tackle the same issues. • Local experiences and achievements in both technical and policy aspects of land management will be especially valuable in selection and design of the demonstration projects. • These sites must be located in DSS source areas or along the pathways and have an acceptable level of accessibility to the site from abroad. • The demonstration sites should be representative of different natural conditions
Additional	• State of land degradation should be substantial in extent and quantifiable by appropriate indicators that enable scientists to determine the original vegetation level. • Land degradation should be caused by human activity. • Land degradation is currently contributing to the increase of DSS events • Appropriate monitoring is possible to evaluate the effectiveness of DSS measures.
Specific	***Scope*** - size of a project site generally greater than 10,000 ha. - components to be tested and demonstrated should be site specific. - focus areas should have a range of land forms, types and uses. - duration should be minimum of 5 years. ***Purpose*** - environmental - economic (cost effective) - sociological - replicable - contributing to poverty reduction. Livelihood: - The choice of livelihood should be indicated (continue to use land, not to use land, or find another livelihood for the local people; resettlement; etc.) Land Use: - Crop land: Cultivating methods, which avoid bare land between the months of February and April will be introduced. - Grazing land: Measures to avoid over-grazing will be inrtroduced. - Protected area: Enclosure, revegetation, and choice of plan species will be considered. Water Resource: - Estimation of available water resources and the distribution of the limited resource will be considered. - Current water table and the appropriate level will be considered. - Control measures against over exploitation of ground water will be introduced. Estimation of the Effects: - The influence of DSS measures to the parameters, which describe dust entrainment will be quantified. - Estimation of the effectiveness of DSS measures by controlling simulation model parameters, which describe dust entrainment. Evaluation of the Demonstration: - The items and methodologies of DSS baseline data monitoring will be indicated. - Both detailed evaluation for the extent of DSS reduction and development of simple monitoring method for routine work will be needed. - Continuous (long span) monitoring to evaluate DSS reduction by using simple method will be needed.

Land degradation is accelerated by human activities. Degradation has particularly accelerated in the PRC, over the past 60 years, due to well-intentioned policies that had negative environmental consequences. Examples include:

(i) converting grasslands for cropping and increased livestock grazing in marginal areas, especially in the frontier regions;
(ii) relocating people from more densely populated areas to develop marginal lands;
(iii) developing industry on a large-scale in remote and generally water-deficient parts of the country, which allowed factories unlimited access to state-financed water supplies;
(iv) expanding irrigated agriculture into some of the driest parts of the country;
(v) keeping water prices low, thereby providing no incentive for farmers to adopt water efficient techniques; and
(vi) inappropriate land use practices and labor mobility restrictions.

About 29% and 27% of the DSS that affects Northeast Asia both originates from Mongolia and Inner Mongolia Autonomous Region of the PRC, respectively (Table 3.2). Dust is transported downwind to places to the east of the PRC and to the Republic of Korea and Japan. For this reason the nine demonstration projects should be conducted at sites within the focus areas identified under this project. The main purpose of the demonstration sites is to develop a package of actions/measures that can significantly reduce the occurrence of DSS.

Table 3.2 Results of Asian DSS Occurrence for the Past 43 Years (1960 – 2002)

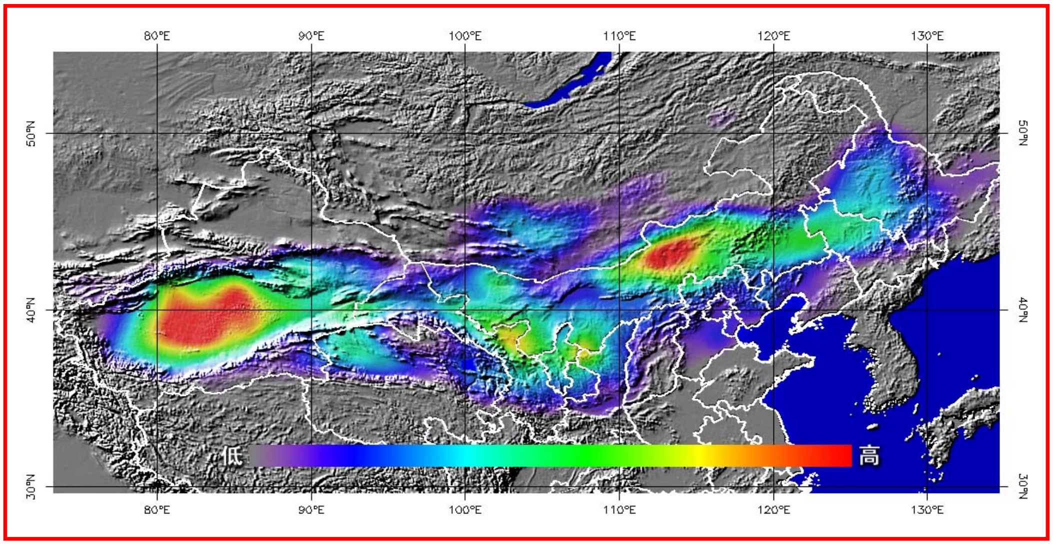
DSS Source Regions	Dust Production / Total Emission (for the past 43 years)
Mongolia	29%
Inner Mongolia Autonomous Region	27%

Source: Chinese Academy of Meteorological Sciences

3.3 Proposed Focus Areas for the Demonstration Projects in the PRC

Although DSS are known to originate in several places in the western and northern PRC, it was the decision of the PRC government to concentrate the choice of focus area for each demonstration site within Inner Mongolia Autonomous Region. Accordingly, four areas of the PRC and one cross-border area were visited by the consultant team in cooperation with local government officials and technical experts from the local bureaus with a view to seeing at first hand the ecological and socio-economic situation in the nominated areas, and assessing the potential components/activities that could be demonstrated there. The four focus areas (Alashan, Ordos Plateau, Xilingol, and Hulunbuir) and the cross-border focus area of Erinhot are all located along a 1,500 km west-east transect that samples the various environments in the DSS source areas. It should be noted that Erinhot (the fifth focus area) is the nominated area for the cross-border focus area on the PRC side. The four focus areas of the PRC represent four important grassland ecozones, namely, Hunlunbuir for mountainous meadow grasslands, Xilingol for typical grasslands, Ordos for dry grasslands, and Alashan for desert grasslands. The focus areas are those that are the degraded rangelands but are reversible, given appropriate measures and timely treatment. In the west, the Alashan area is arid (annual rainfall ranging 40-200 mm) and in the Ordos area (annual rainfall ranging 190-300 mm) there is a mosaic of sandy land from source-bordering dunes along the Yellow River system, sand plains on the margins of the various deserts and Loessal hills. In Xilingol (annual rainfall of >350 mm), there are plains with loess under a layer of sand. The grasslands of Hulunbuir are on rolling plains and the annual rainfall is > 300 mm. The soil is underlain with deep sand of the Quaternary age. Table 3.3 sets out the basic bio-physical characteristics of each focus area and Figures 3.1 and 3.2 are maps showing their location.

Figure3.1 Map of Known DSS Source Areas



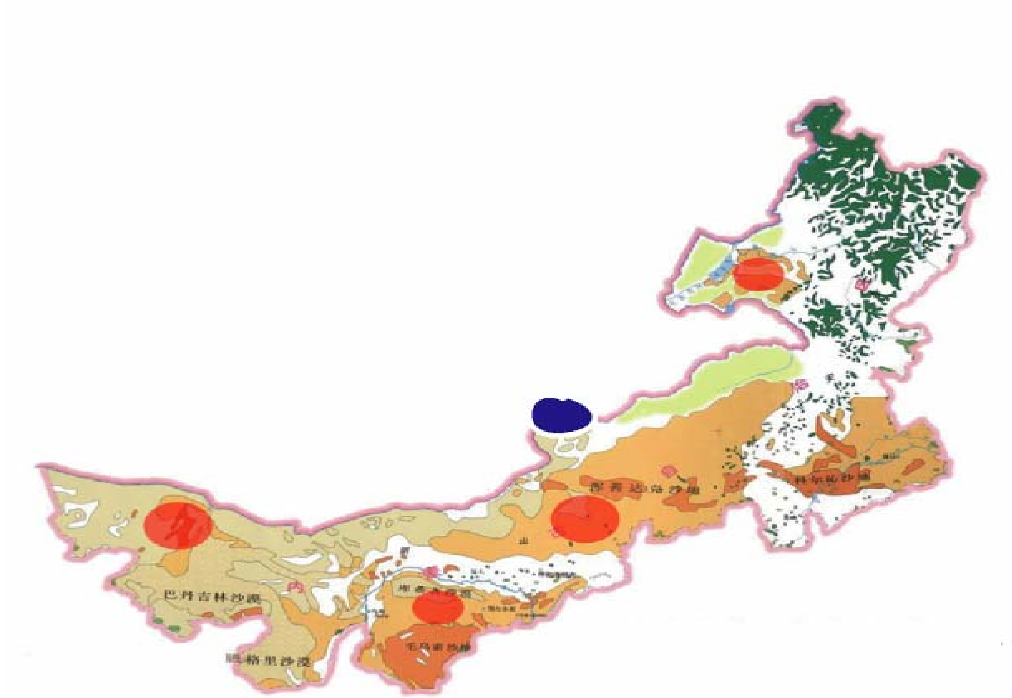
Note: The red and yellow areas are the DSS "hot spots" for sand storms. Dust may originate in desert margins (in the blue and green areas).

Table 3.3 Physical and Ecological Data for the PRC Focus Areas

Attribute	Alashan	Ordos	Xilingol	Hulunbuir
Altitude	900-1400 m	1400~1700 m	1000~1200 m	550~1000 m
Climate zone	Arid and Hyper-arid areas	Semi-arid area	Dry sub-humid area	Dry sub- humid area
Mean annual temperature (^{0}C)	6.8 ~ 8.5	5.3 ~ 8.7	1.6	-5 ~ 2
Maximum temperature (^{0}C)	41.7	38.7	38.3	42
Minimum temperature (^{0}C)	-36.4	-33.9	-42.4	-50.2
Frost free days	40~120	120-140	110-120	115~124
Mean annual precipitation (mm)	130~165	190~300	350-380	150~350
Annual evapo-transpiration (mm)	4 200	2200~3000	2300	2000
DDS days 1/	70	11.4~18.5	7.6~15	31.8~38
Topography	Plateau, plains, hills	Plateau, plains, hills	Plateau, plains	Plains
Groundwater depth (m)	>80	10-100	>60	>40
Soil type	Sandy	Sandy	Sandy	Sandy
Major vegetation type	Desert Steppe	Warm-temperate Steppe	Grass and shrub	True Grassland

1/ floating dust and blowing dust.

Figure 3.2 Map of Focus Areas in Inner Mongolia Autonomous Region, the PRC



Legend:

- ● Four focus areas in the PRC from west to east are Alashan, Ordos, Xilingol, and Hulunbuir
- ● Cross-border focus area at Erinhot on the PRC side

3.3.1 The PRC Focus Area 1: Alashan

The Alashan Plateau is a region located in the far west of Inner Mongolia Autonomous Region. It is characterized by low mountains separated by intermontane basins. Ridges attain elevations of 2,000 to 2,500 m while the basins tend to lie at 900 to 1,400 m. It is a fragile area of desertified rangeland. The 57% of the area is sandy and Gobi desert, 40% is grassland (95% of which is degraded), 3% forest, and 0.1% irrigated agriculture. It contains the three large deserts of Badain Jaran, Tenggeri and Wulanbuhe. The climate of the Alashan Plateau is severe with large seasonal and diurnal temperature variations (Table 3.3). Annual precipitation rarely exceeds 150 mm per year and it is both spatially and temporally variable.

Extreme drought, population growth, prolonged overstocking and irrational use of water, soil, and rangelands over many years have resulted in sustained decline in the environment. The result has been drying and disappearance of lakes, loss of wetlands, contraction of oases, decline in underground water levels, deterioration in water quality and vegetation, loss of biodiversity, expanding desert and increased frequency of sandstorms.

This increasing environmental degradation is adversely affecting the local production activities of the people and threatening their local economy and social development. For the past decade, Alashan has been the source of most sandstorms experienced in the PRC[1]. The three great deserts are gradually expanding. Living conditions for humans and livestock

[1] According to data held by the SFA and the CMA monitoring team and published in the 2004 Natural Disaster Report produced by SFA

have deteriorated in many locations and there has been a dramatic rise in the number of herders facing economic and resource management problems.

Human population is increasing due to government-initiated translocation programs that are underway. These programs are accompanied by efforts to convert "empty desert" to irrigated agricultural land. In most well-watered sites, irrigated agriculture is very productive so that little trace of the native forest and woodland vegetation remains. With population increases come increases in hunting and trapping of wildlife. There have been recent efforts to fence rangeland areas to control livestock and improve vegetation cover. Livestock have been totally excluded from some areas and natural regeneration of vegetation is occurring. Unfortunately though the implementation of the *Grassland Law* and attempts at sedentarization have not met with success as the practice concentrates livestock on inadequate sized plots and leads to overgrazing and accelerated land degradation[2].

The government and people of Alashan have worked long and hard to establish a basic environmental restoration strategy that can slow environmental decline, improve living conditions, standard of living and quality of life. Innovative schemes involve private sector partnerships to produce medicinal plants such as “desert ginseng” and development of urban areas, including industrial parks, to absorb surplus rural labor and assist in the re-settlement process.

Precipitation is too low and too unreliable to support efforts to revegetate the sites in western Alashan without supplementary irrigation. Water is in short supply. So, for the strategy, there will be need to rely on natural regeneration of the rangelands. This will require closure of the areas and relocation of the herders to other sites. The principal strategy being followed can be summarized as: “Fence degraded rangeland, and plant vegetation and convert cropland to forest and pasture.” Convert desert (Gobi), severely degraded grasslands and areas of special ecological value from grazing to natural forest and grassland. Relate the stocking rates to carrying capacity (rangeland condition, and the ability to stall-feed animals using fodder brought from artificial pastures nearby or from afar).

Given that Alshan league is so big and the problems are serious everywhere, it is proposed that the left banner be the location of the demonstration project with a project management office (PMO) in Bayanhot[3]. The demonstration sites would provide the “value adding” referred above and involve the site-specific elements/activities as rangeland management, private sector partnerships in desert based industries, private sector partnerships in developing alternative energy sources, skills training for resettled herders, and capacity building in local government.

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[2] In arid environments, the only way that stable grazing systems can be achieved is to allow seasonal migration. Sedentarization is unlikely to be sustainable. (see “Grapes of Wrath in Inner Mongolia Autonomous Region,” Report from US Embassy in Beijing, May 2001).

[3] An Australia-China project of AusAid is located there. The synergies that would arise from the two projects operating in close proximity would be significant.

3.3.2 The PRC Focus Area 2: Ordos Plateau

The Ordos plateau is a vast region of desert, degraded grassland and loessal hills through which the Yellow River runs. The Ordos Plateau lies within the Great Bend of China's Yellow River, also known as Huang He. High shifting sand dunes to the north give way to sparse scrub vegetation and forest thickets at the river margins. This eco-region lies at roughly the same latitude as Washington, D.C., but its temperatures are much colder. Average January temperatures range from 9 to 14° F (-13 to -10° C). Unprotected by surrounding mountains, the region is blasted with cold winds from the north and west. Vegetation varies across the region. Parts of the region have supported centuries of farming, so irrigated fields cover places once filled by native forests and scrub vegetation. Elsewhere, desert plants cling to life on the sand dunes.

Heavy grazing and agriculture have taken a severe toll on this region, creating areas of desert and increasing the occurrence of dust storms. Sheep grazing is very heavy in areas too dry for agriculture. And high prices for cashmere wool have encouraged increased grazing of goats, which are particularly damaging to the grassland habitat.

It is a region of unparalleled opportunity and is undergoing rapid transformation both physical and in terms of investment and diversification in land use and in employment opportunity. The future of this region is bright and the scope for accelerating the rate of ecological improvement is higher than in any of the other regions visited. Because of the good economic base it is possible to borrow money and get a return from the investment within short time. Large scale (US$800 million to US$1 billion) borrowing by government should be a large part of the investment strategy in this sub-region but of course GEF and other grant money (including bilateral funding) should be sought to accelerate the rate of implementing measures to combat DSS.

3.3.3 The PRC Focus Area 3: Xilingol

This is part of a large desertified area northeast of Inner Mongolia Autonomous Region that borders Mongolia in the north and stretches 1,098 km east to west. Sandy land covers 70,100 km^2. Over 330,000 people in eight banners including 61 communities/townships are affected. Population density is 4.7 /km^2. Livestock raising is an important source of livelihood with livestock population at 5.7 million heads.

Xilingol can be divided into three parts. In the drier *western* part grazing is banned and emphasis is on protecting and restoring shrub lands. In the *middle* part where precipitation is >300 mm, air seeding, tree planting and small watershed management[4] is the focus. While in the *east,* where precipitation >350, cropping is more common, grazing is banned and regeneration of shrubs and other woody vegetation is given priority.

For DSS prevention, a 420 km long green belt, which varies in width from 3-5 km, has been established through a combination of tree planting, air seeding and protection from human uses. The belt offers protection against sand movement in the previously mobile dunes. The total planned area to be included in this scheme is 1,282 km^2. Fodder bases have been established in favored sites to provide fodder for the displaced livestock that are now in feedlots. Resettlement has been major part of the government's strategy and so far over 27,210 people and 156,000 heads of livestock have been removed from the degraded rangeland. Many herders now own dairy cows and supply fresh milk for processing by a private company.

[4] Several households combine their efforts to manage microcatchments

The main problem is human activity although climate change and reduced snow melt may be a contributor. Major components of the demonstration site here would need to be complex and integrated with efforts combining technical, social, economic and regulatory aspects. Poverty reduction must be an important part. Because of the large differences in land use patterns, environmental conditions and lifestyle in the three parts of Xilingol, it will be necessary to tailor the activities and components to the specific site.

3.3.4 The PRC Focus Area 4: Hulunbuir

This area lies to the northeast of Xilingol and close to the border of Russia in the north. It is the location of the extensive Hulunbuir grassland, a rich and vast area of great significance to the Mongolian people because of their long association with it and the herding lifestyle that it supported. In the past few decades, there has been unprecedented destruction of ecological environments (land, vegetation, lakes, rivers and wildlife). This has come about from displacement of the traditional herding system to make way for large-scale crop cultivation and the concentration of livestock on the reduced area of grassland. Once the thin soil was broken, the thick layer of loose Quaternary sands was exposed and sandification has proceeded at a rapid and seemingly unstoppable rate. The rapid growth of human population due to the expansion of farming has led to an accelerated consumption of timber for construction and for fuel wood.

The highest priority is now being given to *protecting and restoring the grassland*. The number of animals is now decreasing as fencing of the grassland and the implementation of the household responsibility system, including assignment of land use rights, is extensively pursued. Carrying capacity of the degraded grassland is being assessed more scientifically and is used as basis for setting stocking rates and regulating animal population. Supplementary measures include the stabilization of mobile dunes using air seeding, tree planting and complete protection from grazing. There is widespread planting of Chinese Sand Pine (*Pinus sylvestris*) on sandy land.

3.4 Proposed Focus Areas for the Demonstration Projects in Mongolia

Four focus areas were selected in Mongolia after discussions with the government officials, scientists in research institutes and after field visits. Each of the focus areas occupies several local administrative areas and each covers a significant range of physical and human resources. The locations, administrative boundaries and some relevant data on DSS are shown in Figure 3.3.

Mongolia’s natural resources are under unprecedented threats, which create conditions favoring the outbreak of DSS. Table 3.4 presents an analysis on the major threats.

3.4.1 Mongolia Focus Area 1: Ovorhangai

Ovorhangai is located in the western part of Mongolia (Figure 3.3.) at a distance of 420 km from Ulaanbaatar. It is bordered by Bayanhongor *aimags* and Uyang, Zuunbayanulaan, Bayangol and Guchinus *soums* of Ovorhangai *aimag* The Ovorhangai site covers 11,700 km^2, of which 6% is sandy and Gobi desert. Total population is at 26,500. Details of its physical and ecological characteristics are provided in Table 3.5 and in Appendix 4.

Extreme drought and livestock population growth, as well as irrational use of water, soil, and pasture over many years have resulted in sustained decline in the Ovorhangai focus area environment. The result has been drying (for example the disappearance of Ongi River) decline in underground water levels, deterioration in water quality and vegetation, loss of biodiversity, expanding desert and increased frequency of sandstorms. The sand storms in the area occur any time during the year.

The main goals of the long term development of the area are to aim at a self-financing and independent economic status via ecologically-oriented development. And the provision of all needs for human development through ecologically sound livestock and mining outputs through the use of environment-friendly technologies.

The principal actions/measures for reducing the DSS in the Ovorhagai area should be:

- promote range land management,
- planting trees in selected areas to stop sand movement in the pasture and settlement areas,
- promote the use of renewable energy resources for local fuel supply, and
- promote the capacity building in local government.

Figure 3.3 Location and Salient Features of the Four Focus Areas in Mongolia (including DSS path)

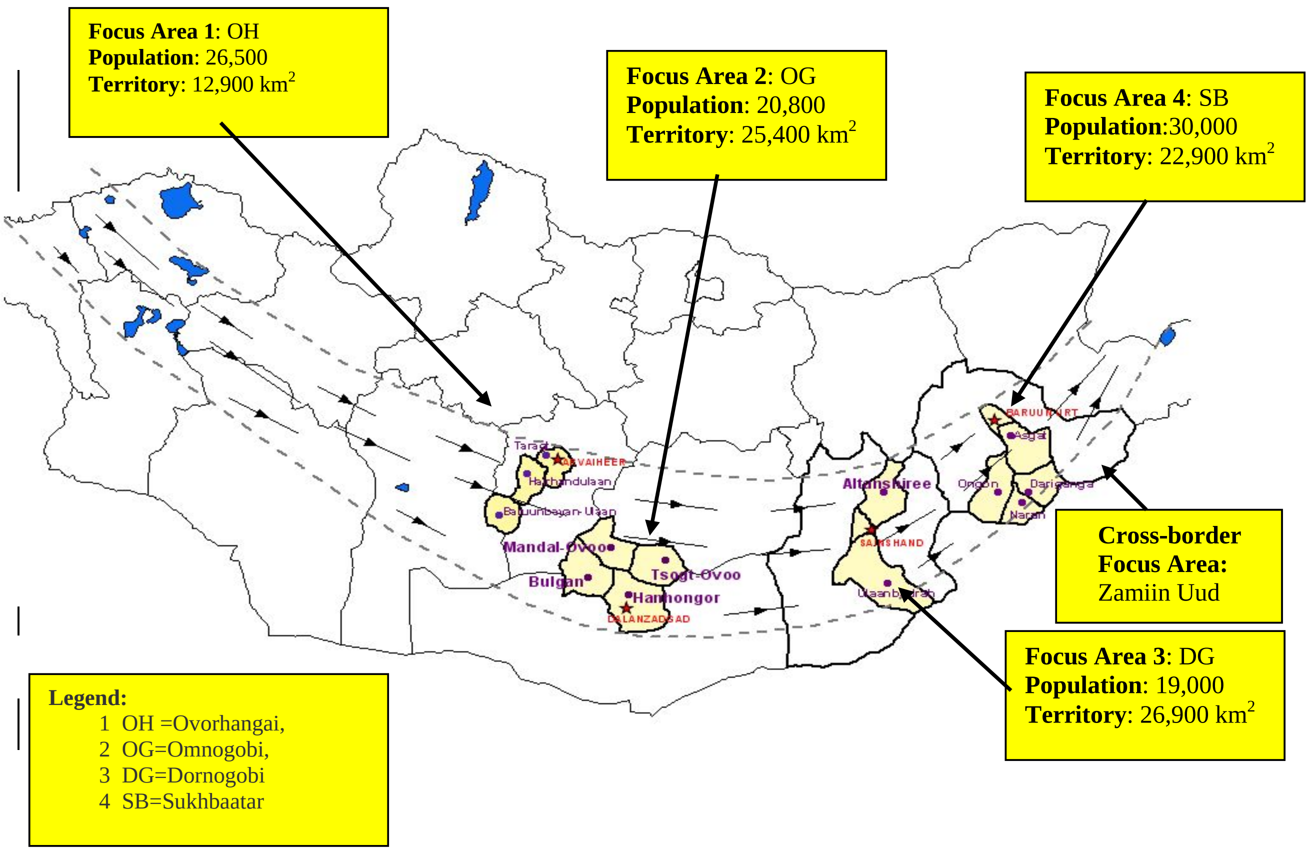

Table 3.4 Ecological Threats in DSS-originating Areas in Mongolia

Issue	Symptoms/ Impacts	Immediate Causes	Root Causes	Extent	Severity
MINING IMPACTS	• Water and air pollution • Soil degradation and erosion of sites and adjacent river banks; deforestation and landslides leading to river siltation • Adverse impact on flora and fauna particularly globally important species	• Use of toxic chemicals and lack of containment and treatment facilities (esp. mercury use in gold mining) • Lack of or inadequate site rehabilitation • Inadequate mining practices • High demand for construction materials and indiscriminate clearing vegetation	• Inadequate policy guidance, lack of or insufficient safeguards (EIA, anti-pollution/ environmental legislation) and enforcement • No regulation/ enforcement of private mining entrepreneurs • Lack of planning and oversight by government	• Localized mining operations in the desert areas include gold, coal, iron ore, fluorite, wolfram, and zinc mines. Critical areas mainly: • Ovorhangai site: "Erel Gold Mining " • Omnogobi site: Hard rock mining Olon Oboot • Shain Shand/Zamiin Uud site: 1. Zuunbayan oil mining 2. Gobi gold mining	Overall low Severe in certain locations
CLIMATE CHANGE	• Increase in severe floods and droughts • Potential negative impacts may include: • Ecosystems: Changes in species distribution and composition ; changes in migration patterns; wildlife habitat deterioration • Food security, agriculture and land use: Decreasing food security; land degradation e.g. through landslides and change in forest and rangeland cover, desertification • Water resources: Change in local water availability; deteriorating water quality	• Climatic changes in temperature, precipitation and wet and dry cycles • Changes in weather and rainfall patterns • Impacts and vulnerability due to floods and droughts • Population pressure on limited resources	• Global phenomenon related to anthropogenic activities leading to increased emission of green house gases	• Certain degradation land in most areas of all sites	Low to moderate

(Cont. Table 3.4)

Issue	Symptoms/ Impacts	Immediate Causes	Root Causes	Extent	Severity
DEFORESTATION	• Decreasing Gobi desert forest cover and bushes, loss of density and diversity • Deterioration of rivers/springs: high run-off associated with increased erosion leading to loss of fertile soil and sedimentation and situation down stream • Large scale habitat destruction and loss of wildlife in terms of numbers and biodiversity • Variability in local climate and rainfall patterns	• Uncontrolled logging for fuel wood and charcoal production (especially with increased fuel wood prices), construction material and local industry fuel needs • Unsustainable and efficient resource use (e.g overgrazing, extensive cultivation for agriculture and uncontrolled logging) • Lack of local planting/ replanting • Human migration and resettlement;	• Poverty of local communities and population pressure leading to pressure on resources; absence of alternative livelihoods. • Insufficient energy alternatives to fuel wood • Unsustainable land use practices perpetuated through weak policies and laws and failure to enforce laws and regulations; lack of forest protection • Insufficient awareness and knowledge of sustainable land use practices and effects of deforestation • Land tenure system leading to allocation and use of marginal lands and lack of incentives for sustainable land use practices • Large number of resettlements without basic support • Drought and overall arid climate	Critical areas: • Gobi forest areas of Dornogobi, Omnogobi and Zamiin Uud sites • Up stream and down stream of Ongi rivers of Ovorkhangai and Omnogobi sites and Ganga lake national Park of Sukhbaatar site • Herders are moving to *aimags / soum* centers and water sources areas of sites	Severe
SOIL EROSION	• Loss of top soil and reduction of soil fertility leading to decrease in pasture production • Reduction of vegetative cover and loss of habitats and biodiversity • Water quality degradation from high sediment loads (after heavy rainfall), siltation of shallow lakes, • Degradation of river and oasis areas; desertification and wind erosion (after heavy rainfall) in highlands	• Massive continued loss of vegetative cover due to deforestation and loss of other land cover, deterioration • Inappropriate husbandry and agricultural practices leading to decreased soil quality and erosion, such as use of marginal lands overgrazing and free grazing. • Lack of soils and water conservation measures and/ or abandonment and poor maintenance of anti- erosion works Bush fires and slash and burn practices	• Population pressure and poverty leading to unsustainable land use practices • Rainfall patterns (floods, droughts, climate variability) • Lack of land use policies and improper land use management; weak extension service on soil conservation often connected with husbandry and agricultural practices • High livestock density • Lack of awareness of land- water interaction • Lack of EIAs or implementation of EIA for infrastructure and agriculture projects due to lack of financial and human resources	Critical areas: • In most locations pasture areas close to settlements and wells of all sites • Agriculture areas of Ovorkhangai and *aimag/soum* centers of all sites	Severe

(Cont. Table 3.4)

Issue	Symptoms/ Impacts	Immediate Causes	Root Causes	Extent	Severity
FLOODS / DROUGHTS	Floods- • Direct impacts include loss of life and property , livestock and pasture land,; other results are food insecurity (availability and increased prices), loss to economy and environmental impacts Droughts • Direct impacts are food insecurity, famine and human migration, long-term impacts include change in water availability (e.g. permanently dried springs, perennial rivers becoming seasonal) Floods/ droughts	Floods • Heavy rainfalls in conjunction with specific natural terrain features, increased by certain land use practices. Droughts • Long/prolonged dry season resulting in water shortage, aggravated by improper management of land and water resources (e.g. deforestation, overgrazing) leading to decrease in vegetative cover, water retention capacity, and groundwater recharge, and increased desertification Floods/droughts	Floods • Irregular and large seasonal and year to year variability in rainfall patterns increased by climatic changes; mismanagement of land and water resources leading to soil erosion and increased run-off Drought • Climatic zone/geography; effects from El Nino	Regional Critical areas: Floods • Many areas of all sites have been eroded by water erosion Droughts • Localized droughts in all sites	Severe
WETLAND DEGRADATION	• Decrease and degradation of wetland areas • Decreased benefits from functioning wetlands, e.g. less groundwater recharge	• Reclamation of wetlands to expand agricultural production • Deforestation, erosion and sedimentation • Pollution from agricultural and domestic sources	• Lack of wetlands protection and management regulations and measures and/or lack of implementation • Poverty and population pressure; shortage of land use policies • Lack of awareness of wetlands function and value; cultural habits	Important and degraded wetlands: • Sukhbaatar site: Dariganga *soum* center and around Lake Ganga, and • Omnogobi site: Areas around Lake Ulaan.	Severe in some areas

3.4.2 Mongolia Focus Area 2: Omnogobi

Omnogobi focus area is located in the southern part of Mongolia at a distance of 700 km from Ulaanbaatar It is bordered by Dornogobi and Ovorhangai *aimags* and Tsogttsetsii, Nomgon, KhurmenNaran and Sevrei *soums* of Omnogobi *aimag* (Figure 3.3). The Omnogobi area covers 40,200 km^2, of which 70% is sandy and Gobi desert. It is a fragile area of desertified grassland.

The major form of land use has always been semi-nomadic animal husbandry in the area. However, the recent increase in the number of livestock and loss of traditional grazing practice are major causes of deteriorated soil and destruction of natural environment. The drastic increase in livestock numbers occurred in the beginning of 1990s. As a result, there are increasing areas of land degradation, decreasing vegetation cover, and drying out of lakes and rivers. Moreover, areas near human settlements are prone to degradation brought about by the practice of removing bushes and small trees (mainly *Salix viminalis*) by the truckloads for fuel wood. It is considered that these activities are being encouraged by the privatization of livestock and elimination of fuel subsidies. Deforestation as well as overgrazing is recognized as the main causes of increased land degradation in the focus area.

DSS occur at any time during the year while severe sandstorms occur frequently from March to May after spring thaw. Wind erosion usually occurs when wind speeds is greater than 8 m/sec. The number of dusty days ranges from 91 to 120 over the Omnogobi focus area. The highest occurrence of dusty days is around the Khongor Els area. Average duration of a dust storm is 4.6 hours and of driving dust is 3 hours in the Dalanzadgad station.

The principal strategy for reducing the DSS in Omnogobi should be:

- promote range land management;
- planting trees in selected areas to stop sand movement in the pasture and settlement areas;
- promote the use of renewable energy resources for local fuel supply; and
- promote capacity building in local government.

3.4.3 Mongolia Focus Area 3: Sukhbaatar

Sukhbaatar is located in the eastern part of Mongolia at a distance of 670 km from Ulaanbaatar It is bordered by the PRC and Dornogobi *aimags* and Asgat, Dariganga, Naran, Ongon *soums* of Sukhbaatar *aimag* (Figure 3.3). The Sukhbaatar focus area covers 22,001 km^2, of which 57% is sandy and Gobi desert. Total population is 23,189.

Sukhbaatar is a fragile area of desertified grassland and livestock raising is the basic economic sector of the site. The site is rich in various natural resources of brown coal and other heavy metals. Extreme drought, increase in livestock population, irrational use of water, soil, and pastureland over many years have resulted in the decline of the Sukhbaatar environment. The result has been the drying and disappearance of small lakes (like the “Tsagaan”), contraction of oases, decline in underground water levels, deterioration in water quality and vegetation, loss of biodiversity, expanding desert and increased frequency of sandstorms.

Consequences of land degradation such as the decrease in vegetation cover and drying out of lakes and rivers, have contributed to the occurrence of DSS. Main reasons for such change are the global air moisture cycle at the continental and local scale and the depletion of precipitation.

Similar to Omnogobi, the major economic activity of the Sukhbaatar site has always been the semi-nomadic animal husbandry in the area. However, the recent increase in the number of livestock and loss of traditional grazing practice are major causes for deteriorated soil and destruction of habitat. In addition, traditional grazing practices, nested on a sustainable land utilization system were abandoned for increased production to meet market demand.

Precipitation is too low and too unreliable to support efforts to revegetate the focal area without supplementary irrigation. Water is in short supply.

3.4.4 Mongolia Focus Area 4: Dornogobi

Dornogobi is located in the southern part of Mongolia at a distance of 700 km from Ulaanbaatar It is bordered by Ikhkhet, Airag, Saihandulaan, Mandakh, Hovsgol, Erdene, Orgon and Delgerekh *soums* of Dornogobi *aimag.*

It has a size of 26,900 km^2 and entirely covers the territory of three *soums* (Shainshand, Altanshiree, and Ulaanbadrakh). Dornogobi covers 26,900km^2, of which 8 % is sandy and gobi desert (see Figure 3.3). Total population is 27,600. It is a fragile area of desertified grassland. The total forested areas is estimated to be 10% of total territory. The land is dry and soil is steppe brown, red–brown, light brown clay poor in humus.

Livestock raising is the basic economic activity of the area. The area is also rich in various natural resources such as coal and gold and construction materials. Extreme drought, livestock population growth, irrational use of water, soil, and pasture over many years have resulted in sustained decline in the Dornogobi environment.. Sand storms occur any time during the year while severe sandstorms occur frequently from March to May after the spring thaw.

Dornogobi province experiences DSS for 26- 321 days per year and of which 26-80 days occur only in April and May. Regarding timing, 60- 67% of dust storm occurrence is between 9 am to 18 pm and 21.7– 26.3 % is between 15 pm to 18 pm. The pattern of DSS is different between stations; Shainshand experiences more DSS (about 44%) events that lasts for < 2 hours while Zamiin-Uud experiences less (about 20%) events lasting between 4-6 hours.

A summary of the key characteristics of the four focus areas in Mongolia is shown in Table 3.5.

Table 3.5 Physical and Ecological Features of Mongolian Focus Areas

Attribute		Ovorhangai	Omnogobi	Sukhbaatar	Dornogobi
Altitude		1469 m	1029 m	962m	952m
Mean annual temperature		0.8^0	4.3^0	0.5°	3.7°
Maximum temperature		21.4°	27.5°	26.2°	29.4°
Minimum temperature		-20.0°	-20.9°	-26.2°	-22.8°
Days of frost free		110	120	126	130
Mean annual precipitation (mm)		245.2 mm	127.1mm	201.8mm	116.7mm
Annual potential evapo-transpiration (mm)		611 mm	654 mm	828 mm	1042 mm
DSS Days[1/]	No.of days with dust storms	9.9	19.8	9.7	24.2
	No.of days with drifting dust	14.3	38.8	10.2	12.7
	No.of dusty days	23.2	58.6	19.2	36.9
Topography		Plain	Plain	Plain	Plain

Groundwater table	>100	>100	>100	>100
Soil type	Sandy substrate	Sandy substrate	Sandy substrate	Sandy substrate

1/ Based on WMO classification of DSS.

3.5 Proposed Cross-border Focus Area for the Demonstration Projects

The proposed focus area for the cross-border or sub-regional demonstration project is in the border region near Erinhot (see Figure 3.2) on the PRC side and Zamiin Uud on the Mongolian side (see Figure 3.3). This focus area is referred herein as the Erinhot-Zamiin Uud site.

Zamiin Uud is located in Dornogobi *aimag*. It has a size of 12,900 km^2 and covers the entire territory of one *soum* (Zamiin Uud) It experiences the same severe climate as Erinhot and lies on the same substrate. Both communities face problems on lack of both surface and ground water. Table 3.6 gives the physical and ecological features of the proposed demonstration site.

The particular challenge that the geographic location, climate, and general lack of natural resources poses have been faced in different ways by the people on each side of the border. In the PRC much emphasis has been placed on ameliorating the environment through a combination of measures. The banning of grazing within a 10-km radius of the city center, planting of wind breaks and other protection forestry, innovative uses of waste water (including sewerage) are some of the measures implemented. Technology transfer may be possible so that the Mongolian side can benefit from the lessons learned and techniques perfected by the PRC side.

There is a clear need for involvement in this sub-regional project by experts from the four partner countries. Potentially, the joint cross-border project area should be an especially useful way to validate the ideas and approaches of many stakeholders. The planting of a greenbelt along the new highway linking Ulaanbataar to the border with the PRC at Erinhot provides opportunities for technical assistance and technology transfer. A training center should be established to facilitate exchange of technical know-how among the four partner countries. Likewise, a hi-tech plant nursery and plant propagation facility should be constructed. Mongolia recommended that attention be also given to fostering ecotourism with strict environmental safeguard controls in the Gobi regions on the Mongolian side as a means to provide alternative livelihood.

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Table 3.6 Physical and Ecological Features of the Cross-Border Site

Attribute		Erinhot	Zamiin Uud*
Altitude		890 – 1020 m	896 m
Mean annual temperature (^{o} C)		4.4	3.5
Maximum temperature (^{o} C)		39.9	29.8
Minimum temperature (^{o} C)		-40.2	-24.7
Days of frost free/ year		125-135	135
Mean annual precipitation (mm)		146	122.5 mm
Annual potential evapo-transpiration (mm)		2,680	1081 mm
DSS Days / year	No.of days with dust storms	-	31
	No.of days with drifting dust	-	47.5
	No of dusty days	> 25	78.5
Topography		Plains	Plain

Groundwater table	25-60 m	25~60 m
Soil type	Grass and shrub	Sandy substrate

1/ Based on WMO classification of DSS.

A summary of expected benefits of controlling DSS at the regional, national, and local level as given in Table 3.7.

Table 3.7 Expected Benefits from Successful Implementation of DSS Prevention and Control

Level	Expected Benefits from the Project	
	Environmental	**Socio-economic**
Regional Level	• Strengthen cooperation with other Northeast Asian countries to deal with DSS at the international level. • Reduce DSS frequency and severity and improve efforts to mitigate effects if DSS outbreak does occur. • Transfer of technology for monitoring, alternative energy, and revegetation.	• Mutual understanding of global and regional problems and their interrelatedness • Trade development for equipment. • Exchange of Ideas through education and training. • Transnational private sector partnerships.
National level	• Cadres trained in technology and approaches to combat DSS as a transboundary environmental problem. • Accelerate efforts to combat DSS and develop national environmental policy. • Better managerial and operational coordination to deal with DSS at the international level. • Beginning of building green belts in semi desert and steppe zones to reduce wind velocity in DSS source areas. • Hazard reduction after establishment of monitoring and early warning system at the national level.	• Mutual understanding of global problems • International future collaboration • Foster relationship between the counties and provinces within PRC and Mongolia • Economical support in selected area • Trade development possibilities between other countries
Province/*Aimag* level	▪ Capacity building of local administrators and technicians ▪ Decrease the sand movement and dust uplift in treated areas ▪ Retard the desertification process and increase soil stability ▪ Change some vegetation composition ▪ Improve water infiltration and storage in soil of treated areas ▪ Wind breaks for pasture and crop land ▪ Bring about some ecological changes in treated areas ▪ Raise awareness about DSS prevention through campaign work	▪ Decrease the drift to urban centers ▪ Transfer new technology and methods in forestry and nursery ▪ Decrease poverty and ameliorate living conditions ▪ Create marketing possibilities to other provinces for goods and services ▪ Development of new business opportunities
Community	• Improvement in land condition and pasture quality • Decrease sand movement in treated areas • Decrease land degradation process, increase soil stability and improve vegetation	• Community participation in fight against land degradation • Community involvement in land tenure reform process • Possibility of new income generation
Household	• Decrease the sand movement in selected areas and improve lifestyle • Decrease losses of animals • Decrease some hazards connected with pasture and wind storms	• Indirectly influence the income of herdsman
Poverty reduction prospects	• Early warning of DSS outbreaks could have positive impacts on animal husbandry and crop, and reduce hazard	• Better resource management will benefit farming and herding households • Create new job and employment opportunities • New income generation possibilities through changed management

3.6 Proposed Activities and Investment Requirements

3.6.1 Project Activities in Focus Areas of the PRC

Table 3.8 sets out a summary of the major proposed actions/measures for each of the Focus areas in the PRC.

Table 3.8 Summary of Proposed Actions for Focus Areas in the PRC

Items \ Sites		Alashan	Ordos	Xilingol	Hulunbuir
Combating land degradation to prevent and control DSS	Prevention	Cropland conversion to forest/ grassland		Documentation of protection measures	
	Rehabilitation	Rangeland management	• Airseeding • Enclosure	Rangeland management	• Rangeland management • Enclosure
	Development	• Desert-based industries • Alternative energy sources	• Desert-based industries • Ecotourism[1]	• Artificial grassland management	• Artificial and natural grassland management • Alternative energy sources
Capacity Building to implement measures for DSS prevention and control		• Training Center for alternative skills • Capacity building for local government	Capacity building of local government	• Training Center for alternative skills • Capacity building for local government	• Training Base for grassland management • Capacity building for local government
Poverty Alleviation to reduce pressure on land and reduce dust entrainment		Solar/wind-power energy[2]	Better practices for fodder plantations	Better practices for fodder plantations	• Better practices for fodder plantations • Solar/wind power energy[2]
Social Development to improve livelihoods, reduce dependence on farming and animal husbandry, improve infrastructure		Develop off-rangeland skills		Develop off-rangeland skills	

[1] Ecotourism should be dealt within the environmental carrying capacity of the area with strict environmental safeguard controls.

[2] Introduction of renewable energy and other fuel-efficient cooking methods can reduce pressure on woody plants that should be left in place to stabilize the soil surface.

Based on the proposed actions/measures or project activities intended for each focus area in PRC, an indicative cost and corresponding coverage is set out below.

A. Project Activities in the PRC Focus Area 1: Alashan

Rangeland Management

Demonstrate the benefits of better rangeland management through fencing, controlling livestock numbers, season of use and species of livestock. Work with local herder communities, strengthen the Herder Association, re-introduce some rotational grazing scheme in areas larger than the contracted land that each household controls. **Indicative**

area: 50,000 ha **Indicative cost**: US$2 million (including training and capacity building and production of manuals, video and posters)

Private Sector Partnerships in Desert-based Industries
Develop a package of measures (and document them) involved in starting up a private sector – local government joint venture. This will involve improving (where necessary) the enabling environment and the development of regulations, administrative guidelines, agreements etc. and the recruitment of local land users to become suppliers of the raw material. **Indicative area**: 10,000 ha **Indicative cost**: US$1 million

Private Sector Partnerships in Developing Alternative Energy Sources
Fuel woods are in short supply. Harvesting of dead trees is harmful and cutting of living trees and shrubs reduces the vegetative cover and increases the risk of DSS outbreaks.

An integrated approach to combining fuel-efficient stoves, production of wind energy, solar energy could be tested with about 100 households. Private sector funding could be provided in cash or in kind to supply equipment and technical back up. **Indicative area**: 5000-10,000 ha **Indicative costs**: US$5-10 million

Training for Alternative Livelihood
Younger herders and their children need to be trained in skills that will allow survival away from the rangeland. Successful resettlement involves more than just a new place to live[5]. Some will find work in local factories and construction sites but others could receive training in aspects of ecological restoration of the degraded rangelands. A training center could be established, equipped and staffed for DSS control with particular focus on alternative livelihood. Production of training manuals, instructional videos, etc. would ensure that the work of the center had a wider reach than those who actually attended classes. **Indicative numbers involved**: 500 persons **Indicative cost**: includes establishment, equipping, staffing US$3 million

Capacity Building in Local Government
There is need for a cadre of local officials and community leaders well acquainted with participatory community-based approaches to preventing and controlling DSS. The capacity building should be aimed at understanding legal, administrative and policy matters as well as acquiring knowledge of the basics of the participatory approach and how to use it. **Indicative size of cadre:** 100-150 over 5 years **Indicative cost** (includes exchange visits and consultant trainers) US$1 million

B. Project Activities in the PRC Focus Area 2: Ordos Plateau

Testing various “development models” on sites within Ordos (5 to 6 sub-components)
Some success has been achieved in the initiation of partnerships between government and private sector investments in such diverse areas as ecotourism, dairy production, seed processing, paper manufacture from *Salix*, medicinal plants and so on. These desert-based industries represent a new and exciting way to use the sandy land. There is a clear need to refine and test these development models under the umbrella of the project. It is important that transparency is maximized and that access to all the documentation on every aspect of the agreements between government and the partner(s), the actual physical operations to transform the land and so on, is readily available. **Indicative area**: 50,000-100,000 ha (several counties) **Indicative costs** US$20 million

[5] “Resettlement involves more than a new address” China Daily July 6, 2004

Refining Air Seeding Techniques and Procedures

Great achievements have been made over the past few years in the whole aspect of air seeding. Along the way, many lessons have been learned and refinements made in terms of aircraft delivery systems, seed pelleting to enhance survivability of seeds, and other useful technologies which have been incorporated into the operations. The project component to be demonstrated is to apply best practice in the air seeding of large tracts of sandy land in several counties. Full documentation (video, manuals etc) will be produced to guide others and improve replicability. Benefit/cost analysis would be an important part of this component. **Indicative area:** 100,000 ha (several counties) **Indicative costs**: US$1 million

Private Sector Involvement in More Cost Efficient Fencing Techniques

The vast area will require many thousands of kilometers of fence. Better and cheaper fencing techniques are available from Australia and New Zealand, for example. Demonstrating these and training people on how to erect them (technology transfer) would be a useful component/activity for this site.

Capacity Building in Local Government

There is need for a cadre of local officials and community leaders well acquainted with participatory community-based approaches to preventing and controlling DSS. Capacity building should be aimed at understanding legal, administrative and policy matters as well as acquiring knowledge on the basics of the participatory approach and how to use it. **Indicative size of cadre:** 100-150 over 5 years **Indicative cost** (includes exchange visits and consultant trainers) US$1 million

Demonstrate the best practice for growing, harvesting and utilizing artificial grassland and shrub plantations such as Hedysarum and Caragana

The heavy reliance now on fodder and forage from a limited area of artificial grassland and from the re-vegetated areas, which are closed to grazing, means that better ways must be explored to maximize yield and get high utilization rates. Best practice in terms of selecting the best plant species (even cultivars), best techniques for establishment and subsequent management, harvesting, transporting and storage all contribute to the higher levels of efficiency and profitability of animal husbandry. Agronomic techniques, soil management and other proven procedures should be incorporated. Harvesting Caragana by machine would be less arduous and forage harvesters could be adapted to do this (scope for private sector involvement to supply and modify the machines). **Indicative area**: Total of 2,000 ha distributed at several sites **Indicative costs:** US$200,000

C. Project Activities in the PRC Focus Area 3: Xilingol Prefecture

Demonstrate the effectiveness of area protection and application of integrated package of policy and technical measures

Whilst there are many areas that have been protected from human and animal impacts over a period of years, none were properly documented. Moreover, trial and error approaches were applied to these areas. There is a clear need to take a piece of degraded land and document the affects of the package of measures. This could be the focus of the demonstration and would allow some cost/benefit analysis as well as ecological monitoring to be conducted from the beginning. Such a demonstration would inspire confidence in the donor community and among those private sector partners who are willing to invest but are uncertain of the outcomes. **Indicative area** 25,000 ha **Indicative costs**: US$500,000

Capacity Building in Local Government

There is need for a cadre of local officials and community leaders well acquainted with participatory community-based approaches to preventing and controlling DSS. The capacity building should be aimed at understanding legal, administrative and policy matters as well as acquiring knowledge of the basics of the participatory approach and how to use it. **Indicative**

size of cadre: 100-150 over 5 years **Indicative cost** (includes exchange visits and consultant trainers) US$1 million

Skills Training for Resettled Herders

Younger herders and their children need to be trained in skills that will allow survival away from the rangeland[6]. Some will find work in local factories and construction sites but others could receive training in aspects of ecological restoration of the degraded rangelands. A training center could be established, equipped and staffed for DSS control with particular focus on alternative livelihood. Production of training manuals, instructional videos, etc. would ensure that the work of the center had a wider reach than those who actually attended classes. **Indicative numbers involved**: 500 persons **Indicative cost**: includes establishment, equipping, staffing US$3 million

Demonstrate the best practice for growing, harvesting and utilizing artificial grassland and shrub plantations such as Hedysarum and Caragana

The heavy reliance now on fodder and forage from a limited area of artificial grassland and from re-vegetated areas, which are closed to grazing, means that better ways must be explored to maximize yield and get high utilization rates. Best practice in terms of selecting the best plant species (even cultivars), best techniques for establishment and subsequent management, harvesting, transporting and storage all contribute to the higher levels of efficiency and profitability of animal husbandry. Agronomic techniques, soil management and other proven procedures should be incorporated. **Indicative area**: Total of 2,000 ha distributed at several sites **Indicative costs**: US$200,000

Rangeland Management

Demonstrate the benefits of better rangeland management through fencing, controlling livestock numbers, season of use and species of livestock. Work with local herder communities, strengthen the Herder Association, re-introduce some rotational grazing scheme in areas larger than the contracted land that each household controls. **Indicative area**: 50,000 ha **Indicative cost**: US$2 million (including training and capacity building and production of manuals, video and posters).

D. Project Activities in the PRC Focus Area 4: Hulunbuir

Demonstrate the Benefits of Rangeland Management

Demonstrate the benefits of better rangeland management through fencing, controlling livestock numbers, season of use and species of livestock. Work with local herder communities, strengthen the Herder Association, re-introduce some rotational grazing scheme in areas larger than the contracted land that each household controls. **Indicative area**: 50,000 ha **Indicative cost**: US$2 million (including training and capacity building and production of manuals, video and posters).

Demonstrate the Best Practice for Growing, Harvesting and Utilizing Artificial Grassland

The heavy reliance now on fodder and forage from a limited area of artificial grassland and from the re-vegetated areas, which are closed to grazing, means that better ways must be found to maximize yield and get high utilization rates. Best practice in terms of selecting the best plant species (even cultivars), best techniques for establishment and subsequent management, harvesting, transporting and storage all contribute to the higher levels of efficiency and profitability of animal husbandry. Agronomic techniques, soil management and other proven procedures should be incorporated. **Indicative area**: Total of 2,000 ha desitributed at several sites **Indicative costs**: US$200,000

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[6] See Voegele, J. 2001. Combating Desertification in Western China: A Perspective. Washington, DC. World Bank

Demonstrate Best Practice for Propagating, Planting and Maintaining Chinese Pine on Sandy Lands

Chinese pine, a native specie, well adapted to growing on sandy land can be used in large scale plantings on degraded grassland as a buffer against the further spread of desertification and ultimately as a source of income for local people. **Indicative area**: 10,000 ha **Indicative cost** US$500,000

Private Sector Partnerships in Developing Alternative Energy Sources

Fuel woods are in short supply. Harvesting of dead trees is harmful and cutting of living trees and shrubs reduces the vegetative cover and increases the risk of DSS outbreaks. An integrated approach to combining fuel-efficient stoves, production of wind energy, solar energy could be tested with about 200 households. Private sector funding could be provided in cash or in kind to supply equipment and technical back up. **Indicative area**: 15,000 to 20,000 ha **Indicative costs**: US$10 million

Capacity Building in Local Government

There is need for a cadre of local officials and community leaders to be well acquainted with participatory community-based approaches to preventing and controlling DSS. Capacity building should be aimed at understanding legal, administrative and policy matters as well as acquiring knowledge on the basics of the participatory approach and how to use it. **Indicative size of cadre:** 100-150 over 5 years **Indicative cost** (includes exchange visits and consultant trainers) US$1 million

Private Sector Involvement in More Cost Efficient Fencing Techniques

The vast area will require many thousands of kilometers of fence. Better and cheaper fencing techniques are available from Australia and New Zealand, for example. Demonstrating these and training people on how to erect them (technology transfer) would be a useful component/activity of the project.

Conduct an Awareness Raising Campaign for Stakeholders

The rapid and unprecedented degradation of the Hulunbuir grasslands is a cause for alarm. A campaign to get every land user involved (including drivers of motor vehicles whose activities in driving over the grassland on any number of tracks is a cause of desertification) in the restoration process is a necessary part of any strategy to prevent and control DSS. Training videos, posters and short courses would supplement the work of community advisors/facilitators. **Indicative area:** 100,000 ha **Indicative costs**: $2 million (including training materials and appointment and support of 10 community advisors/facilitators)

3.6.2 Project Activities in Focus Areas of Mongolia

Table 3.9 sets out a summary of the major proposed actions/measures for each of the focus areas in Mongolia.

Table 3.9 Summary of Proposed Actions for Focus Areas in Mongolia

Items / Sites		Ovorhangai	Omnogobi	Sukhbaatar	Dornogobi
Combating land degradation to prevent and control DSS	Prevention		Plant trees to stabilize sand movement around *soums*	• Strengthen Darganga Natural Park • Plant trees to stabilize sand movement	Windbreaks along roads and railways
	Rehabilitation	• Rangeland management • Enclosure	Rangeland management	Rangeland management	Rangeland management
	Development	• Develop ecologically responsible mining • Renewable energy sources	Renewable energy sources		Rangeland management, water wells
Capacity Building to implement measures for DSS prevention and control		Capacity building of local government	Capacity building of local government	• Capacity building of local government • Awareness campaign	Capacity building for local government
Poverty Alleviation to reduce pressure on land and reduce dust entrainment		Renewable energy use			Strengthen environment sound poverty reduction policies and programs
Social Development to improve livelihoods, reduce dependence on animal husbandry, improve infrastructure			Develop Alternative Energy		Infrastructure and technology development

A. Project Activities in Mongolia Focus Area 1: Ovorhangai

Project Demonstration of Applying Environment Friendly Technology for Gold Mining.

The main objective of the project is to assist the Government of Mongolia in providing guidance for sustainable gold mining development, so that it generates sustainable economic benefits in rural areas without resulting in serious environmental or social problems in those places. Also, the capacity of the central and local government and relevant education bodies and NGO should be strengthened. Major elements of the project would be to make a survey of the current environmental issues in gold mining areas, to evaluate the mainstream environmentally sound technology, and to formulate favorable economic instruments for the gold mining sector towards environment and social achievements in rural areas. Main output of project would be the development of the sector's environment impact assessment guidelines. **Indicative area:** 100,000 ha per year **Indicative costs**: US$0.7 million. Expected results will be the rehabilitation of lands in mining areas to reduce DSS.

Rangeland Management .

This project entails the control of livestock population, season of pasture use, re-introduction of rotational grazing scheme, improvement of legal system including taxation system for conservation of pasture and sustainable use its resources, introduction of the use of alternative energy sources such renewable energy and coal briquettes to the local people, promotion of technical (transport, income generation techniques) and human (knowledge, experiences) capacity of herders for range land management. **Indicative area:** 100,000 ha (several counties) **Indicative costs**: US$1 million

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Promote the Use of Renewable Energy Resources for Local Fuel Supply.

Fuel woods are in short supply. Cutting of living trees and shrubs and using them for local fuel reduces the vegetative cover of the area and increases the risk of DSS outbreaks. The objective of the project is to remove the key barriers for the increased utilization of renewable energy. The project is expected to achieve this goal by: (i) addressing the legal and regulatory barriers in order to provide fair and competitive access to the market for renewable energy producers, to ensure payment, and to encourage investments into renewable energy, (ii) introducing and leveraging financing for a pilot renewable energy fund/ credit line so as to overcome the key financial barriers in the focus area, and (iii) addressing the existing public awareness and capacity barriers so as to provide a basis for the general development and implementation of renewable energy projects. **Indicative area**: Renewable energy technology would be introduced to 50 households per year for 5 years. **Indicative costs**: US$1 to US$1.5 million

Capacity Building in Local Government

There is need for local decision makers such as *soum* and *bag* governors of the focus area and members of the herders' communities to become well acquainted with participatory community-based approaches of preventing and controlling DSS. Capacity building should be aimed at understanding legal, administrative and policy matters as well as acquiring knowledge on the basics of the participatory approach and how to use it. **Indicative size of cadre:** 50 to 100 over 5 years. **Indicative cost** (includes exchange visits and consultant trainers) US$1 million. Expected results will be a cadre of trained and aware community leaders to lead the fight against DSS.

B. Project Activities in Mongolia Focus Area 2: Omnogobi

Rangeland Management

The project entails the control of livestock population, season of pasture use, re-introduction of some rotational grazing scheme, improvement of legal system including taxation system for conservation of pasture and sustainable use its resources, introduction of alternative energy sources such renewable energy and coal briquettes to the local people, promotion of technical (transport, income generation techniques) and human (knowledge, experiences) capacity of herders for range land management. **Indicative area:** 100,000 ha (several counties) **Indicative costs**: US$1 million

Plant Trees to Stop Sand Movement in the Pasture and Settlement Areas.

Stabilize sand movement in selected areas of Khongor els (sand), Dalanzadgad, Bulgan, Mandal-oboo, Tsogt-Oboo *soums* of the focus area through improving sand stabilizing techniques, planting trees and grasses, promoting the technical and human capacity for planting trees and improving the legal system for planting trees (establish responsibility and relationships between nursery and planting companies). **Indicative area:** 100,000 ha (several counties) **Indicative costs**: US$1 million

Promote the Use of Renewable Energy Resources

Fuel woods are in short supply. Cutting of living trees and shrubs and using them for fuel reduces the vegetative cover and increases the risk of DSS outbreaks The objective of the project is to remove the key barriers for the increased utilization of renewable energy for local fuel. The project is expected to achieve this goal by: (i) addressing the legal and regulatory barriers in order to provide fair and competitive access to the market for renewable energy producers, to ensure collection of payment and to encourage investments into renewable energy, (ii) introducing and leveraging financing for a pilot renewable energy fund/ credit line so as to overcome the key financial barriers in the focus area, and (iii) addressing the existing public awareness and capacity barriers so as to provide a basis for the general development and implementation of renewable energy projects. **Indicative area**: Renewable energy technology would be introduced to 50 household per year for 5 years.**Indicative costs**: US$1 to US$1.5 million

Capacity Building in Local Government

There is need for the local decision makers such as the *soum* and *bag* governors of the focus area and members of herders' communities to get better acquainted with the participatory community-based approaches for preventing and controlling DSS. Capacity building should be aimed at understanding legal, administrative and policy matters as well as acquiring knowledge on the basics of the participatory approach and how to use it. **Indicative size of cadre:** 50- 100 over 5 years **Indicative cost** (includes exchange visits and consultant trainers) US$1 million. Expected benefit will be a cadre of trained community leaders to lead the fight against DSS

C. Project Activities in Mongolia Focus Area 3: Sukhbaatar

Strengthen "Darganga" Natural Park

The project is to develop and implement a collaborative management plan for "Darganga" natural park. As recommended by the Government of Mongoia, ecotourism will be promoted in the park and its buffer zones and alternative incomes will be identified and generated. Capacity for natural park planning and management will be strengthened. Likewise, a long term land and pasture monitoring program will be developed. **Indicative area:** 20,000 ha per year **Indicative cost**: US$300,000

Rangeland Management

The project entails the control of livestock population, season of pasture use, re-introduction of some rotational grazing scheme, improvement of legal system including taxation system for conservation of pasture and sustainable use its resources, introduction of alternative energy sources such renewable energy and coal briquettes to the local people, promotion of technical (transport, income generation techniques) and human (knowledge, experiences) capacity of herders for range land management. **Indicative area:** 100,000 ha (several counties) **Indicative costs**: US$1 million

Plant Trees to Stop Sand Movement in the Pasture and Settlement Areas.

Stabilize sand movement in selected areas of Moltsog els(sand) and Nomgon els (sand), Dariganga, Nomgon and Baruun Urt *soums* of the focus area through improving sand stabilizing techniques, planting trees and grasses, promoting the technical and human capacity for planting trees and improving the legal system for planting trees (establish responsibility and relationships between nursery and planting companies). **Indicative area:** 50,000 ha (several counties) **Indicative costs**: US$600,000

Capacity Building in Local Government

There is need for the local decision makers such as the *soum* and *bag* governors of the focus area and members of herders' communities to get better acquainted with the participatory community-based approaches for preventing and controlling DSS. Capacity building should be aimed at understanding legal, administrative and policy matters as well as acquiring knowledge on the basics of the participatory approach and how to use it.

Indicative size of cadre: 50- 100 over 5 years **Indicative cost** (includes exchange visits and consultant trainers) US$1 million.

Awareness Raising Campaign for Stakeholders

The people of the community near the project site will note that something is going on and there is need for information. Public awareness efforts will be conducted through public meetings and other information activities (top-down and bottom-up communication combined). Such activities will be carried out continuously through the implementation period of the projects in the site. A campaign to get every land user involved (including drivers of motor vehicles whose activities in driving over the grassland on any number of tracks cause desertification) in the restoration process is a necessary part of any strategy to prevent and control DSS. Information materials such as videos and posters as well as short educational courses would supplement the work of community advisors/facilitators. **Indicative area**: 100,000 ha **Indicative cost**: US$ 500,000 (including materials and the support of 10 community advisors/facilitators).

D. Project Activities in Mongolia Focus Area 4: Dornogobi

Establishment of Windbreaks along the Road and along the Railways.

Windbreaks are needed in Dornogobi area. However, a project of this kind needs to be limited to a certain part - as a pilot project. The proposed project consists of two parts: one is along the new highway linking Ulaanbaatar with PRC road, and another is along the international railway south of Ulaanbaatar. The total area of the windbreaks will be 240 ha for the cultivated area and 13 ha along the road.

Investments and various disbursements for the two-part pilot project concerning cultivated land and along road will include nurseries and greenhouses, lorries and tractors and various other machinery, equipment, as well as different kinds of planting materials including fertilizers. **Indicative area:** 253 ha per year **Indicative costs**: US$500,000. The result is expected to be sand stabilization.

Rangeland Management

The project entails the control of livestock population, season of pasture use, re-introduction of some rotational grazing scheme, improvement of legal system including taxation system for conservation of pasture and sustainable use its resources, introduction of alternative energy sources such renewable energy and coal briquettes to the local people, promotion of technical (transport, income generation techniques) and human (knowledge, experiences) capacity of herders for range land management. **Indicative area:** 100,000 ha (several counties) **Indicative costs**: US$1 million

Capacity Building in Local Government

There is need for the local decision makers such as the *soum* and *bag* governors of the focus area and members of herders' communities to get better acquainted with the participatory community-based approaches for preventing and controlling DSS. Capacity building should be aimed at understanding legal, administrative and policy matters as well as acquiring knowledge on the basics of the participatory approach and how to use it. **Indicative size of cadre:** 50- 100 over 5 years **Indicative cost** (includes exchange visits and consultant trainers) US$1 million.

Strengthen Sound Poverty Reduction Policies and Programs Facilitating the Solution of Poverty-Environment Issues at Local Level

Addressing poverty and environment issues and working with the poor require political will and strong commitment given the sensitive issues of ownership, access, natural resources and power. Some practical solutions are: (a) Protect and expand the asset base of the poor (land reform, management of rangelands); and (b) Reduce the vulnerability of the poor to environment-related shocks and conflicts (DSS disaster), (c) Co-invest and co-manage resources with the poor (empowering, engaging and providing incentives to the poor for implementing community-based natural resource management systems), (d) Support infrastructure and technology development by supporting policies that promote environmentally friendly technologies and infrastructure geared toward the needs of the poor, especially the women. **Indicative area:** Shainshand *soum* center**, Indicative cost** (includes exchange visits and consultant trainers) US$1 million.

3.6.3 Project Activities in Cross-border Focus Area of Erinhot-Zamiin Uud

The proposed major project activities for the cross-border focus area are given in the table below.

Table 3.10 Summary of Proposed Actions for Cross-border Focus Area

Items \ Sites		Erinhot-Zamiin Uud
Combating land degradation to prevent and control DSS	Prevention	Rangeland and livestock management
	Rehabilitation	Revegetation and tree planting
	Development	• Waste water re-use; Model forest planting with waste water irrigation • Alternative energy
Capacity Building to implement measures for DSS prevention and control		Training center for traditional and hi-tech nursery facility; training of local government officials
Poverty Alleviation to reduce pressure on land and reduce dust entrainment		Ecotourism[1/]
Social Development to improve livelihoods, reduce dependence on farming and animal husbandry, improve infrastructure		Awareness campaign for stakeholders

[1] Ecotourism should be dealt within the environmental carrying capacity of the area with strict environmental safeguard controls.

Based on the proposed actions/measures intended for the Erinhot-Zamiin Uud focus area, and indicative cost and corresponding coverage is set out below.

Develop a Plant Nursery and Plant Propagation Facility

The plant nursery and plant propagation facility will be developed to provide seedlings for nearby areas of the focus area. The facility will also serve as a training center for technicians from both PRC and Mongolia. At present, Mongolia imports seedlings from PRC. In the future, the demand for seedlings will increase and there will be a requirement to increase capacity to produce adapted seedlings in bulk and at low cost and to pass on the technology for this to the Mongolian counterparts. There is an opportunity to upgrade the existing facility on the PRC side. **Indicative coverage** is the training of 100 technicians each year. **Indicative costs** is US$500,000 for set up.

Establish an International Training Center

The center will facilitate technology transfer and provide a venue for input from all four partner countries. Control of DSS requires expertise in a number of disciplines. There is a strong case to provide a venue for training courses in many aspects of land management, meteorology and participatory approaches, etc. The proposed component would provide a center that has accommodation, classrooms, and other necessary facilities to function as an International Training Center serviced by staff and visiting lecturers from the four partner countries (and beyond). **Indicative coverage** is 200 persons trained per year. **Indicative costs** is US$500,000 as establishment costs.

Application and Refinement of Water-saving Techniques

This is with particular reference to use of sewage and other waste water for plantation forestry. Erinhot City has expanded in recent years and the need for windbreaks and shelter belts around the city has been met by utilizing waste water and sewerage. Water saving technologies, including "dry water" have been employed. This needs to be scaled up and enhanced by further research and investigation. **Indicative cost** is US$200,000. Expected benefit is the amelioration of the environment around Erinhot and a demonstration to Mongolia of what can be done. It also provides the opportunity to research and adopt methods for waste water re-use and disposal .

Development of Alternative Energy Technologies (Solar, Wind, Power, Fuel Efficient Stoves)

This is to assist local residents and contribute to the preservation of woody species on the Gobi desert. A major source of DSS is the disturbed and denuded Gobi. Many of the woody plants are harvested for fuel. Provision of energy efficient stoves, solar and wind powered energy generation are options that need to be adopted for use by local herders. Education programs to protect the woody plants and in the use of alternative energies is a high priority. **Indicative coverage** is the inclusion of 50 trainers and 100 local herders per year. **Indicative cost** is US$600,000.

Development of Ecotourism Opportunities

This is proposed by the Government of Mongolia as part of the program for poverty alleviation and as a means for generating income. Ecotourism is a relatively recent phenomenon, representing but one segment of the overall tourism industry. It is defined as tourism that involves traveling to relatively undisturbed natural areas with the specific object of studying, admiring, and enjoying the scenery and its wild plants and animals, as well as any existing cultural aspects found in these areas, without spoiling the environment. The main goal of the projects would be to generate economic support for conversation and enhancement of natural areas. Main activities of this project would be to develop an inventory of ecotourism attractions in the Erinhot-Zamiin Uud areas and fostering the social-economic advancement of local communities. **Indicative area** is the area of one *soum*. **Indicative cost** is US$1 million. Expected results will be the promotion of the income of the local community. It will also slow down the rate of land degradation that now contributes to increased frequency and severity of DSS.

Rangeland and Livestock Management

The project is to arrest land degradation and improve livelihoods. Most of the DSS outbreaks in this region arise from overgrazed rangelands in the Gobi region. Better rangeland and livestock management practices would assist in preserving biodiversity and improving livestock and output while arresting land degradation. Poverty alleviation through better marketing of livestock and livestock products and higher livestock productivity will assist in the prevention and control of DSS. **Indicative coverage** is 100 households. **Indicative cost** is US$2 million. Expected outcomes are poverty alleviation through better marketing of livestock and livestock products and higher livestock productivity.

Windbreak/Shelter Belt along the Road and Rail Link

The newly built highway from Ulaanbaatar to Zamiin Uud needs protection from wind and sand. There is an opportunity to build properly integrated windbreak/shelter belts along the entire stretch of the highway. A fully operational system for growing and establishing trees would serve as a demonstration of what can be done along infrastructure developments such as the nearby international railway and around urban centers. **Indicative area** Is 500 ha (30 km). **Indicative cost** is US$200,000. Expected benefits are the successful demonstration of techniques and appropriate technologies and the protection of the highway.

CHAPTER 4 AN INVESTMENT STRATEGY

4.1 Context of the Investment Strategy

The basic investment principle is to consider each country's financial capacity and mobilize external and internal resources for mutually beneficial cooperation. When considering the financing of DSS related investments, there are significant differences in the problems faced by the DSS affected countries and the problems faced by the DSS source countries. The proposed Investment Strategy is consistent with each country's NAP, Agenda 21 and other programs and its implementation is needed to deal with transboundary environmental problems such as DSS.

The ongoing activities in each DSS-source country that relate to prevention and control of DSS fall into several broad groups:

- Those primarily aimed at combating desertification and/or preserve biodiversity (e.g., the ADB/GEF OP 12 in the PRC); and
- Reforms to land tenure, access and use rights and other policy measures designed to improve land stewardship.

Each country has its own strategy for funding its national development program.

- At the core of national development planning is the recognition that the future will depend upon sustainable and balanced development across the whole country.
- Sound ecosystems are fundamental to achieving nationwide sustainable development.
- Each country has obligations as a signatory to the various international conventions (e.g., United Nations Convention to Combat Desertification, Unite Nations Framework Convention on Climate Change, and Convention on Biological Diversity)

Essentially, DSS prevention and control involves a two-tiered investment strategy. At the first tier, the focus is on reducing damages and mitigating the impact of DSS on public health and safety, property and everyday life. Important questions include: (a) how much money is required to perform DSS prevention and control activities, (b) how those funds may be raised, and (c) how to allocate the funds among alternative activities. These types of questions are referred to as "level of protection" issues. In the context of DSS prevention and control, defining a particular level indicates the extent to which certain programs would be expected to reduce the detrimental economic damages and social impacts of DSS in affected areas.

It is difficult to determine in a precise manner the optimal level of DSS prevention and control, simply because DSS cannot be totally eliminated. Meanwhile, it is equally difficult to quantify the effects of prevention and control programs. However, one of the DSS prevention and control objectives is the precision in predicting the occurrence of DSS events. Level of program effectiveness can also be determined in two ways, namely, (i) DSS return intervals or DSS cycles, which provide an estimate of the average time between DSS events at chosen monitoring sites, and (ii) the intensity and extensiveness of damages. While the first aspect is straightforward, the second aspect is concerned with the cost of DSS prevention and control. Using the "Least Cost-Plus-Loss" criteria that have been discussed earlier in the report, the level of DSS prevention and control in financial terms may be viewed as the summation of two elements, i.e., (a) the direct and indirect costs of DSS damages, and (b) the costs of replacement and restoration. As far as the value of property destroyed by DSS, it is acceptable to use depreciated value or replacement value, at prevailing market prices whenever they are available.

From a landscape perspective, financial resources may be allocated for the restoration of DSS-damaged areas where these (i) have proven nature conservation interest, (ii) are a particular feature in the landscape, (iii) are of high historic value, and (iv) have a high amenity value, i.e., where it is visually prominent.

It is difficult to say by how much a particular prevention program would achieve in terms of reducing the impact of DSS. Due to the concentration of economic assets in cities, it may be a much more effective strategy to concentrate on those measures that help reduce effects of dust storms on cities by improving forecasting capacity as well as disaster preparedness and management. However, effective DSS prevention and control must start at the source areas, and that is why the second tier of the investment strategy is also essential because of its central concern with addressing the underlying causes of DSS, such as overgrazing, over-cultivation, unsustainable use of water resources, and so on. Models have been developed to predict the levels of vegetation cover required for stability given certain environmental conditions[1]. After validation, these models could be applicable to determining grazing areas, and identifying the specific sites and the required amount of ground cover. There is scope within the context of the demonstration projects to refine these models. From the point of view of local herders and planners, it is important to maintain these critical cover levels in order to avoid overgrazing and allow dust entrainment.

4.2 Key Points for Consideration

The following is a suggested Vision Statement to guide development of an investment strategy for DSS prevention and control in the Northeast Asian region.

Vision Statement:
The health, safety as well as welfare of the peoples in DSS source areas and DSS impacted areas and the economic, social and environmental sustainability of the Northeast Asian region will be safeguarded through implementation of a region-wide DSS prevention and control strategy. This strategy will be realized by:

- applying the principles of cooperation;
- adopting a sound emergency management approach that includes risk mitigation, preparedness, response and recovery;
- utilizing the respective resources and expertise of individuals, communities, industries, governments of various levels and international organizations in accordance with their respective and shared responsibilities;
- mobilizing and implementing an appropriate and affordable level of investment of resources over time, commensurate with the values at risk;
- promoting Northeast Asia regional cooperation, sharing of knowledge, information, and services; and
- adopting the transparent investment mechanism.

The investment strategy will provide a framework that is flexible and can effectively harness the capabilities of all partners. It will provide useful guidance for the development of detailed implementation and investment plans. A business-planning approach is likely to work best. This implies working around specific actionable areas, with potential for concrete forms of collaboration. Broadly, such actionable areas would pertain to one of the following main clusters: policy and institutions, investment opportunities, management support and monitoring and evaluation, technical assistance and capacity-building support.

The strategy will have the following features:

[1] Heinschmidt, R.K and Stuth, J.W. (eds) 1991 Grazing management: An ecological perspective. Timber Press, Portand and Leys, J.F. 1991. The effect of prostrate vegetation cover on wind erosion. Vegetation 91:49-58

1. Relevant and responsive – the strategy will be of relevance to mandates of various levels of government and international organizations and be aligned with their existing and emerging priorities. DSS prevention and control represents a significant expenditure for governments. The strategy will be responsive to other related issues including sustainable development, public health and safety, food security and welfare in rural areas, and climate change.
2. Integrated – mitigating the risks and impacts of DSS will be fully incorporated into aspects of land and resource management as well as social development at large.
3. Science-based – the strategy will be based on a thorough analysis of current capacity, DSS trends, available options and socioeconomic impacts of DSS. Options will be defined on the basis of scientific analyses and best practices.

4.3 Partnerships and Options for the Investment

Viable partnerships for investing in projects are based on shared objectives, well defined tasks or actions, clear delineation of obligations and of each partner's responsibility, respect for each partner's internal modalities and operating procedures, and financial resources and technical support from partners to back up the partnership.

The Inner Mongolia Autonomous Region Forestry Department, which has been actively involved in planning the PRC demonstration projects, has proposed a financing arrangement of cost-sharing on a 1/3:1/3:1/3 basis. Specifically, for the four proposed demonstration focus areas, a total investment of RMB492 million (approximately US$61.5 million) will be required. It is suggested that one third will come from government of various levels—principally the central government, one third from GEF and other donors in the forms of grants and loans, and the last one third from the private sector and local communities.

Of the three major funding sources, the government component appears to be earmarked without much problem. Senior officials that the consultant team met have reassured repeatedly that the recommended demonstration focus areas in Inner Mongolia Autonomous Region are precisely the PRC Government's priority areas. The assistance to be requested from external financial sources will comprise grants and loans. Grants will be conditional on the preparation of an approved management plan, and the grant rate may be flexible, higher for activities where multiple objectives will likely be achieved. The third financial component will require more work than the other two sources, in terms of mobilization and arrangements. Nevertheless, some very encouraging signs are emerging in both Mongolia and the PRC, regarding the willingness of the private sector to get involved in desertification control. In June 2004, a group of Chinese entrepreneurs were gathered in the Alashan League and reached a well publicized "Alashan Declaration", vowing to commit a significant amount of financial resources to help with DSS prevention and control. Perhaps, the most successful experience of private sector involvement with desertification control came from the Dongda Mongolian King Group Co., which is based in the Dalate Banner of Erdos, one of the four proposed demonstration project areas in Inner Mongolia (Box 4.1).

4.4 Recommended Investment Strategies

It is recommended that a *demonstration project approach* be adopted in implementing the investment strategy. External financial resources should finance the implementation, with domestic counterpart financing and contributions from the private sector and local communities. The demonstration projects are of the utmost importance to the success of any investment strategy or regional master plan.

Box 4.1 Private Sector Involvement in Desertification Control

Incorporated in 1996 on the basis of the Dongda Cashmere Products Company Ltd., which was established in 1991 in the Inner Mongolia Autonomous Region, Dongda King Group Company Ltd. possesses 16 member companies in 5 fields such as cashmere products, highway and bridge construction, coal mining and marketing, paper making, ecological development and goat breeding. The total assets of the Dongda King Group amount to 0.7 billion yuan, with 0.43 billion yuan net assets. The Group has donated more than 10 million yuan to support public welfare initiatives. It ranks 127th among the Top 500 private enterprises in the PRC, and has been evaluated with class AAA credibility for years.

Of relevance are two of the subsidiary companies, namely, the Dongda Mongolia King Paper Industry Company, and Dongda Ecological Construction Company. Dongda has established an ecological base to address the root causes of grassland degradation through increased forage production and introduction of improved breeds, and encouraged development of pen-feeding livestock production systems in order to reduce the stocking rates on natural grasslands.

Dongda's ecological projects include sandy land improvement, forestry, grass industry, with an aim to restore ecological conditions and improving local people's living standards. In particular, the industrial product of desert willow integrated utilization in Kubuqi desert. This project has four components: the first one is the paper board made of desert willow wood pulp with a rated annual capacity of 0.5 million tons with an investment of 2.1 billion yuan, the initial stage capacity being 0.1 million tons; the second one is the construction of 3 million mu[2] desert willow industrial material base in Kubuqi desert with an investment of 0.3 billion yuan; the third one is 0.25 million white cashmere goats base with fenced breeding with an investment of 0.15 billion yuan; the fourth one is the industrial project of annual treatment capacity of 0.1 million beef cattle and meat sheep with an investment of 0.3 billion yuan.

In order to start these projects, Dongda has invested 40 million yuan to acquire the former paper mill in Dalate Banner to form a paper company and ecological development company and started the development of desert willow plantation base for pulp making. The Dongda paper company has manufactured high-strength corrugated and box board finishing paper with desert willow.[3] It is estimated that, upon completion of the projects, annual output values will reach 3 billion yuan, which will provide many employment opportunities for local residents and provide 300 million yuan to local farmers and herders as direct source of income. This is a "company + household" model.

For years, participation by local people in land degradation control was encouraged in PRC, but the outcome was generally sub-optimal. Incentives are important policy instruments to enhance participation by rural communities in rehabilitation activities. Incentives that promise immediate and short-term benefits are required to ensure local participation. However, such incentives may be counterproductive when long-term ecological rehabilitation is the major objective.[4]

The involvement of private sector does not have to be limited to domestic firms. ROK and Mongolia have collaborated in this respect, with positive results. The Korea-Mongolia Joint Research Project for Development and Utilization of PV/Wind Power Generation Systems for Rural Electrification in Gobi Desert commenced in June 2003. Operated by the Daesung Institute for Clean Energy, the objective of the project is twofold: (1) by application of Korean PV/Wind power products in the severe weather conditions in Mongolia, accomplish system optimization, technology upgrade and marketability of products; (2) realize new market and Northeast Asian cooperation model, through cooperation between the two nations. Successful installation and test run were completed in October 2003.

Located at Urn and Naran Soum, the solar Ger[5] system comprises two types, namely, (i) 50 W economy type for nomads, i.e., DC supply, 6 hours capacity for 1 bulb (12 W), 1 B/W TV (20 W) & 1 radio (8 W), and (ii) 150 W luxury type for nomads, i.e., AC supply for one household of 3 Gers or an owner of more electric appliances, capacity for 2-3 bulbs (12 W), 1 color TV (50 W) & 1 radio (8 W). A hybrid system for Naran Soum was installed with 8 kW (PV 5 kW+Wind 3 kW) as electric supply for small village or public building, such as school, government office, community hall and hospital. Besides, system facilities at a Ulaanbaatar site is capable of supporting some solar street lamps and a solar fountain.

The project is scheduled to last for two years (from June 2003 to May 2005), at a total cost of 975 million Won (approximately US$1 million). In terms of environmental benefit, through building of the solar power plants in the Gobi desert, the project is expected to reduce almost 30% yellow dust that originates in the desert area in Mongolia. The project has considerable socio-economic benefit as well. As a high-tech system, the project will boost related domestic industries and create employment opportunities.[6]

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[2] 15 mu =1 ha
[3] Brochure on Inner Mongolia Autonomous Region Dongda King Group Company Ltd., undated.
[4] J.J. Kessler and P. Laban. 1994. Planning Strategies and Funding Modalities for Land rehabilitation. Land Degradation and Rehabilitation 5: 25-32.
[5] Ger is the traditional Mongolian tent that is transportable. It is called yurt in other regions of the western PRC and central Asia
[6] Based on an undated brochure produced by the Daesung Institute for Clean Energy.

The Northeast Asian Forest Forum (NEAFF), which is a non-governmental organization (NGO) founded in 1998 for the restoration and conservation of forests in the Northeast Asian regions, is based at Seoul, Korea. The NEAFF is composed of representatives from the business sector, environmental organizations, forester's group, academic communities, and individuals from the Northeast Asian countries. The unique characteristic of the NEAFF is the wide participation and support financially and technically from the government body (support from Korea Forest Service and others), private companies (Yuhan-Kimberly, Ltd. which initiated campaigning "KEEP KOREA GREEN" 20 years ago), public fund (Green Fund), and ordinary citizens.

The international cooperation is directed towards rehabilitating degraded forestlands and combating desertification, such as combating desertification in the PRC (around 400 ha in inner Mongolia Autonomous Region) and Mongolia (450 ha in Selenge and 40 ha in the Gobi Desert) by planting trees and sand fixation, exchanging personnel and information among the participating countries, organizing international workshops and seminars with the UNCCD, the UNDP, and other international organizations. The total fund size is around US$ 1 million for these activities from 2003-2006. Combating desertification is not the sole responsibility of each government, but rather it involves partnership and collaborative interdependency among NGOs, international society, various business sectors, scientists, and community leaders.

It makes economic sense to adopt capital-extensive management strategies in some areas while taking a capital-intensive management approach in some other areas. Changes in budgeting procedures are required; in particular, a long-term approach to programming is preferred. The cumulative effects of DSS damages need to be financially evaluated from a long-term perspective. By not taking a long-term investment-return approach, returns on DSS management activities in terms of reduced future losses and reduced control expenditures may be negative.

Variability in levels of DSS damage must be incorporated into the investment strategies. Because of the deficiency in information regarding storm damage functions, incorporating variability and conducting sensitivity analyses are highly important since they can illustrate the range of potential impacts.

CHAPTER 5 PROPOSED FINANCING PLAN

5.1 Phased Approach

According to analysis by the Asian Development Bank and the World Bank specialists,[1] the PRC's costs associated with environmental degradation are estimated at 10% of the country's annual Gross Domestic Product (GDP), as compared with around 5% for East Asia and the Pacific region. Partnership building between development partners and domestic stakeholders will emerge through a constructive dialogue to enhance understanding of the strategic and policy framework underlying the serious transboundary problem that DSS presents and the heightened pressure from neighboring countries to mitigate the problem. The emergence of an investment platform to translate that framework into concrete investments in the DSS source areas is one of the expected outcomes of the regional cooperation promoted by the RETA 6068.

Traditionally the management of ecosystems has been the responsibility of the affected countries, with external financial support mostly channeled through bilateral programs or the executing agencies such as the World Bank, the FAO, the UNDP, and the ADB. Transboundary concerns like DSS, where the origin and impacts of a phenomenon may fall in different countries, requires greater efforts for international cooperation. The lack of predictable, sustainable and sufficient financial resources continues to impede efforts by countries to implement the UNCCD and combat desertification effectively.[2] Efforts need to be strengthened to explore existing national and international financial mechanisms to ensure a steady flow of funding required in the fight against desertification, through publicly-funded projects and programs. New funding mechanisms are needed, including private sector and non-governmental sources and other innovative means of securing the financial resources.

Some innovative sources and financial mechanisms that may be explored include:

- Clean Development Mechanism (CDM);
- investment by industry in ecosystem restoration;
- ecotourism;
- incentive measures and market based instruments; and
- debt relief initiatives, and so forth.

CDM, is an initiative arising from the Kyoto protocol on reduction of greenhouse gases. CDM has potential for application in some areas in the PRC and Mongolia. Whilst carbon sequestration[3] is the major thrust, there is provision for biomass fuels and other land-based measures to qualify for support under the CDM. There is an opportunity to test some land management initiatives in the demonstration sites that specifically aim at assessing the potential for CDM support in the expanded program that comes with scaling up from the demonstration sites.

The project RETA 6068 and follow up projects will provide opportunities to explore the tradeoffs between ecological restoration and development endeavors in DSS source areas,

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[1] *China Daily*, July 3, 2004.

[2] "Mobilizing Finance for Combating Desertification," a workshop organized as part of the First Inter-Regional Session of the Global Biodiversity Forum on sustainable approaches for drylands ecosystem, La Havana, Cuba, 22-24 August 2003; http://biodiversityeconomics.org/finance/030822-00.htm

[3] Drylands can sequester significant amounts of carbon see Squires, V. and Glenn, E. "Carbon sequestration in the drylands: an agenda for the twenty-first century" World Atlas of Desertification. Edward Arnold/UNEP (2nd ed) pp.140-143 and Squires, V.R. (1998). Dryland Soils: their potential as a sink for carbon and as an agent in mitigating climate change. *Advances in GeoEcology* 31: 209-215.

and generate useful experiences in identifying sustainable options for local rural communities that can ensure livelihood security while improving the ecological functions of DSS source areas and pathways. In particular, the conceived demonstration projects will likely promote:

- best practices on how to balance ecosystems with requirements for improving livelihoods in DSS source areas and pathways;
- obtaining better understanding of the merit of the ecosystem approach as a tool to guide development of policies and governance for DSS source areas;
- the value and importance of integration of local knowledge and equity including gender equality in developing and implementing DSS prevention & control measures; and
- technical and organizational capabilities and, more importantly, partnerships among the government agencies, industries, and civil societies and individuals of the Northeast Asian countries and participating international organizations; these capacities and partnerships will be extremely valuable for achieving ecosystem restoration and livelihood requirements in DSS source areas, in the sense that they will serve as catalysts for developing specific financing arrangements to implement pre-determined investment strategies.

The importance of prevention (e.g. the interventions that could help prevent the land from degrading) needs to receive considerable attention. Additional analysis/prediction of the socioeconomic conditions in the selected project areas over the planned intervention period would be helpful and should be part of the project design when the actual sites are chosen. Special consideration should be given to improving water resources management and energy resources management in rural areas.

The investment needs to be developed at two levels. As part of the regional master plan to combat DSS, a phased approach is required to implement a long term strategy that encompasses:

- Monitoring, early warning and forecasting of DSS
- Prevention and control of DSS in source areas
- Mitigation of impacts in downstream locations

At the second level there is the need to finance the implementation of the demonstration projects that comprise the core of the investment strategy.

Prevention and control of DSS is a long-term endeavor that requires firm commitment and massive investment. The Investment Strategy needs to be implemented in a phased manner, step by step, through pilot demonstration projects to identify the best practices and the most appropriate and effective mitigation measures before promoting their replication.

The nine demonstration projects proposed for development in the DSS source areas will cost considerable amount of money. Funds must be mobilized. There are several potential funding sources:

- Grants from bilateral and multilateral agencies (e.g., GEF)
- Government – central and local
- Investments by corporations
- Private sector partnerships
- Public participation - subscriptions, donations

Because of the high cost and the need to get trained personnel and mobilize physical and financial resources it is proposed that a phased approach be devised. Phasing is at two levels:

- Give priority to some focus areas

- Prioritize actions/measures to be evaluated in each selected Focus area

The Investment Strategy should highlight the importance of capacity building and raising of public awareness because success of the Investment Strategy will require not only physical investment, but also public participation that, in turn, requires changes in the mindset of people. Activities designed to improve capacity and raise awareness should be in the first phase of the implementation.

5.2 Financing Plan for the PRC and Mongolia Demonstration Project

The scale of the demonstration projects is flexible and can be tailored to the available funds. Preliminary estimates for each focus area range from US$ 3 million to over US$22 million but not all of the money needs to available at one time. Some of the proposed project components can be packaged and funded as stand-alone measures and some are candidates for private sector partnerships. Among the donor community there may be project components that more closely fit their current aid program. A possibility is to establish a regional fund dedicated to the prevention and control of DSS, which could receive contributions from the participating countries (including private corporations, international agencies or organizations). Government donations to the fund could be used as the seed money and could serve as a vehicle to mobilize additional funding support from other sources, public or private.

Every demonstration project has its special capital costs. A major element of each site must be the installation of appropriate monitoring systems whose intent is to measure any reduction in frequency and intensity of DSS that can be attributed to the intervention being tested. The monitoring system will vary between sites but an extra 1% can be added to the cost estimates to provide for it.

There are a few possible funding sources for DSS investments, to wit:

- **Internal sources.** There is budget allocation for environment management in different levels of the national government but not much is available for DSS investment in the PRC and Mongolia. Likewise, internal resources can be tapped from the domestic private sector, communities, and small stakeholders of the project area.

- **Bilateral Channels.** The bilateral donors such as Japan typically concentrate on funding pre-project activities and pilot project. Bilateral assistance is most often given as grants. The bilateral support from donors has an important role in insuring that the projects are well documented and well structured through support for feasibility studies and pilot projects. Without the combination of bilateral assistance for feasibility studies and pilot projects with international financing of subsequent larger scale implementation many projects with important environmental benefits would not be implemented or their scope would be significantly reduced.

- **International Financing Institutions.** Apart from bilateral donors, a number of the international financial institutions are active in connection with the financing of environmental projects in the region. The most important actors are the Asian Development Bank (ADB), the World Bank, and the European Union. There is a well-developed cooperation between the Government of Mongolia and the international financial institutions. The large international financing institutions such as the World Bank and ADB typically provide long-term loans financing large-scale investment projects. However, governments are cautious on increasing their foreign debt and are least likely to borrow funds for the purpose of combating DSS.

- **Global Environment Facility.** GEF considers DSS as a subset of land degradation. However, there is a hope that GEF would consider Mongolia's case for funding because Mongolia has never received any financing from GEF for OP 15[4]. Everybody agrees that land degradation is becoming worse and worse in Mongolia. The PRC, on the other hand, is already a partner of GEF OP 12[5] on Land Degradation in Dryland Ecosystems.

- **Private Sector Involvement.** It should be expected that the opportunities for mobilizing additional resources for environmental investments through involvement of the private sector in a Public-Private Partnership. It should increasingly be tested in both DSS affected countries and source countries in the coming years. The Government of Mongolia will be following these developments and seek to contribute constructively to ensure that such new cooperation models are implemented in a way that secures the public interest. The need to mobilize additional resources for investments in DSS prevention and mitigation leads governments and international financing institutions to consider new forms of cooperation where the private sector is involved in a Public-Private Partnership. In conclusion, both the PRC and Mongolia should mobilize significant internal and external resources for investments, which are necessary for mitigating DSS impacts in the region. .

Table 5.1 presents a possible mix of funds for indicative components of a sample pilot project for DSS prevention and control.

Table 5.1 Indicative Components and Costs for Single Pilot Site (US$ 000)

Components	GEF	Government In-kind Contribution (central & local)	Others (bilateral donors, NGOs, private sector, etc.)
Land-based activities	**2,000**	**600**	**1,400**
rangeland improvement	800	250	600
livestock management	800	250	600
forestation	300	50	100
other	100	50	100
Social development	**1,600**	**500**	**1,000**
income generation	1,000	300	600
education	50	25	50
training/ extension	50	25	50
women participation	50	25	50
health	50	25	50
infrastructure	400	100	200
Management	**400**	**100**	**400**
project management	300	50	300
monitoring	50	25	50
evaluation	50	25	50
Total disbursement	**4,000**	**1,200**	**2,800**

Since a phased approach is more viable to implement, the financing plan should strictly stick to the phased approach. The project should have three phases for the next 10 years (see Table 5.2).

[4] GEF's Operational Program on Sustainable Land Management, which includes creating appropriate enabling environment, institutional strengthening, and investments.
[5] GEF's Operational Program on Integrated Ecosystem Management.

Table 5.2 Phases of DSS Prevention and Control Program

Phases and Proposed Activities	Funding Needed (US$ 000)	Funding Sources [1/]
Phase I. 2006-2007		
1. Feasibility studies	1,000	GIC, BS, PS
2. Capacity building	8,000	
3. Institutional development and policy framework	500	
4. Public awareness	500	
Subtotal	10,000	
Phase II. 2008-2010		
1. Implementation of pilot projects (Zamiin-Uud and Erinhot)	5,000	GEF, GIC, PS, BS
2. Monitoring (equipment)	1,600	
Subtotal	17,600	
Phase III. 2010-2015		
1. Implementation of projects in three dust source areas based on the feasibility studies and lessons learnt from pilot projects.	24,000	GEF, GIC, PS, BS
2. Monitoring (equipment)	240	
Subtotal	24,240	
Grand Total	**40,840**	

1/ GIC – Government in-kind contribution; GEF – Global Environment Facility; BS – Bilateral sources; PS – Private Sector.

As part of the regional master plan to combat DSS there is a need to replicate and expand the treated area. The "package" of measures/actions that are proven to reduce the frequency and severity of DSS should be scaled up to involve an area more commensurate with the size of DSS source area.

As a next step to the realization of any of the demonstration projects, a feasibility study is warranted. It is one of the proposed activities in the first phase of implementing the DSS prevention and control program. It is here that the sustainability of the demonstration projects will be explored through cost recovery mechanisms.

APPENDIX 1

LIST OF PARTICIPATING PARTIES AND THE STUDY TEAM

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[2] Ms. Segawa assumed the position of Mr. Wada during the course of the study.

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[1] These experts were provided by their respective governments, as part of the in-kind contribution to the RETA 6068, to give technical advice and guidance to the consultant team.

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8 Appendix 1 List of Participating Parties and the Study Team

APPENDIX 2

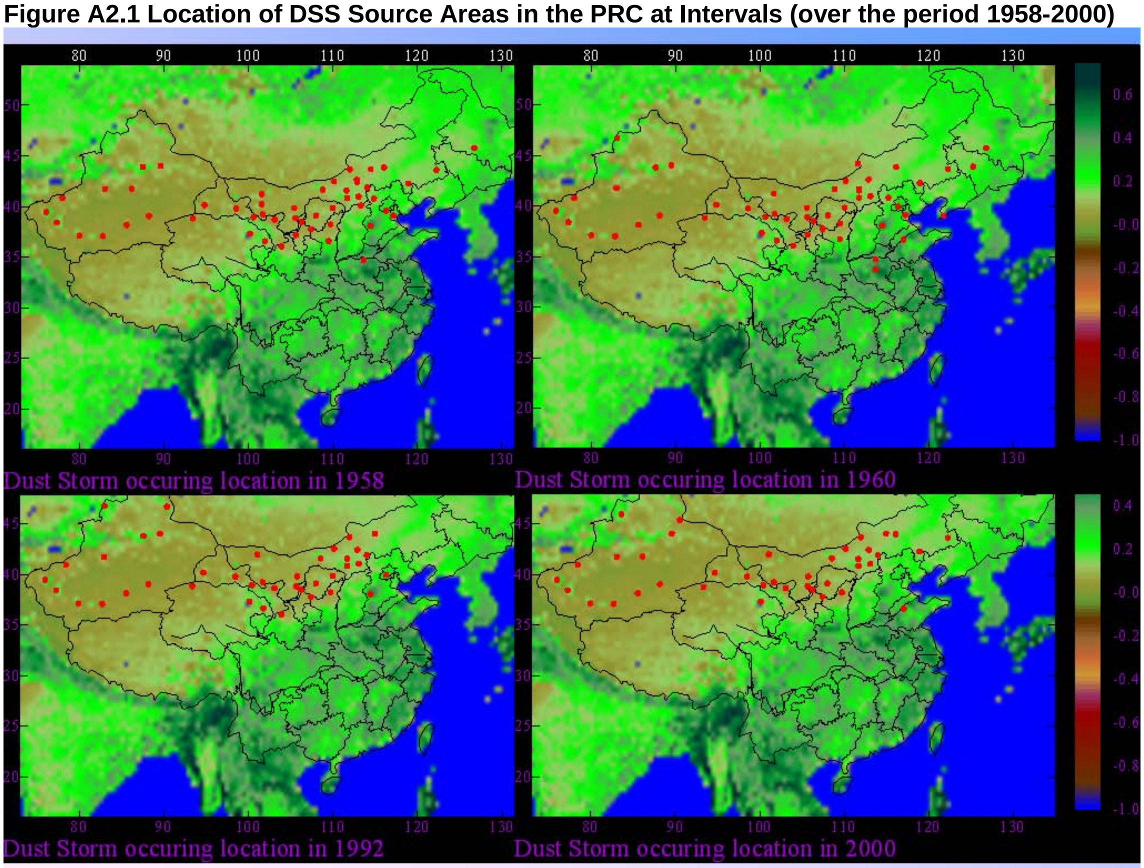
BIOPHYSICAL PROFILE OF FOCUS AREAS IN THE PRC

All four focus areas and one cross-border focus area have been designated by the government of the PRC. All are in the Inner Mongolia Autonomous region, an area that has been identified as a major source of DSS. Inner Mongolia Autonomous Region is located in the north part of the PRC with a total area of 1.183 million km^2 .

Basic data are included in Table A2.2

The central-west region of Inner Mongolia Autonomous Region 36-46^{o} N,96-118 ^{o} E, belongs to arid and semiarid areas of Central-East Asia. It receives less than 300 mm annual precipitation on average and 94% falls in summer-autumn. There are six deserts or sandy-lands from west to east in Inner Mongolia Autonomous Region where there is sparse vegetation and an abundance of sand and dust materials. Therefore, it is one of the main dust storm source regions in the PRC. Dust storms occur not only in modern time, but also in ancient time.

Figure A2.1 Location of DSS Source Areas in the PRC at Intervals (over the period 1958-2000)



Climate change is one major influence factor on surface environment of the DSS source regions. Besides natural factors, the impacts of human activities should not be ignored. Human impacts have made the DSS source areas expand rapidly.

Table A2.1 Desertified Areas of Two DSS Source Regions in Inner Mongolia Autonomous Region

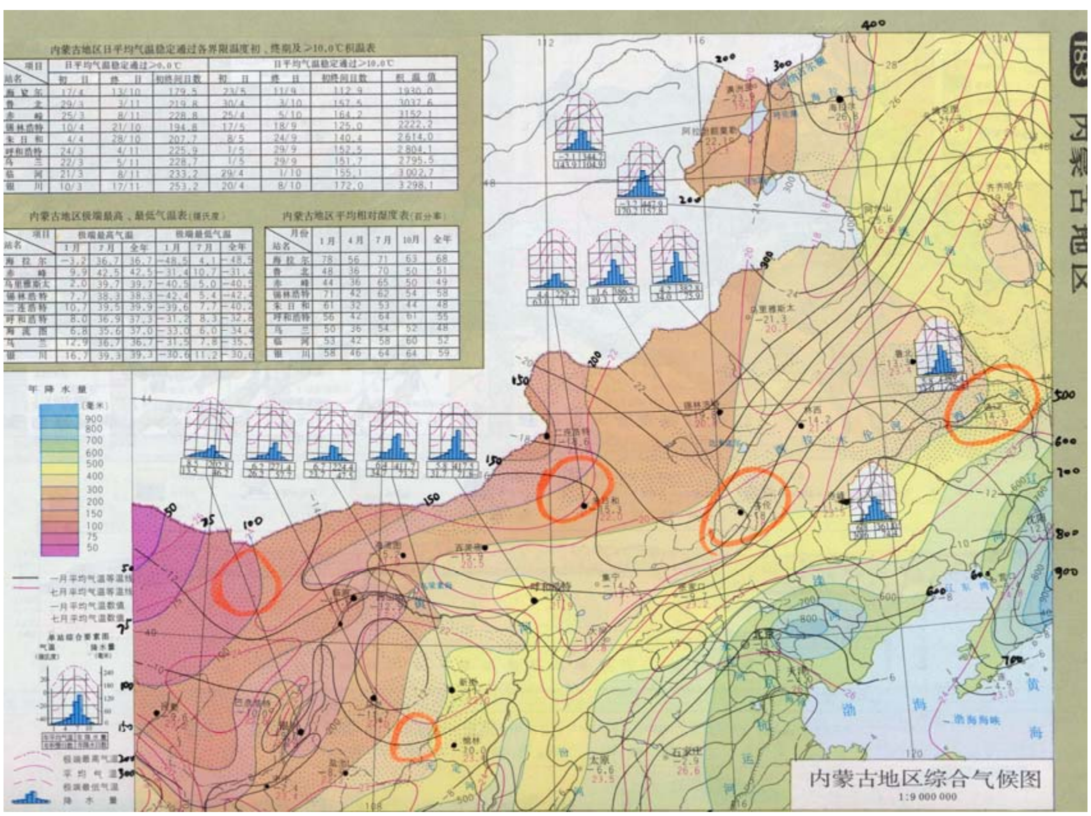
Region	1970's	1980's	1990's
Whole IM region (in ha)		30,433,066	31,352,001
Alashan	7,597,000	8,456,000	12,887,004
Xilingol	_2,658,700	3,069,087	

Table A2.2 Area of Grasslands and Degraded Grasslands in Two DSS Source Regions

Focus area	1980s	1980s	1990s	1990s
	Total area of grasslands (ha)	Deteriorated area (ha)	Total area of grasslands (ha)	Deteriorated area (ha)
Alashan	17,534,933	1,561,267	16,665,133	3,651,933
Xilingol	2,054,400	971,133	1,995,400	1,925,133

The four focus areas and one cross-border focus area in the PRC are located along an West-East transect. All are grasslands but the plant communities they support are different in structure and plant associations.

Figure A.1.2 Rainfall Distribution at the Designated Focus Areas in Inner Mongolia Autonomous Region, PRC

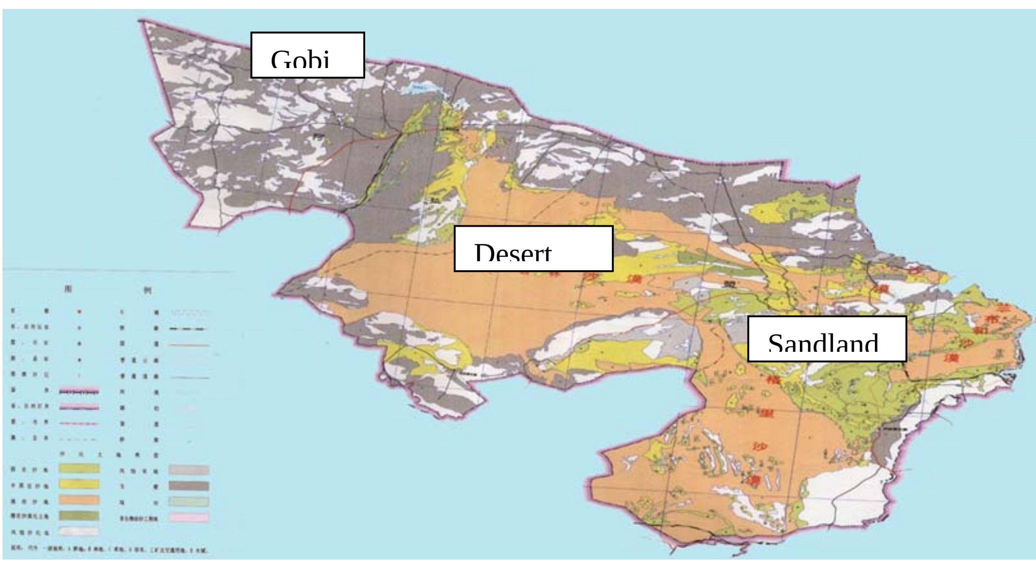


A. Alashan

The Alashan extends from the Tibetan Plateau northward into Mongolia's Gobi Desert. Its basin and range topography creates an arid climate. Yet increased rainfall in the mountain areas turns the desert green for a short time in the summer and shrub vegetation is found in many areas.

The Alashan Plateau is a region of low mountains separated by intermontane basins. Ridges attain elevations of 2,000 to 2,500 m while the basins tend to lie at 1,000 to 1,500 m. The whole ecoregion is enclosed by the Helan Mountains to the East and the Qilian Mountains and the northeastern part of the Tibetan Plateau to the southwest. Northward, the plateau extends into southern Mongolia where it constitutes a large portion of the cold, dry Gobi Desert. It is bounded on the north by the Altai Mountains that separate the desert from grassland and forest ecosystems that are transitional to the Siberian taiga. Because the region is enclosed by mountains and lies a great distance from the sea, conditions here are arid. However, numerous oases, fed by mountain snowmelt, occur along the southern flank of the Qilian Range.

Figure A.1.3 Principal Features of Alashan Showing Distribution of Sandy Land, Desert and Gobi



The driest parts of the Alashan Plateau consist of shifting sand in the south and denuded, stony landscapes in the north. For example, more than 80 percent of the Badain Jaran Desert in the western part of the Alashan Plateau, an area of 33,000 km^2, consists of shifting sand blown into dunes 200 to 300 m high.

The climate of the Alashan Plateau is severe with large seasonal and diurnal temperature variations. Annual precipitation ranges rarely exceeds 150 mm per year, and it is both spatially and temporally variable. In the drier areas of the Gobi Desert in southern Mongolia, several years may pass with no measurable precipitation, or enough rain may fall in one summer to create a green flush of vegetation and fill hundreds of ephemeral ponds with fresh water.

Table A2.3 Key Facts: Physical and Environmental Attributes of Alashan Focus Area

Alashan	Latitude 37°21'~42°47' Longitude 97°10' ~ 106°52', elevation 900~1400 m
	Climate: Arid-hyper-arid area, mean annual temperature 6.8-8.5^{o} Minimum temperature –36.4 ^{o} Maximum temperature 41.7^{o} Precipitation: 130-165 mm, Frost free days 40-120, potential evaporation 4200 mm, dusty days 70/year

A few rivers, such as the Dong He and Xi He, traverse the Alashan Plateau, and the Elbow Plains of the Huang He (Yellow River) lie near its eastern edge. Typical vegetation here consists of riparian forests dominated by poplar (*Populus diversifolia*) where the water is fresh and *Tamarix* spp. where the water is brackish. Low-lying depressions in the western part support meadows and flooded reed beds of *Phragmites communis*.

Arid locations that are more stable acquire communities of the salt-tolerant, xerophytic shrub species, saxaul (*Haloxylon ammodendron*) and *Reaumuria soongolica*. Once sand dunes become stabilized with sufficient cover of shrubs like these, they cease to shift and soil development can occur, albeit slowly, enabling a more diverse assemblage of plant species to colonize the site. Other places that are slightly less arid support semi-desert shrub communities, comprised of wormwoods (*Artemisia salsoloides, A. ordosica*), beancaper (*Zygophyllum xanthoxylum*), and *Calligonum mongolicum*.

The southern margin of the plateau lies at the foot of the Qilian Mountains. Streams that flow from the mountains seep underground when they reach the unconsolidated alluvial soils at the foot of the mountains, then emerge again near the valley floor in a "green necklace" of desert oases.

Human population is increasing due to government-initiated translocation programs that are underway. These programs are accompanied by efforts to convert "empty desert" to irrigated agricultural land. In most well-watered sites, irrigated agriculture is very productive.

B. Ordos Plateau Steppe

The Ordos Plateau lies within the Great Bend of the PRC's Yellow River, also known as Huang He. High, shifting sand dunes to the north give way to sparse scrub vegetation and forest thickets at the river margins.

This ecoregion lies at roughly the same latitude as Washington, D.C., but its temperatures are much colder. Average January temperatures range from 9 to 14° F (-13 to -10° C). Unprotected by surrounding mountains, the region is blasted with cold winds from the north and west.

Table A2.4 Key Facts: Physical and Environmental Attributes of Ordos Focus Areas

Ordos	Latitude 37°27'~39°22' Longitude 107° ~ 111°, elevation 1400~1700 m
	Climate: Semiarid area, mean annual temperature 5.3-5.7^{o} precipitation 190-300 mm, Frost free days 120-140, potential evaporation 2200-3000 mm, dusty days 11-18/year

Vegetation varies across the region. Parts of the region have supported centuries of farming, so irrigated fields cover places once filled by native forests and scrub vegetation. Elsewhere, desert plants cling to life on the sand dunes.

C. Xilingol

The climate here is continental. Summers are warm to hot, depending on elevation, and winters are intensely cold. Winter conditions are harsher here than other parts of the PRC at similar altitude and latitude because there are no mountains to shelter the region from cold northerly winds. The mean annual temperature varies from -2 to -6^{o}C, with January mean temperatures of -20 to -28^{o}C. Annual precipitation here is about 100 to 150 mm, although total precipitation varies considerably from one year to the next. Most of this precipitation falls during summer.

Table A2.5 Key Facts: Physical and Environmental Attributes of Xilingol

Xilingol	Latitude 41°46'~43°02' Longitude 113° ~ 116°, elevation 1400~1200 m
	Climate: Dry subhumid area, mean annual temperature 1.6^{o} Minimum temperature –42.3 Maximum temperature 38.3 Precipitation: 350-380 mm, Frost free days 110-120, potential evaporation 2300 mm, dusty days 7-15/year

Vegetation tends to be homogenous across vast areas of the Eastern Gobi Desert Steppe and distinct from the vegetation of grasslands to the east and deserts to the west. It consists of drought-adapted shrubs and thinly distributed low grasses. Dominant shrubs include two Caragana species (*C. bungei* and *C. leucocephala*). This shrubby legume is also dominant over much of the Tibetan Plateau in the transitional area between the cold, moist grasslands of the east and the cold deserts of the western plateau. Other shrubs include gray sparrow's saltwort (*Salsola passerina*), gray sagebrush (*Artemisia xerophytics*), *Potaninia mongolica,* and *Nitraria sibirica*. Low grasses include needle grass (*Stipa gobica* and *S. glareosa*) and bridlegrass (*Cleistogenes soongorica*).

D. Hulunbuir

This area consists of nearly flat or rolling grasslands. Average elevation throughout is 1,000 to 1,300 m. The Hulunbuir grassland is part of the most important grassland area and livestock production area in the PRC. There are about 250,557km^2 land area and 11.27 million km^2 area of natural grassland, which take up the 25% of total land and 14.9% of total natural grassland in Inner Mongolia respectively. The borderline is 1685 km long, Russia is in the north and northwest, and Mongolia is in the west and southwest.

The climate is temperate. January mean temperatures are -25^{o}C or less, decreasing westward. Annual precipitation, concentrated during a weak summer monsoon, decreases from an average of 300 to 350 mm in the east to 150 to 200 mm in the west. Because of the "continental monsoon effect" created by winter season low pressure over the South China Sea, cold air is sucked southeast from the high latitude regions of Central Asia, creating much colder winter temperatures than occur at other regions of similar latitude. (equivalent to Nova Scotia, Canada).

Table A2.6 Key Facts: Physical and Environmental Attributes of Hulunbuir

Hulunbuir	Latitude 47°20'~49°50' Longitude 117° ~ 121°, elevation 550~1000 m
	Climate: Dry sub-humid area, mean annual temperature –5-2^{o} maximum temperature 42, minimum temperature -50.2, precipitation 150-350 mm, Frost free days 115-124, potential evaporation 2000 mm, dusty days 32-38/year

Human and livestock population has increased sharply over the past decades. So too, has the area of land under cultivation.. The total grain production in 1998 reached 1.75 billion kg grain produced from all 1.26 million crop farming land. Total production value is RMB Yuan 2.42 billion. There is also the biggest area for agricultural machines using in Mongolia, where the total power is 1.36 billion KW with the total 67.3 thousand sets of tractor and total 1651 sets of transportation auto for farming using.

The degenerated area is expanding gradually. It was limited in the sides of river and around the water points in the past, but is now expanding. So far the area of sandy grassland is 0.557 million km^2. In the past 50 years, the farmer population has almost doubled in the focus area,. The herders face a limited natural grassland resource as more and more of the better (more productive) grassland is converted to cropping.. As a result the area of utilizable natural grassland become smaller and smaller. The imbalance between animal feed demand and grassland forage supply become worse and worse.

E. Erinhot Focus Area

The Erinhot focus area is within the Eastern Gobi Desert Steppe extends from the Inner Mongolian Plateau situated at 1,000 to 1,500 m elevation, northward into Mongolia. Beyond the mountains that lie inland from the PRC's coastal plain, semi-arid steppe gives way to the Central Asian deserts, called *gobis*. Here the driest places support desert wildlife, but few people. The peripheral steppe regions, however, receive a flush of grass during summer that allows the areas to be inhabited, if sparsely, by herders whose goats and horses feed on the region's meager productivity. Nowadays there is an urban center supported by water piped from mountains 60 km away.

It is a broad ecotone. Boundaries are determined to the east and north by the relatively moist grasslands of Mongolia and Manchuria, and to the west and south by the extensive semi-deserts of the Alashan Plateau. Traditionally it supported a sparse human population of semi-nomadic herders.

The climate here is continental. Summers are warm to hot, depending on elevation, and winters are intensely cold. Winter conditions are harsher here than other parts of the PRC at similar altitude and latitude because there are no mountains to shelter the region from cold northerly winds. The mean annual temperature varies from -2 to -6^{o}C, with January mean temperatures of -20 to -28^{o}C. Annual precipitation here is about 100 to 150 mm, although total precipitation varies considerably from one year to the next.

Most of this precipitation falls during summer.

Table A2.7 Key Facts: Physical and Environmental Attributes of Erinhot

Erinhot	Latitude 42.°57'~43°47' Longitude 111°20' ~ 112°26', elevation 890~1020 m
	Climate: Semiarid area, mean annual temperature -2 -6^o Minimum temperature –40.2 Maximum temperature 39.9^o Precipitation: 146 mm Frost free days 125-135 potential evaporation 2680 mm, dusty days >25/year

See the description for Zamiid Uud Focus Area (across the border from Erinhot) in Appendix 3 Mongolian Focus Areas.

Vegetation tends to be homogenous across vast areas of the Eastern Gobi Desert Steppe and distinct from the vegetation of grasslands to the east and deserts to the west. It consists of drought-adapted shrubs and thinly distributed low grasses. Dominant shrubs include two Caragana species (*C. bungei* and *C. leucocephala*). This shrubby legume is also dominant over much of the Tibetan Plateau in the transitional area between the cold, moist grasslands of the east and the cold deserts of the western plateau. Other shrubs include gray sparrow's saltwort (*Salsola passerina*), gray sagebrush (*Artemisia xerophytics*), *Potaninia mongolica,* and *Nitraria sibirica*. Low grasses include needle grass (*Stipa gobica* and *S. glareosa*) and bridlegrass (*Cleistogenes soongorica*).

APPENDIX 3

SOCIO-ECONOMIC ANALYSES FOR FOUR FOCUS AREAS IN THE PRC[1]

1. Socio-economic Baseline for Four Focus Areas for Demonstration Projects

The four focus areas lie along a line that stretches from east to west within Inner Mongolia Autonomous Region. The total area is 812,600 km^2 with a population of 5,133,600 which accounts for 21.6% of Inner Mongolia's total (Table A3.1). These areas belong to typical agro-pastoral transitional zones. Agricultural production is operating under difficulty and drought-prone climatic conditions, which can easily result in severe land degradation.

Table A3.1 Basic Data of the Four Focus Areas in the PRC, 2002

Items	Hulunbir	Xilingol	Ordos	Alashan	Sub-total	(%)
Total Population (10000 persons)	267.65	93.31	134.42	17.98	513.36	21.6
Total Area (10000 km^2)	25.30	20.26	8.68	27.04	81.26	69.0

Note: % refers to proportion to total province.
Source: Inner Mongolia Yearbook, 2003

Inner Mongolia Autonomous Region as a whole is one of most under-developed western region in the PRC. The four selected demonstration areas all have depressed economy aside from Ordos that possesses several strong enterprise groups. Inner Mongolia ranks low in economic status. Although the counties/banners of four sites account for 69% of whole autonomous region, they just yield 29% GDP of Inner Mongolia Autonomous Region of 2002. Primary industry still contributes a high proportion of the GDP compared the to average for the PRC. as whole. For instance, the primary industry of Hulunbir account for 24% of the GDP of 2002, Xilingol account for 28%, comparing to 15% for the PRC. Detailed information is presented in Table A3.2. This indicates that agricultural productivity of four focus areas is very low and agricultural production is based on extensive cultivation of marginal cropland. Therefore land abuses and land degradation are unavoidable.

Table A3.2 GDP Indicators for Three Sectors within the Project Areas, 2002

Monetary Unit: RMB 100 million

	GDP	Primary Industry		Secondary Industry		Tertiary Industry	
		Value	%	Value	%	Value	%
Hulunbir	190.3	45.11	23.7	54.79	28.8	90.45	47.5
Xilingol	81.91	23.15	28.3	32.48	39.7	26.27	32.1
Ordos	204.77	28.11	13.7	119.34	58.3	57.31	28.0
Alashan	29.56	4.19	14.2	13.36	45.2	12.02	40.7
China	104,790.60	16,117.30	15.4	53,540.70	51.1	35,132.60	33.5

Source: Inner Mongolia Yearbook, 2003 Note: % refers to proportion to GDP

[1] Prepared by Dr He Kaili

Farming and animal husbandry contributes most to the agricultural economy. For instance, the farming proportion of Hulunbir reached 63.4% in 2002 and animal husbandry proportion of Xilingol reached 66.3%, over half of total commercial value of agriculture (Table A3.3). Therefore, large areas of cultivated land and large herds of livestock were needed to support this high proportion value of farming and animal husbandry.

Table A3.3 Commercial Value of Agriculture (by sector), 2002

Monetary Unit: RMB 10000

	Total	Farming		Forestry		Animal husbandry		Fishery	
	Value	Value	%	Value	%	Value	%	Value	%
Hulunbir	812,392.9	514,672.0	63.4	36,046.9	4.4	244,877.8	30.1	16,796.2	2.1
Xilingol	339,740.2	104,983.1	30.9	8,851.8	2.6	225,405.3	66.3	500.0	0.1
Ordos	432,581.6	207,527.7	48.0	29,679.3	6.9	191,246.9	44.2	4,127.7	1.0
Alashan	65,161.9	33,443.0	51.3	3,834.5	5.9	27,350.8	42.0	533.6	0.8

Source: Inner Mongolia Yearbook, 2003

The statistical data also show that the cultivated land area and animal heads increased greatly over the past 20 years. For example, there are 647,600 ha of cultivated land in Hulunbir of 1990, but in 2002 it was 1,220,800 ha (1.87 times greater than in 1990). In Xilingol, animal number is just 4,498.400 heads in 1978, but there were 9,598,000 heads in 2002 and three sectors (2.13 times higher than in1978), meanwhile, the number of sheep and goats increased nearly 300% since1978. The continuous increase of cultivated land and number of animals no doubt contributed to overgrazing and land degradation. Over the past ten years, although net income of farmers and herdsmen in the four focus areas has enhanced greatly, most of them still live a hard life. Average net income of these people is just close to or lower than the level of whole country (Table A3.4). For instance, although the average annual growth rate of the net income of Xilingol reached 6%, net income per capita was only 1,940 yuan in 2002, a lot lower than 2,476 yuan/capita for the whole country. The poverty population can be found mostly in this area. In 2002, there were 74,348 people, or 8% of the total population, who live under the state-defined absolute poverty line of RMB 625 in Xilingol. In addition to the absolute poor, approximately 292,894 people classified as low-income population accounts for 31% of the total population of Xilingol (Table A3.5).

Table A3.4: Net Income Profile in Four Focus Areas

Monetary Unit: Yuan

	1990	1995	1999	2001	2002	%
Hulunbir	715.00	1468.00	2037.00	1934.53	2278.04	9
Xilingol	861.00	1536.00	2383.00	1867.68	1940.32	6
Ordos	600.00	1251.00	2371.00	2257.59	2469.92	11
Alashan	921.00	1504.00	2284.00	2514.05	2664.00	9
PRC	686.31	1577.74	2210.34	2366.40	2475.63	10

Source: Inner Mongolia yearbook, 2003; China Yearbook, 2003

Note: Net income refers to that of farmers and herdsman

Note: % refers to average annual growth rate of net income from 1990-2002

Table A3.5: Poverty Profile of Four Focus Areas , 2002

	Poverty population under state-defined poverty standards (in 10,000 persons)		
	Absolute poor with average net income < 625 yuan	Low-income with average net income = 625-865 yuan	Total population with average net income < 865 yuan
Xilingol	7.4348	10.9273	18.3621

Above all, the project area is the source region locating at the under-developed western part of the PRC. Rural people live under difficult natural conditions that make them vulnerable to recurring drought. The depressed economy makes it difficult for local government to find a lot of money to solve the eco-environment problem. However, local authorities have already been aware of the importance of environment and economy sustainable development, and try their best to eradicate the harmful impacts brought by desertification. The key question is how to adopt a coordinated, integrated and balanced approach to realize socio-economy sustainable development.

2. Socio-economic Analyses About the Causes of DSS Occurrence

Generally speaking, there are two factors about the causes of DSS occurrence: one is change of nature (natural causes), the other is human activities (socio-economic causes). These two factors interweave and make the frequency and intensity of DSS become more much and strong. The later is the direct cause of DSS occurrence in recent years. Our selected focus areas show the same reasons for their present status as DSS source areas.

2.1 Demography Factors

Local people are not only the custodians of resources but also the destroyers. Rapid growth of population in project areas has been exerting enormous pressure on the carrying capacity of grassland and leading to the grassland degradation. Table A3.6, shows that the number of people in four focus areas has quadrupled since the age of 1950s. Annual average growth rate reached 4%, compared to 2% for the PRC as a whole.

With the rapid growth of population over the past 20 years, the demand for cultivated land increases continuously (Table A3. 7). For instance, from 1950-2002, the arable land area of Hulunbir has increased from 1,472,000 hectares to 12,080,000 ha (a 7-fold increase). This increase was achieved by converting grassland mostly, at the expense of the ecological environment. Instead, the arable land of per capita declined a little with the great volume of population. It is said that 70% of the expansion of the area of cultivated land in the western part of the PRC in the period 1995-2000 came through reclamation of grassland. Furthermore, most of the reclaimed area was abandoned after 2-3 years, and eventually become degraded land[2]. Grassland conversion and denudation went hand in hand.

[2] There were several episodes of major land reclamation, notably during the Great Leap Forward and in the 1970s

Table A3.6 Population Profile for Four Focus areas

Unit: 10000 persons

	Hulunbir		Xilingol		Ordos		Alashan	
	Total	Rural residents	Total	Rural residents	Total	Rural residents	Total	Rural residents
1950	30.86	17.80	21.58	17.88	42.77	41.94	--	--
1960	119.95	48.32	50.34	31.93	66.11	61.20	--	--
1970	135.49	56.05	59.14	45.05	84.16	77.75	--	--
1980	225.48	103.75	76.40	51.83	103.46	91.07	13.97	7.55
1990	257.54	110.24	88.91	57.98	120.4	98.40	16.05	7.24
1997	271.87	111.06	91.98	58.18	126.58	94.52	17.05	7.08
2002	267.65	100.59	93.31		134.42		17.98	
Growth-rate (%)	4	3	3	2	2	2	--	--

Source: Inner Mongolia Yearbook, 2003 Note: rural residents include farmers and herdsman

Table A3.7 Cultivated Land Profile for Four Focus areas

Unit: 10000 hectares, mu/person

	Hulunbir		Xilingol		Ordos		Alashan	
	Arable land[1]	Per capita[2]	Arable land	Per capita	Arable land	Per capita	Arable land	Per capita
1950	14.72	7.15	16.30	11.33	64.67	22.68		
1960	30.21	3.78	30.71	9.15	66.83	15.16		
1970	30.61	3.39	21.67	5.50	45.95	8.19		
1980	60.57	4.03	25.41	4.99	24.40	3.54	1.05	1.13
1990	64.76	3.77	19.74	3.33	22.64	2.82	1.12	1.05
1997	133.10	7.34	30.60	4.99	37.10	4.40	1.60	1.41
2002	120.8	6.77	20.00	3.22	41.50	4.63	2.33	1.94

Notes: 1 = Arable land x 10,000 ha 2 = Mu per capita
Source: Inner Mongolia Yearbook, 1991,1998,2003; Prosperity of Inner Mongolia (1947-1999)

At the same time, population growth promotes the increase of livestock (Table 2.8). Rapid growth of livestock contributes to the grassland desertification. For example, in Xilingol, the largest grassland of the PRC the degraded grassland area increased from 1.44 billion Mu in 1985 to 1.92 billion Mu by 1999 with the sheep and goats increasing from 5,073,700 to 10,527,000. In Hulunbir, the degraded grassland area increased from 5,577,000 ha in 1994 to 8,763,000 ha in 1999 with sheep and goats increasing from 1,962,671 to 2,781,488, (6% annual average growth rate. In the early stages of national establishment the ratio of livestock to land was 11.1 ha/sheep but by 1980 this had narrowed to only 2.7 hectares (25% of 11.1/ ha). In other words, the stocking rate per ha of grassland increased from 0.09 head/hectare to 0.37 head/hectare in this period (a 3-fold increase).

Table A3.8 Sheep and Goats Profile for Xilingol and Hulunbuir

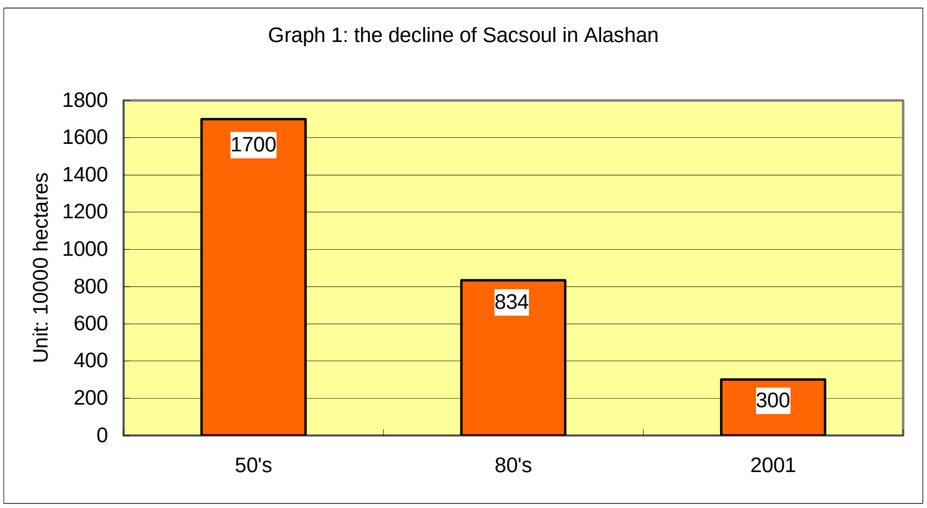
Unit: Heads

	1978	1985	1990	1994	1999	2002	%
Xilingol	3476100	5073700	6816800	7542000	10527000	8994000	5
Hulunbir			1570197	1962671	2781488	3873400	6

Note: % refers to average growth rate from 1985 to 1999 for Xilingol and from 1994 to 1999 for Hulunbir.
Source: Inner Mongolia yearbook, 2003

2.2 Livelihood Factors

Farmers and herdsman live in the economically backward area where transportation and other infrastructure is poorly developed. It is difficult for them to connect with outsiders for trade and commerce. Goods they need couldn't reach there because of high cost or bad roads. The fuel for daily life is the commodity in shortest supply. To cook their food, they cannot help but cut shrubs growing over the sandland. This has serious implications for sand fixation. Sacsoul (*Haloxylon* spp) is one of the most wonderful shrubs protecting sandland in Alashan . But by 2001 just 3,000,000 ha in 2001, less than 18% of the 17,000,000 ha ofin the 1950s last century (graph 1). It is said each rural household consumes 10,000 kg of firewood each year (equal to fifty Mu of 40 year-old Sacsoul).



In addition, local people also cut wild forest on the Helan Mountain for fuel. Two-third of tree cover was destroyed and soil erosion was a big problem. The Alashan deserts are expanding to the southeast at a rate of 1000 km^2 every year. One-fourth of herdsmen have become ecological refugees.

2.3 Household Structure Factors

There is economic development and conditions are changing. But it will not be sustainable unless the two factors (environment and economy) change at nearly the same pace. Considering the four focus areas, it could be concluded that attention to the environmental factors has lagged behind. (Table A3.9).

Taking Xilingol as example, the structure of GDP has changed between 1978 to 2002 with the contribution of primary industry declining but the structure for demography changed little from 1978 to 2002. This indicates that large numbers of surplus agricultural labors have been remained in rural areas. There being no adequate off-farm employment opportunities they could just live on farming and animal husbandry and develop extensive production through over-cropping and overgrazing. This is the evidence seen from the severe desertification and land degradation.

Table A3.9 Structure for Demography and GDP

Unit: %

	Structure for GDP			Structure for Demography		
	Primary	Secondary	Tertiary	Primary	Secondary	Tertiary
Hulunbir						
1978						
2002	23.7	28.8	47.5	43.7	23.5	32.7
Xilingol						
1978						
2002	28.3	39.7	32.1	15.8	19.9	64.3
Ordos						
1978						
2002	13.7	58.3	28.0	61.0	15.5	23.5
Alashan						
1978						
2002	14.2	45.2	40.7	42.7	20.4	36.9

Source: Inner Mongolia yearbook, 2003

All in all, the demography element is at the center of the DSS problem. How to deal with the great number of surplus farmers and herdsman is the key element for our DSS protection and control.

3. Polices and Institutions Adopted by State and Local Authorities and their Impacts on Local Economy

Protection and control of DSS occurrence is not only a technological point, but is also concerned with administrative and policy decisions made by state and local authorities. In the four focus areas, agricultural and animal husbandry policies often conflict or negate one another or are too narrowly-focused. This is a root cause of land degradation and desertification, which leads in turn to the enormous damage cost of DSS.

3.1 Food Self-sufficiency Policies Result in Over-cropping

Taking Xilingol league as an example, over the past fifty years, there were four times great reclamations in this area under the national policy of " Food self-sufficiency". The first of these started in the 1950s at the early stage of establishment of the PRC. At this time, a big immigration occurred in this area. For the sake of livelihood, local governments encouraged land reclamations and subsidized the cultivators, bringing about enormous growth in the area of cultivated land. Cultivated land had increased 640 thousand Mu within one year of 1952 in Xilingol league, an increase of 124% over the previous year. The second was in the period of 1958-1961 ("the Great Leap Forward"). To achieve high agricultural production, large areas of grassland was converted into cropland. The cultivated land increased 2,160,000 Mu in 1960, (a 157% increase over the previous year. The third time occurred in 1966-1976 (period of "Cultural Revolution"). Under the direction of the government herdsmen must eat food produced by themselves, so an additional 800,000 Mu of grassland changed into cultivated land at this time. After the reforming and opening to the world of the PRC, the fourth period of large-scale reclamation occurred in this area. Large areas of grassland became industrial land to support the growing need for economic development..

This policy of food self-sufficiency gave birth to serious land abuse in the agro-pastoral belt of northern PRC. This policy resulted in large areas of grassland degradation with a shortage of grassland custodians in this agro-pastoral area. For instance, analysis of satellite imagery shows that 2,350,000 Mu, out of a total of 4,470,000 Mu cultivated land in Xilingol of 1999 (satellite picture) had become desertified.

3.2 "Animal Heads" Policy Leading to Overgrazing

Animal husbandry policies based simply on "animal heads" have led to overgrazing. Taking the number of animals as the only statistical attribute and planning indicator is an easy guideline for local government. Furthermore, the achievement of local officials was always mainly judged by their success in increasing of "animal heads", and not judged by net income of herdsmen or ecological status of the grassland. Although 《Grassland Law, 1998 revised 2002》 stipulates that the number of animal must be determined by production capacity of grassland, the fact that the livestock husbandry tax was based on the number of animal weakened the power of law. Rarely did local officials ban grazing or seek to curb the growth in herd size. Therefore, the local government just only concentrates their minds and energy on the animal husbandry tax and did not take carrying capacity of grassland into account. So the number of animals has exceeded carrying capacity of grassland for a long time.

3.3 Incomplete Property Right Reforms Bringing about 'Tragedy of the Commons"

After reforming and opening to outside world, the pasturing area was also reformed. The institution of property rights to grassland and livestock was enshrined in law. Grassland and livestock both were contracted to herdsmen on the basis of household structure. This was called "double contracts of livestock and grassland" which is propitious to mobilizing enthusiasm of herdsman to managing grassland and enhancing its production efficiency. But the actual fact is that livestock has been contracted with herdsman in the middle of 80's and grassland had not been contracted with herdsman until 1997~1999. The formalization of grassland contract lagging behind livestock led to enormous increases of animal number within ten years from 1989-1999. Being short of owner of grassland, there is no somebody to administer it, and became an example of the "Tragedy of the commons". This failure to formalize property right reforms resulted in pillaging of grassland.

3.4 Absence of a Mechanism for the Supervision and Management of Grassland

Grassland station under the control of the Bureau of Animal Husbandry is the sole agency managing grasslands. Due to the small outlay for grassland construction and administration and the policy referring to "animal heads", the station paid little attention to grassland management and supervision. Furthermore the Grassland Law is difficult to implement, so the power of grassland station is weakened.

What is more, some herdsman with large area of grassland and quite a few livestock rent more grassland after contracts are in place. Lessor and leaseholder both ignore the grassland condition. Overgrazing is unavoidable and contracting policies haven't achieved a lot.

3.5 Overlapping and Fragmented Institutional Mandates

Government agencies such as agriculture, forestry and animal husbandry each functions in a different area. The Agricultural agency plays an important role in husbandry and grassland and the forestry agency mainly is responsible afforestation and desertification control. The dividing of government function endows each agency with a different set of powers. They function within their mandate without any communication and coordination with others. This means that policies often bring about the fragmentation of institutional mandates. For example, in the recent backbone project of returning farmland to forest and grassland (Green for Grain), the forestry agency is responsible for the use of the money, the quota of returning area and the standard of subsidy quite independent of the other government agencies. The forestry agency does not manage the grassland so Grassland management was neglected in this backbone project. There are many examples like this that undermine the national effort to prevent and control DSS.

To sum up, institutional factors are often the root causes of DSS occurrence. Many institutional and policy barriers that have been found to exist in the agro-pastoral zone that have contributed to land degradation and desertification. For the sake of long-term sustainable development, it will be indispensable to take the policy-making into consideration.

APPENDIX 4

BIO-PHYSICAL PROFILE OF FOCUS AREAS IN MONGOLIA

1. Ovorhangai Focus Area

Location: Longitude: 102^{0}7 ' Latitude: 46^{o}3 '

Ovorhangai is located in the western part of Mongolia at a distance of 420 km from Ulaanbaatar It is bordered by Bayanhongor aimags and and Uyang, Zuunbayanulaan, Bayangol and Guchinus soums of Ovorhangai aimag (Picture 1). The Ovorhangai site covers 11,7 00 square kilometers, of which 6 per cent is sandy and gobi desert. Total population is 26,500.

The total forested areas in site is estimated to be 20 percent of total territory. Livestock is the basic economic sector of the site. Site is rich in various natural resources of Gold, other heavy metals and construction materials.

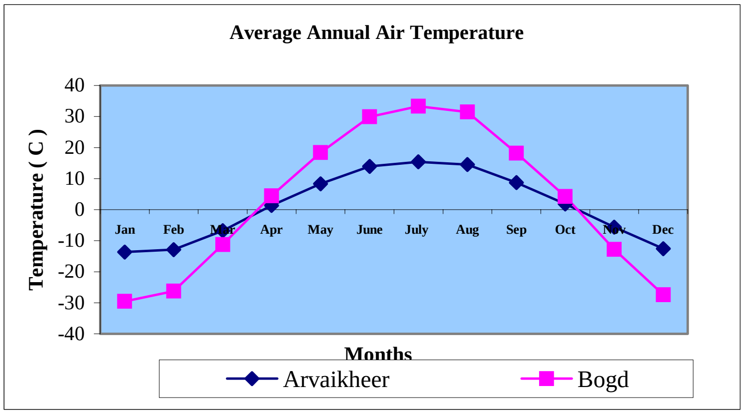
About 250 plant species are found and wildlife fauna is assembled by mountain sheep (argali), mountain goat (yangir), antelope, a residence for a number of soft fur animals, such as marmots, fox, wolf, and etc.

The main goals of the long term development of the site are to aim at self-financing and comparably independent economic status and ecologically-oriented development and provision of all needs for human development through ecologically sound livestock and mining outputs by the use of environment-friendly technologies.

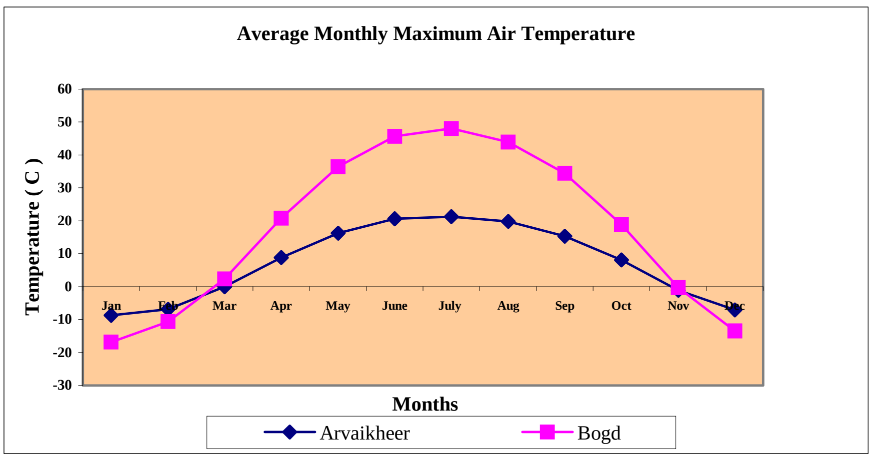
Extreme drought, livestock population growth, irrational use of water, soils and pasture over many years have resulted in sustained decline in the Ovorhangai site environment. The result has been drying and disappearance of of river Ongi, decline in underground water levels, deterioration in water quality and vegetation, loss of biodiversity, expanding desert and increased frequency of sandstorms. The sand storms in the site occurred any time during the year.

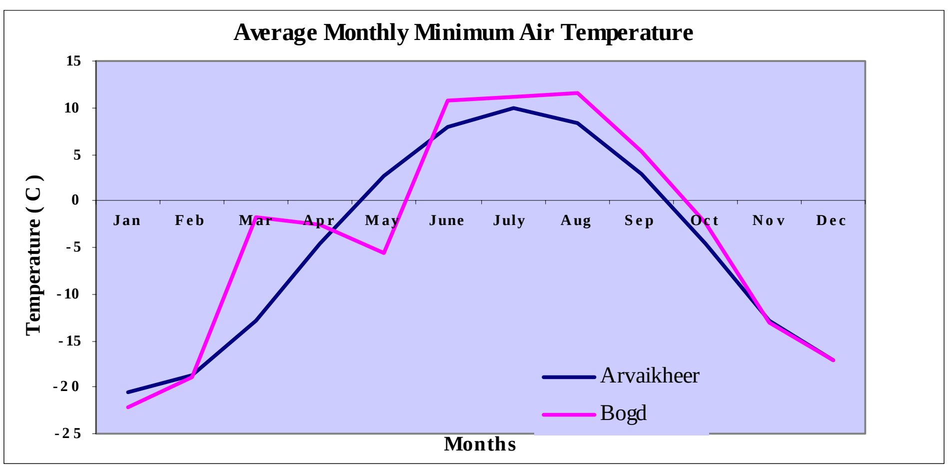
Climate:

Air Temperature:
The average air temperature in mountain areas –2.1^{0}C, steppe 1.0^{0}C and in gobi 1.7^{0}C. Lowest air temperature in January –13.7^{0}C in Arvaiheer and –15.8^{0}C Bogd but in July 15.4^{0}C in Arvaikheer and 17.9^{0}C in Bogd.

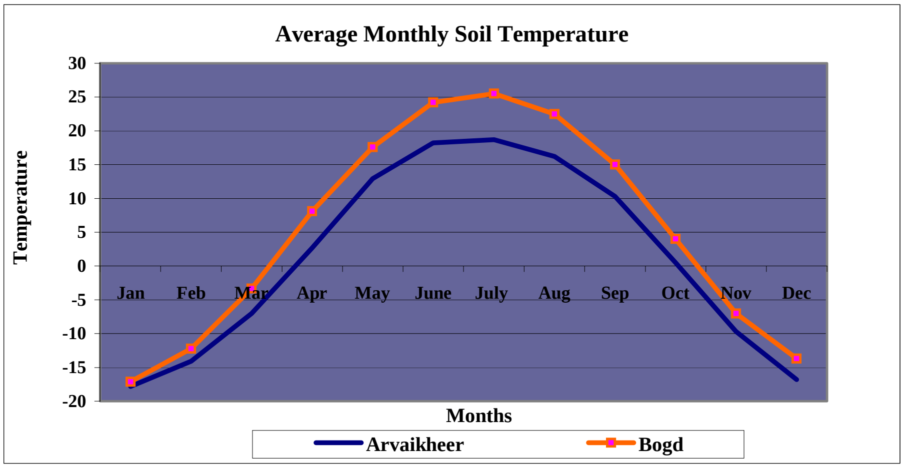


Maximum air temperatures in mountain, steppe and gobi areas are 6.3^{0}C, 7.4^{0}C and 10.3^{0}C respectively.

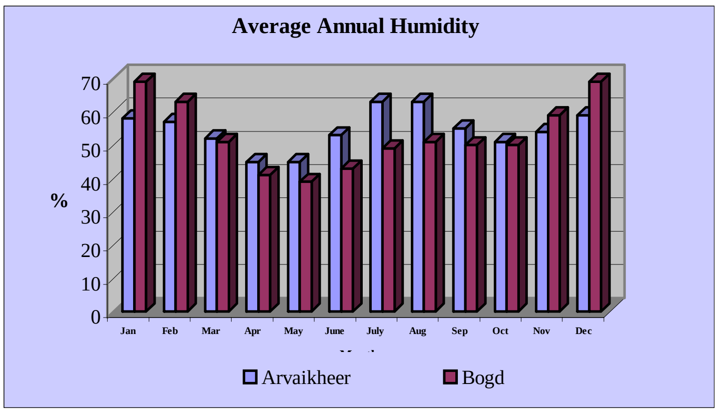




Soil Temperature:
Annual average soil temperature in mountain, steppe and gobi areas are 0.0^{0}C, 1.0^{0}C and 4.4^{0}C.

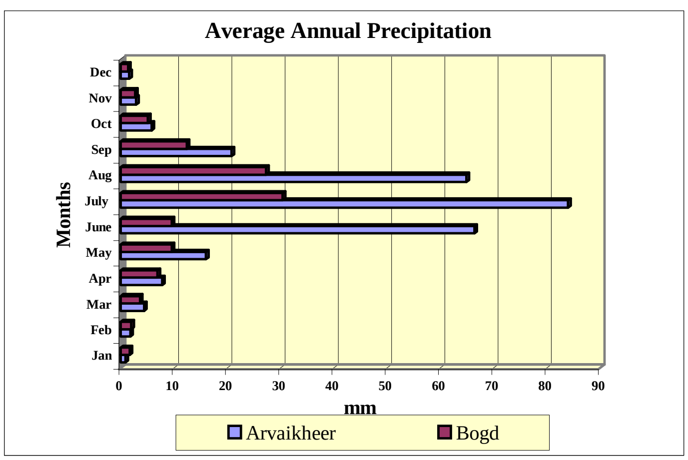


Humidity:



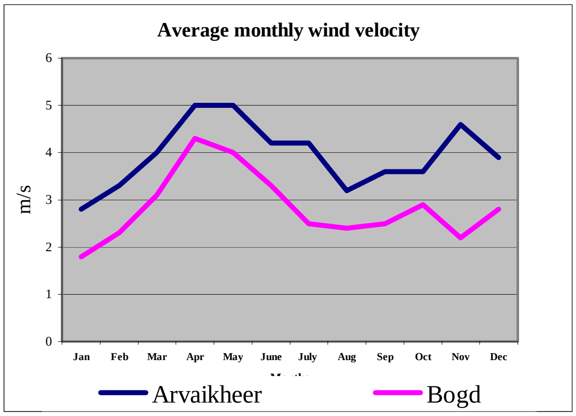
Precipitation:

Average annual precipitation in mountain areas 306.2 mm, steppe 277.3 mm and gobi areas 117.2 mm. Most of precipitation is fallen only in warm seasons like June, July and August.

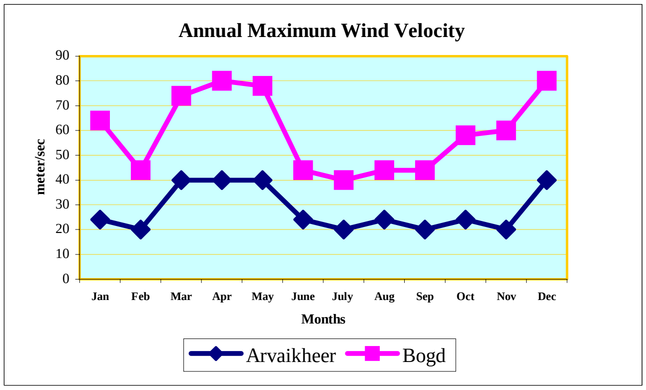


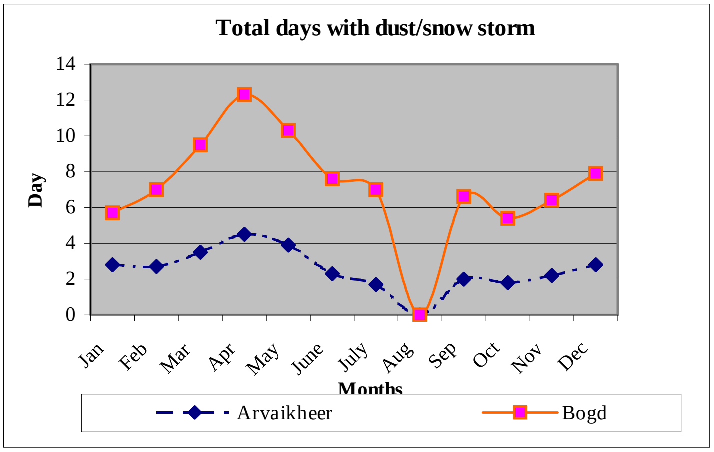
Wind:

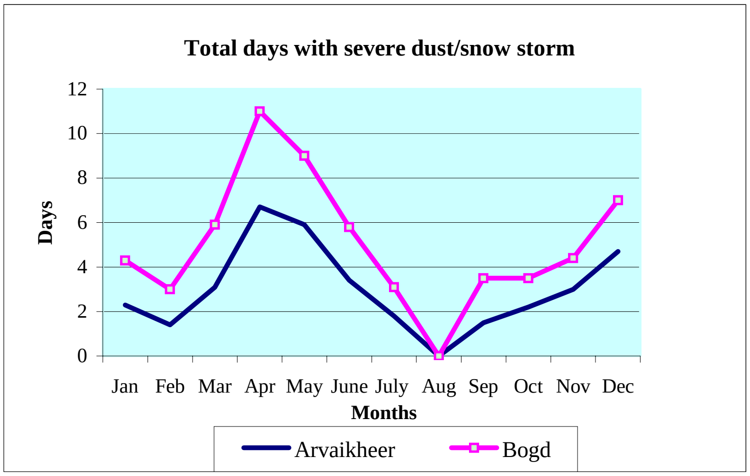
Wind velocity varies in different areas: 18 –25m/s in mountain, 20 –40m/s in steppe and gobi areas.



The highest wind velocity is observed only March, April and May with speed of 40 m/s or more than.





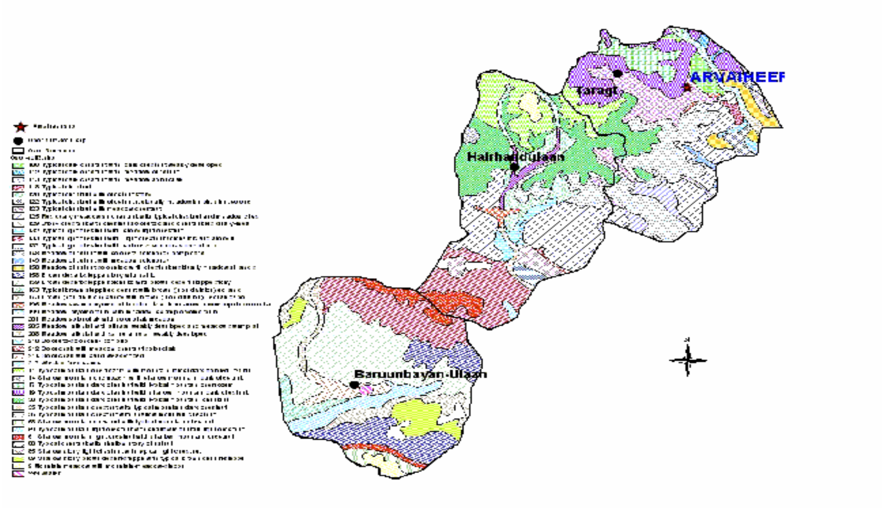


Vegetation and soil condition.

The vegetation and soil condition of Ovorkhangai site is shows in picture 10. It is a fragile area of desertified grassland, 35 percent of which is degraded.

Desert-like steppes are widely encountered to the south of regular/dry/steppes in between the isopluvial lines of 200 and 150 mm on chestnut soils. They stretch in narrow strips south of Khangai and form a transient belt between shrubby grass and desert semi-shrub/shrubby grass steppes. Main dominating species are *Stipa gobica, S. Klemenzii* in the east and S. glareoza in the west. Besides the above species the following plants are usually co dominating in typically sub zonal areas: *Artemisia frigida, Caragana stenophylla and C. pygmaea, C. lencophloea, Agropyron crystatum, and Cleistogenes squarrosa.* The cover of this dry steppe elements increases in light textured soils. Saline substrates support Central Asia types of semi-shrubs *(Salsola passerine, Anabasis brivifolia, Reamuria songorica).* Desertified semi-shrub grass steppes (or grass-type deserts) cover vast areas in the southern part of Mongolia on Northern (desert-steppe) brown soils, thus the latitudinal or sub zonal belt of desertified steppes stretches from lake Bon-Tsagan-Nur to the borderline of Mongolia taking up the entire territory of the East Gobi.

The Soil Types of Ovorkhangai Site



2. Omnogobi Demonstration Site and Proposed Activities

Location:
Longitude: 104°4' Latitude: 43° 6'

Omnogobi site is located in the southern part of Mongolia at a distance of 700 km from Ulaanbaatar It is bordered by Dornogobi and Ovorhangai aimags and Tsogttsetsii, Nomgon, KhurmenNaran and Sevrei soums of Omnogobi aimag (Picture 1). The Omnogobi site covers 40,2 00 square kilometers, of which 70 per cent is sandy and gobi desert.

It is a fragile area of desertified grassland. The total forested areas in site is estimated to be 5 percent of total territory. Biggest sand dune which is called as Moltsog els. Livestock is the basic economic sector of the site. The focus area is rich in various natural resources of coal and gold and other heavy metals.

The land is dry and soil is steppe brown, red –brown, light brown clay poor in humus. About 300 plant species are found and wildlife fauna is assembled by mountain sheep (argali), mountain goat (yangir), antelope, black tail gazelle and provides a residence for a number of soft fur animals, such as marmots, fox, wolf, hare, rabbit, lynx, and etc.

The poor development of agriculture, including vegetable gardening. The main goals of the long term development of the site are to aim at self-financing and comparably independent economic status and ecologically-oriented development and provision of all needs for human development through ecologically sound livestock and mining outputs by the use of environment-friendly technologies.

Extreme drought, livestock population growth, irrational use of water, soils and pasture over many years have resulted in sustained decline in the focus area environment. The result has been drying and disappearance of lake " Ulaan", loss of wetlands, contraction of oases, decline in underground water levels, deterioration in water quality and vegetation, loss of biodiversity, expanding desert and increased frequency of sandstorms. The sand storms in the site occurred any time during the year while severe sandstorms occurred frequently from March to May after spring thaw. The wind erosion in the site usually occurs where wind speeds are greater than 8 $ms^{-1.}$ The number of dusty days ranges from 91 t0 120 over the Omnogobi focus area. The highest occurrence of dusty days is around the Khongor Els area. Average duration of a dust storm is 4.6 hours and of driving dust is 3 hours in Dalanzadgad station.

There are increasing of areas of land degradation, decreasing of vegetation cover and drying out of lakes and rivers are clear consequences of the desertification that contributing to DSS. One of the main reason of such changes are global air moisture cycle in continental and local scale and depletion of precipitation.

Precipitation is too low and too unreliable to support efforts to revegetate the focal are without supplementary irrigation. Water is in short supply. So, the strategy there will need to rely on natural regeneration of the rangelands. Therefore, there is need to enhance the precipitation using of cloud influencing technology (cloud seeding).

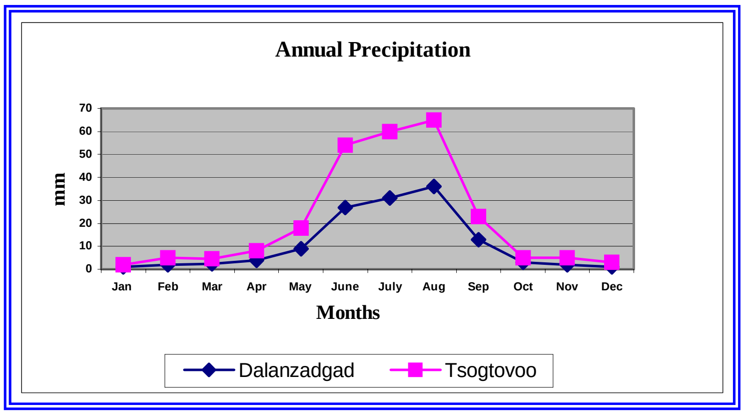
The major from of land use has always been semi-nomadic animal husbandry in the area. However, the recent increase in the number of livestock and loss of traditional grazing practice are major causes for deteriorated soil and destruction of habitat. The drastic increase in livestock numbers occurred in the beginning of 1990s, due to introduction of market economy and privatization of livestock. In addition, the traditional grazing practices, nested on a sustainable land utilization system was lost and forgotten under the planned economy system.

Further, riparian habitats heavily disturbed by human activities. They suffer the removal of bushes and small trees (mainly willow *Salix viminalis*) for fuel wood. Truckloads of fuel wood extracted and many of the forest habitats particularly around the Ongi River, is heavy grazed. It is considered that these activities are being encouraged by the privatization of livestock and elimination of fuel subsidies along with the shift from planned to market economy. Deforestation as well as overgrazing is recognized as main causes of increased desertification in the focus area.

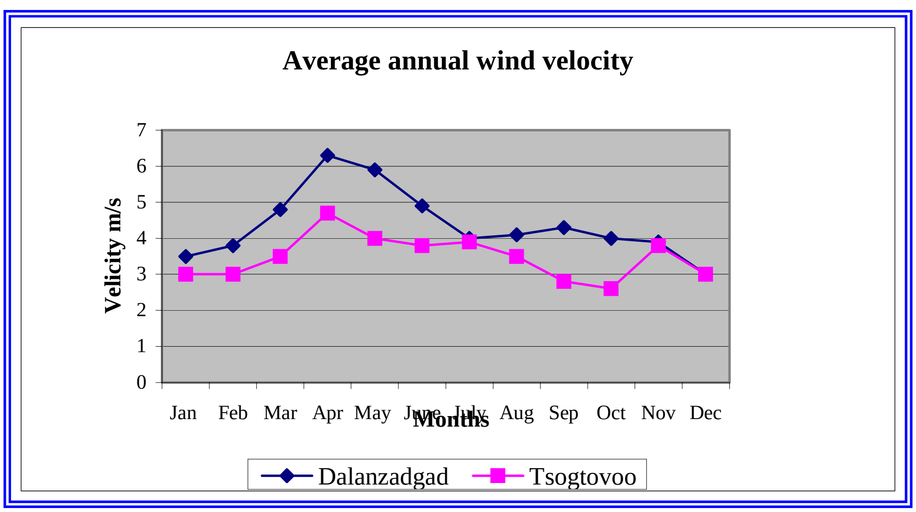
Climate

Spring:

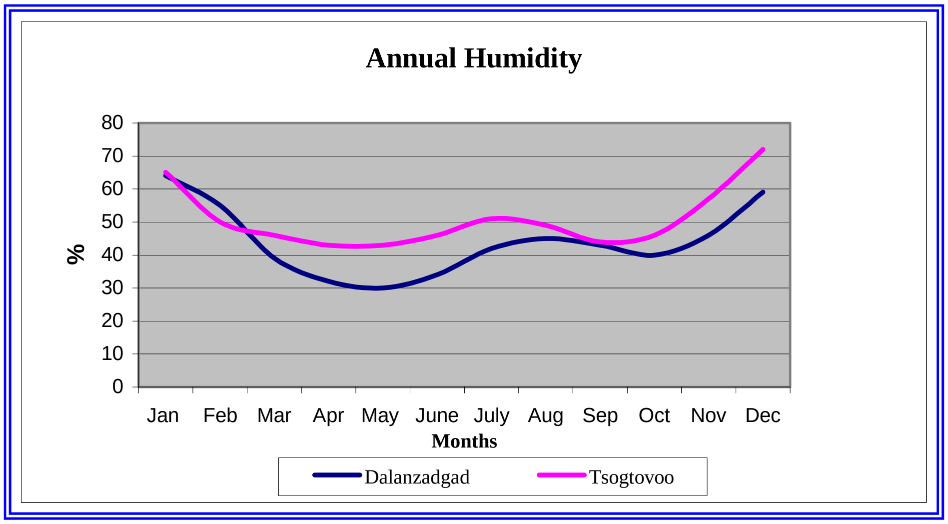
Starting from 6th- 9th March till 2nd of May with total 48-54 days. The steppe areas gets warm 10- 20 days earlier than mountain areas, but period is almost same. Air temperature is –1.2 to 7^{0}C at the beginning and increases 12.6 to 16.4^{0}C in late of spring. Maximum temperature is 32.0 – 36.0^{0}C.

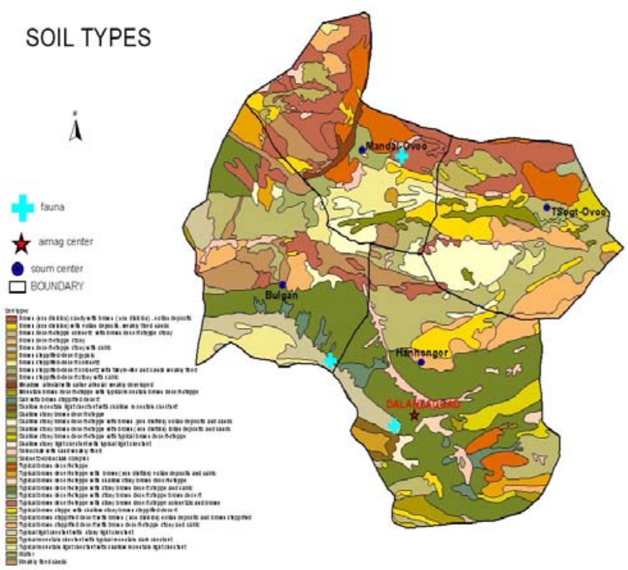


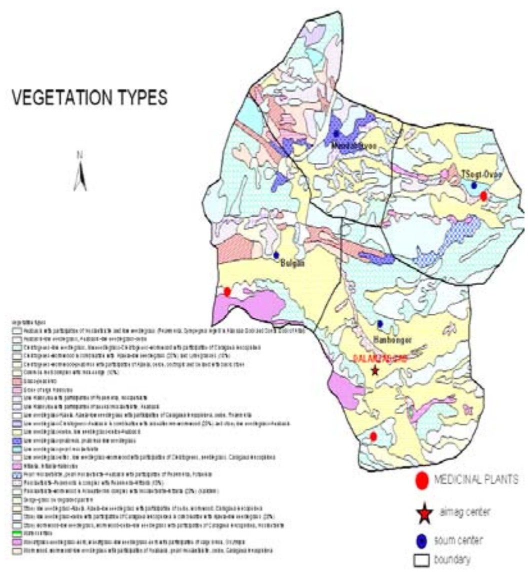
The wind is coming mainly from west and northwest and its velocity (6.0- 9.3 m/s) is high comparing to other seasons.



Relative humidity is low as 28-45% in month of May. Precipitation is 2-4 mm in March, 4-10 mm in April and 10 mm in May.





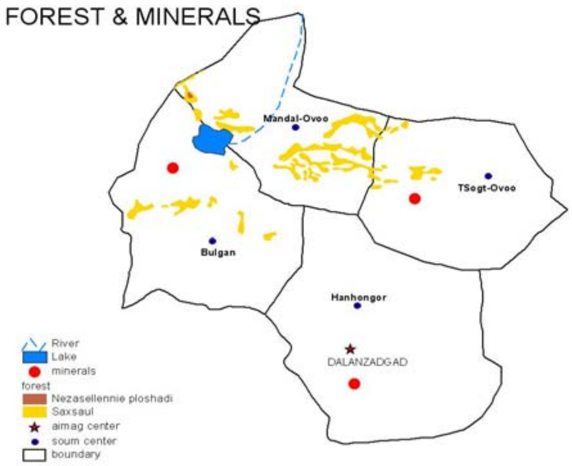


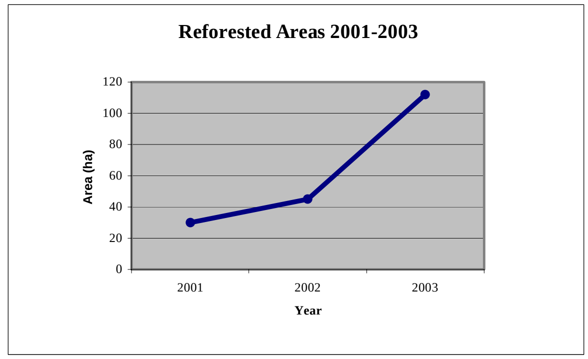
Soil types of Omnogobi **Vegetation types of Omnogobi**

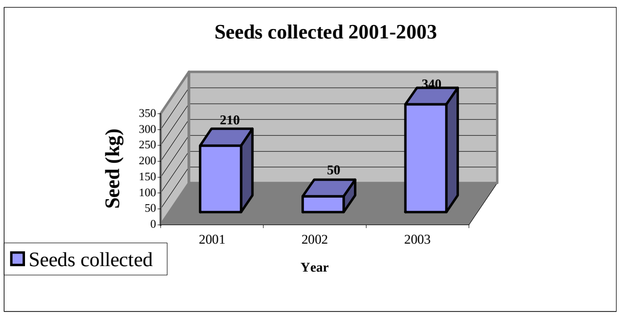
Projected foliage cover of vegetation communities in desertified steppes averages 20-25%, but may be low as 15%.

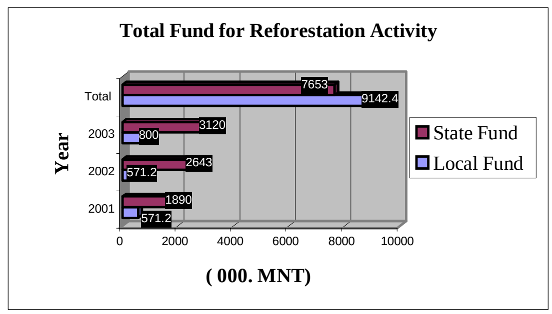
Sandy-grass family semi-shrub communities develop on southern brown soils south of destified steppes. They form the specific sub zone of steppe-like deserts. The main element of the structure of the communities is the dominating superiority of semi-shrubs (*Anabasis breviflora, Reamuria sangorica, Salsola passerine, Sympegma regeli, Artemisia xerophytica, Namophyto erinaceum, Anabasis salsa, Anabsis aphylla, Artemisia gracilescens).* The four latter species concentrate in the Ozhungar Gobi. Shrubs are represented by *Potaninia mongolica, Zygophyllum xantoxylon, Ephedra przeuvalskii, Brachanthemum gobicum etc.*

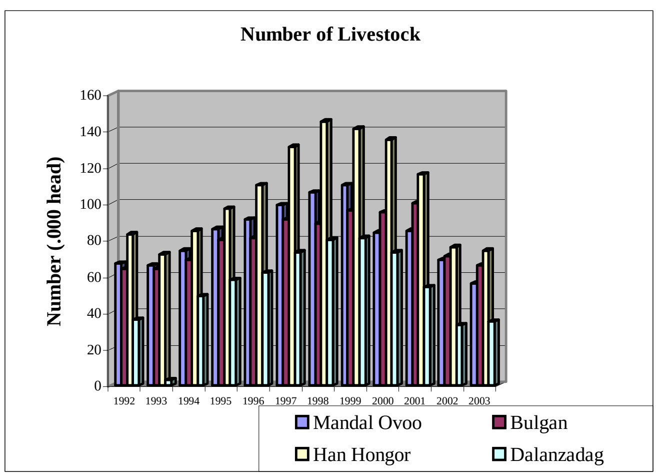
Soddy grass family plants, onions play a secondary role *(Stipa glareosa, S. gobica, Cleistogenes songorica).*



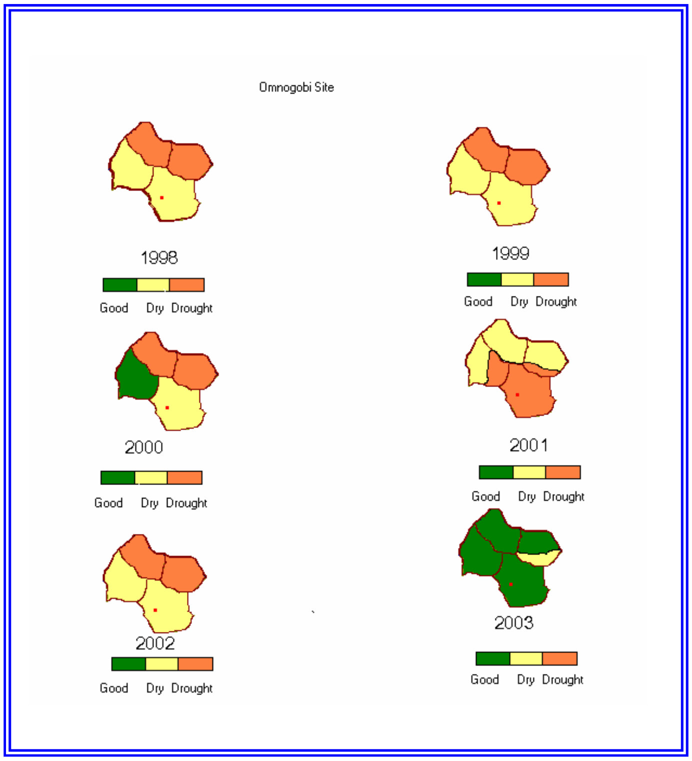








Drought Sequences 2003 and Seasonal Trends 1998-20



3. Sukhbaatar Focus Area and Proposed Activities

Location: Longitude: $113^0$3' Latitude: 46^0,3'

Sukhbaatar site is located in the eastern part of Mongolia at a distance of 670 km from Ulaanbaatar It is bordered by PRC and Dornogovi aimags and Asgat, Dariganga, Naran, Ongon soums of Sukhbaatar aimag.

The Sukhbaatar site covers 22,001 square kilometers, of which 57 per cent is sandy and gobi desert. Total population is 23,189.

It is a fragile area of desertified grassland. The total forested areas in site is estimated to be 10 percent of total territory. Biggest sand dune which is called as Moltsog els and Ongon els.

Livestock is the basic economic sector of the site. Site is rich in various natural resources of brown coal and other heavy metals.

About 200 plant species are found and wildlife fauna is assembled by antelope, black tail gazelle and provides a residence for a number of soft fur animals, such as marmots, fox, wolf, hare, rabbit, lynx, and etc.

Extreme drought, livestock population growth, irrational use of water, soils and pasture over many years have resulted in sustained decline in the Sukhbaatar site environment. The result has been drying and disappearance of small gobi lake like lake " Tsagaan", contraction of oases, decline in underground water levels, deterioration in water quality and vegetation, loss of biodiversity, expanding desert and increased frequency of sandstorms.

There are increasing of areas of land degradation, decreasing of vegetation cover and drying out of lakes and rivers are clear consequences of the desertification that contributing to DSS. One of the main reason of such changes are global air moisture cycle in continental and local scale and depletion of precipitation.

Precipitation is too low and too unreliable to support efforts to revegetate the focal are without supplementary irrigation. Water is in short supply. So, the strategy there will need to rely on natural regeneration of the rangelands. Therefore, there is need to enhance the precipitation using of cloud influencing technology (cloud seeding).

The major from of land use has always been semi-nomadic animal husbandry in the area. However, the recent increase in the number of livestock and loss of traditional grazing practice are major causes for deteriorated soil and destruction of habitat. The drastic increase in livestock numbers occurred in the beginning of 1990s, due to introduction of market economy and privatization of livestock. In addition, the traditional grazing practices, nested on a sustainable land utilization system was lost and forgotten under the planned economy system.

Climate

a. Total days with light

It varies based on the geographic location and cloud thickness. According to data received from Bayandeleger and Baruun Urt weather monitoring station total day lights continues 2832 – 3064 hours. Its higher by 130-160 hours than Hentii province and lower by 40 –15 hours than Dornodgobi province. Average days with sun continues 7,9 to 8,5 hours. In Baruun-Urt 9-10 hours with sun during summer season, and 7-8 hours during winter season.

b. Seasonal difference

Winter:

Starting from 2nd –5th November to 22nd –26th of March total 138-143 days. Soil temperature normally gets –21^{0} C in month of January and maximum rich – 43^{0} – 45^{0} C. In winter precipitation is only 5- 7% of total annual precipitation. Days with snow cover continue 85-110 days. Typical deepness of snow is 13-17 cm.

Spring:

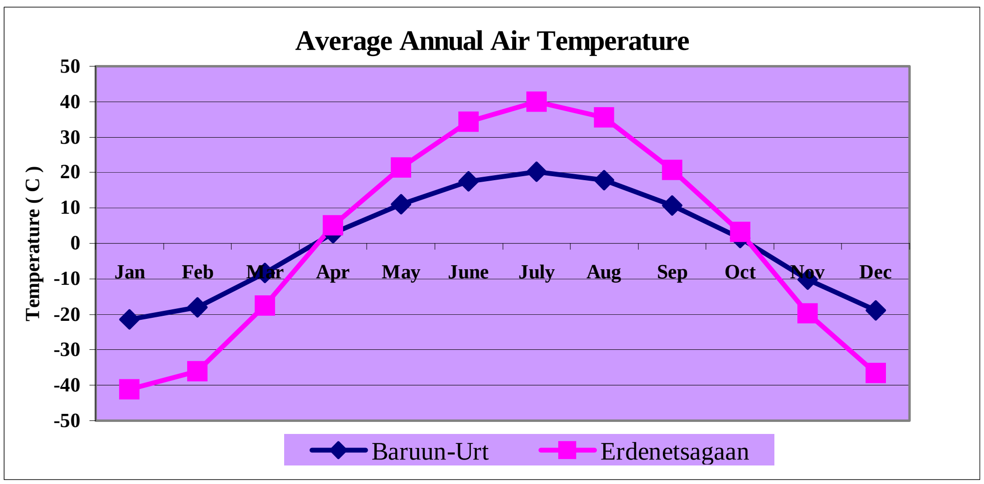
Starting from 22nd- 26th March till 5th-11th of May with total 44-50 days. Even thought days are comparatively short during this season climate originated disaster occurrence is high. The spring is categorized into 2 groups based on variances of air temperature:
Beginning: –5^{0} to +5^{0} C Late: +5^{0}C to +10^{0}C

Air temperature fluctuation is high during month of April with average temperature is 2.2^{0}C to +4^{0}C and daily maximum temperature reaches +20^{0}C to 30^{0}C in day time and –17^{0}C – 21^{0}C in night time.
Average soil temperature during month of April is +4^{0}C to 5^{0}C and daily maximum temperature reaches + 32 to +42^{0}C and –18 to –25^{0}C.
Wind velocity variation is high during this season. In April average wind speed reaches more than 15 m/sec and days with dust storm is 3- 7 days. Due to low precipitation and high fluctuation of air temperature its climate become dry. Humidity in the air is only 38-28% during this period. Total days with lower than 30% humidity is 16-22 days in month of April.

Summer:
Starting from 8-15th of May till 16th of September with total 121 –131 days. In July having 55-74 mm and in August 44-65 mm precipitation and evaporation is high so air humidity increases by 58-66 % in August.
Most warm period is month of July and average monthly temperature is 19.8 – 22^{0}C. One of the important parameter for successful agriculture development is calculation total temperature with more than +10^{0}C. Total temperature is around 1930 –2400^{0}C all over province and its higher by 200^{0}C than neighboring Henthii Province.

Autumn:
When temperature decreases from -10^{0}C to winter season temperature with total 45 – 47 days.
Maximum temperature reaches 24 -30^{0}C and minimum temperature reaches –5 to -9^{0}C in September and –17 to -23^{0}C in October. Its mean daily temperature fluctuation is high. In Autumn precipitation is only 10.5 – 17.6% of total annual precipitation and in Sep. around Erdene-tsagaan soum 35 mm, and rest of areas 12-23 mm. Wind speed increases up to 3-5 m/s which is higher that summer.

Temperature:



From this graph temperature increases by passing 0^{0}C in month of April and reaches its highest temperature in July and slowly reduces and reaches the lowest temperature in January.

Maximum and minimum air temperature:

Based on the many years data max. temperature is 40^{0}C and min. temperature -44^{0}C.

Total temperature: Its necessary for any plant species to have good condition to grow. In field of agriculture the total temperature during the warm seasons is one of important parameter. Based on this data we can explore the best opportunity for planting and cultivating fruits, vegetable and fodder plants. Total temperature above 10^{0}C is +1930 to +2450^{0}C and above +15^{0}C total is 1370 to +2002^{0}C. As altitude increases the total positive temperature of that place decreases.

Table A3.1 Total Temperature of below 0,-5,-10,-15,-20 and above 0,5,10,15 and 20

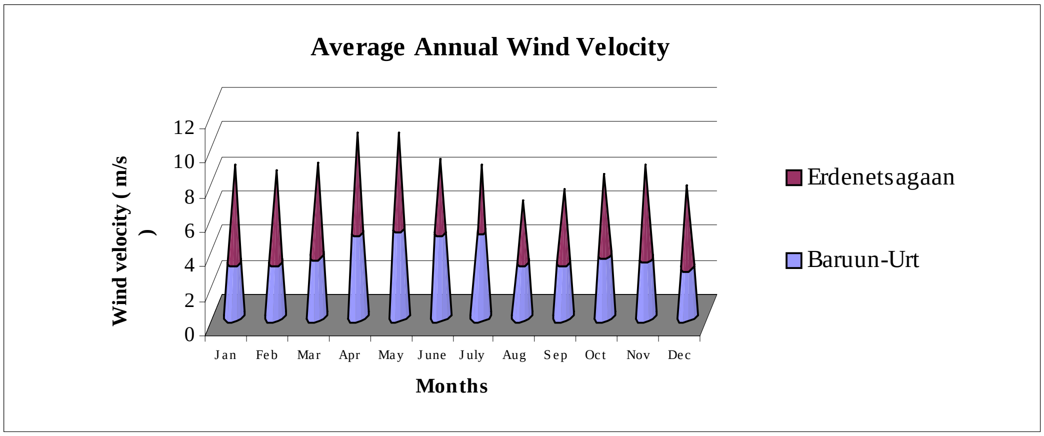
Station	-20^{0}C	-15^{0}C	-10^{0}C	-5^{0}C	-0^{0}C	0^{0}C	5^{0}C	10^{0}C	15^{0}C	20^{0}C
Baruun-Urt	-1350	-1759	-2238	-2340	-2502	2520	2435	2162	1650	322
Baishint	=1651	-2132	-2408	-2559	-2590	2798	2716	2436	2002	1127
Erdenetsagaan		-1697	-2050	-2226	-2270	2350	2258	1931	1370	-

Soil Temperature:

Annual average soil temperature of Sukhbaatar province is fluctuating between 1.3 to 2.6^{0}C. Minimum soil temperature is -20^{0}C in month of January, which is lower than air temperature in same period. This can be explained as snow cover.
Soil temperature increases from April by 4^{0}C to 7^{0}C and in May reaches to 13^{0}C to 17^{0}C. Maximum temperature is in month of July when its reaches 24-26^{0}C. It's also higher by 2.0 – 4.0 ^{0}C than air temperature.

Air pressure and wind direction:

Generally, most wind direction is originated from north and north-west side. Wind direction is varies because of Central Asian seasonal differences. For example, for Erdenetsagaan soum in January most wind originated from west and when get warmer the direction changed into east.



Annual average wind velocity is 3.2 –4.9 m/s and in west, south-west and south (which is relatively high) 4.3-4.9m/s and in other areas the wind velocity is 3.2 – 4.1 m/s. Wind velocity in winter is low and in spring slowly increases and reaches at maximum 3.2 –4.9 m/s only in month of April and reduces in summer. If we compare with neighboring aimags the wind velocity is higher 1.0 – 1.9 m/s than Khentii and 0.3-1.0 m/s than Dornod and Dornogobi province.

Sukhbaatar aimag is an area which has high wind velocity because it does not have major hills and mountains which can block the wind.

Table A3.2 Frequency of Wind with Different Speed

Name of Station	Baishint					Erdentsagaan				
	Velocity					Velocity				
Frequency	0-1	2-5	6-10	11-15	> 15	0-1	2-5	6-10	11-15	> 15
Jan	*50.4*	*43.7*	*5.2*	*0.7*	*0.04*	*16.0*	*35.4*	*40.9*	*6.2*	*1.5*
Feb	*44.8*	*47.3*	*7.2*	*0.6*	*0.1*	*18.0*	*38.0*	*37.1*	*5.8*	*1.1*
Mar	*37.3*	*44.3*	*14.2*	*2.7*	*1.6*	*20.6*	*39.1*	*30.5*	*7.7*	*2.1*
Apr	*30.2*	*37.1*	*24.4*	*6.3*	*2.0*	*18.3*	*36.0*	*34.3*	*8.2*	*3.2*
May	*26.8*	*37.7*	*27.2*	*5.8*	*2.5*	*21.0*	*34.6*	*34.9*	*7.2*	*2.3*
June	*30.7*	*42.7*	*22.0*	*3.6*	*1*	*29.1*	*41.9*	*25.5*	*2.9*	*0.6*
July	*35.4*	*43.7*	*18.4*	*2.1*	*0.4*	*32.7*	*46.2*	*19.3*	*1.4*	*0.4*
Aug	*36.7*	*47.9*						*18.1*	*1.5*	*0.8*
Sep	*38.0*	*43.8*						*24.7*	*3.0*	
Oct	*42.9*	*39.6*	*14.5*	*2.6*	*0.4*	*23.7*	*41.9*	*27.9*	*5.1*	*1.4*
Nov	*45.7*	*40.1*	*12.0*	*1.8*	*0.4*	*20.8*	*38.8*	*38.8*	*33.7*	*5.0*
Dec	*54.5*	*38.2*	*6.7*	*0.5*	*0.1*	*18.8*	*35.1*	*39.0*	*5.7*	*1.4*

Frost:
Frost is a phenomenon when spring and autumn air temperature above 0^0C the air or soil temperature drops below 0^0C. The plant is very sensitive during its planting or growing period so the frost is one of the negative weather phenomenon which will create negative impact to plant germination and slowing/ damaging growth, even destroys recently planted species. In Sukhbaatar aimag the last frost occurs from 3^{rd} ten days to 4^{th} ten days of May. This is important data for planning the planting measurements

Table A3.3 Latest and Earliest Frost Occurrence in Sukhabatar Aimag

Indicators	Late spring			Beginning of autumn			Non frost period		
	Average	Earliest	Latest	Average	Earliest	Latest	Average	Short	Long
Baruunurt	May16	May4	June4	Sep19	Sep9	Oct2	126	114	138
Baishint	May17	May17	May31	Sep20	Sep6	Sep30	126	103	157
Bayndelger	May14	May4	May21	Sep17	Aug30	Sep24	126	94	139
Erdentsagaan	May21	May1	June12	Sep11	Aug28	Sep27	113	87	145

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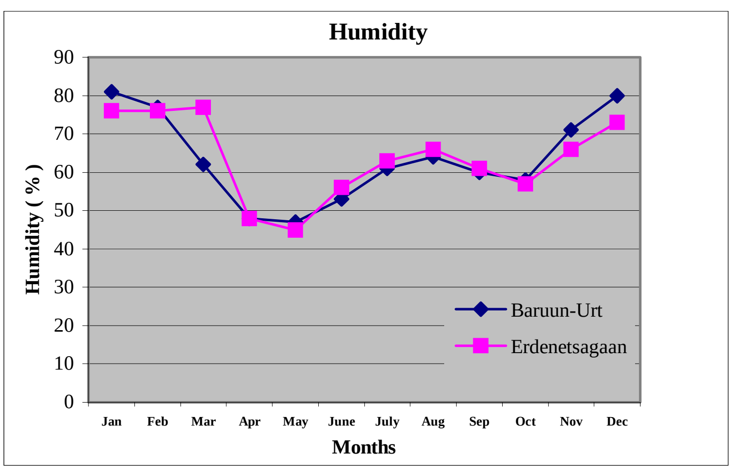
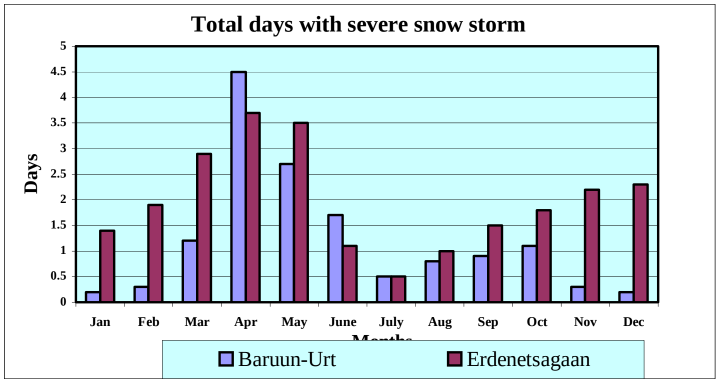




One of the critical parameter for development of crop farming is humidity. Besides of positive temperature and lights the humidity is important factor for growth of fodder and pasture plants and selection of right plant species.

Days with strong wind is low in winter and summer (0.2 –0.3 days) but in spring and autumn high (0.8 –4.3 days). Specially in springtime most strongind occurrence is high in Baruunurt 4.3 days and some year even 9 days.

Its practically important to know how long and what level of speed wind is continuing. For Sukhbaatar province annual average continuation is 62-114 hours and the longest storm occurs during spring and autumn. Wind, mostly from west and northwest, blows for around 1.1 to 6 hours/day on average. In some cases, velocity of strong wind reaches up to 28-34m/s.

Table A3.4 Frequency of Strong Winds at Different Velocity (meters/second)*

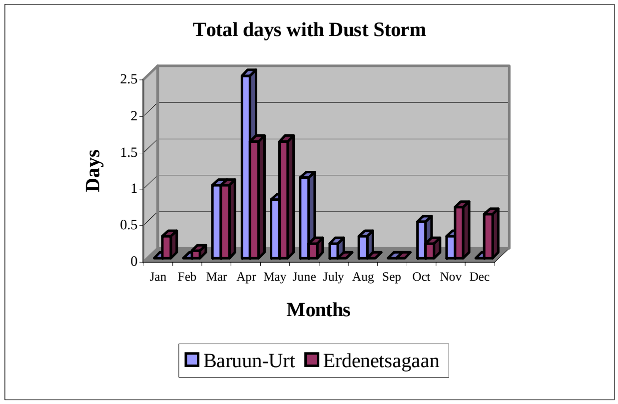
Stations	15-18 m/s	19-22 m/s	23-26 m/s	27-30m/s	31-34m/s
Baruunurt	88.6 %	8.9 %		1.3%	1.2%
Erdenetsagaan		20.2%	2.8%	0.8%	

* Force 8 winds on the Beaufort scale is about 12 m/s

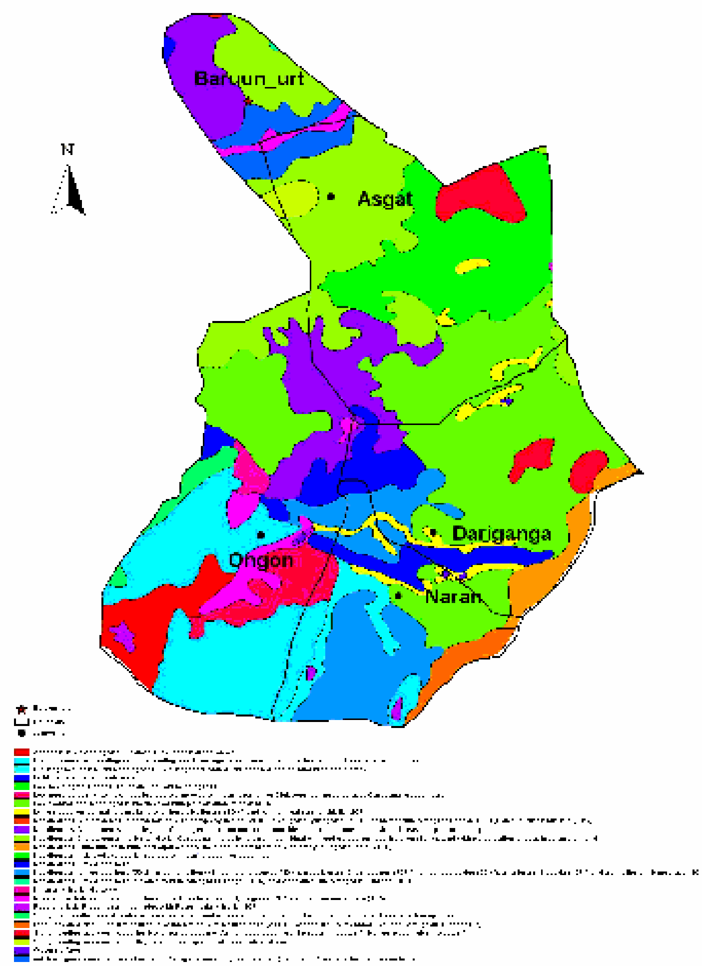
Sand storm:

Sand storm damages the country's economy. Sand storm is one of natural disasters and its periodicity, frequency (number of days) and geographic extent varies widely.

The province is counted as one that has frequent sand storms (6-19 annually) most of which originates in spring and autumn. They occur less often in winter and summer.



The frequency of sand storm is high during April (a month of low precipitation) because of the melting of snow cover that exposes the dry soil. Even though storm velocity is low the possibility of sand storm is high in selected sites because low precipitation, and hot and dry air, at a time when vegetation cover is sparse. The main types of vegetation are low needle grass in association with the shrub *Caragana* spp..



Vegetation Type Sukhbbatar aimag

A map of soil type, soil erosion and degradation and its distribution was prepared at a scale of 1:50,000. The results of the investigation showed that the dominant soil of the Gobi desert zone is a brown clay loam characterized by poor fertility with a low humus content and a high sensitivity to wind and water erosion. In this area should implement following activities such as decreasing of land use capacity, rehabilitation of land vegetation cover and plantation of trees and shrubs combat to land degradation.

The pasture land map shows that there are 12 vegetation associations and 10 pasture land types. The main pasture land type is the *Caragana* shrub association which is overgrazed around the settlements.

4. Dornogobi Focus area

Location

Latitude: 44.8^0
Longitude: 110, 2^0
Altitude: 900 m above sea level

Dornogobi site is located in the southern part of Mongolia at a distance of 700 km from Ulaanbaatar It is bordered by Ikhkhet, Airag, Saihandulaan, Mandakh, Hovsgol, Erdene, Orgon and Delgerekh soums of Dornogobi aimag.

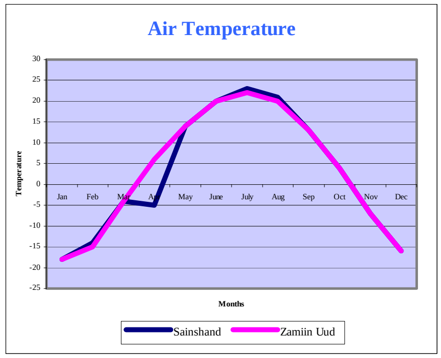
It has a size of 26,900 km^2 and covers entirely the territory of three soums (Shainshand soum, Altanshiree soum, and Ulaanbadrakh soum) (see Picture 1).

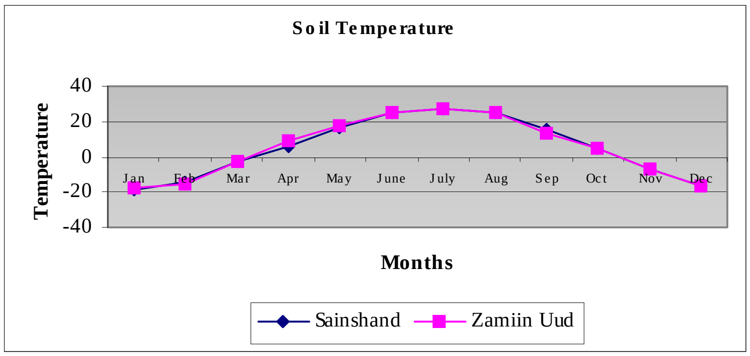
The Dornogobi site covers 20,9 00 square kilometers, of which 8 per cent is sandy and gobi desert. Total population is 7,600. It is a fragile area of desertified grassland. The total forested areas is estimated to be 10 % of total territory. Livestock raising is the basic economic sector of the site.The area is rich in various natural resources of coal and gold and construction materials. The land is dry and soil is steppe brown, red –brown, light brown clay poor in humus. About 200 plant species are found and wildlife fauna includes antelope, black tail gazelle, fox, wolf.

Extreme drought, livestock population growth, irrational use of water, soils and pasture over many years have resulted in sustained decline in the Dornogobi site environment.. The sand storms in the site occurred any time during the year while severe sandstorms occurred frequently from March to May after spring thaw

Climate

Air temperature:
Dornogobi province has 7 months where the air temperature is above zero. The coldest period is January. In Zamiin-Uud temperature gets – 20 centigrade where other areas will have only –15 to -18^0C. In April temperature gets warm in 2.3 to 7.5 ^{0}C.





Soil Temperature:

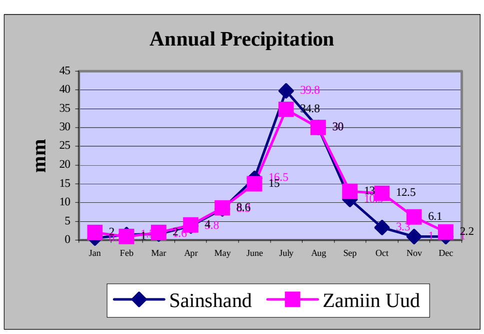
Average annual soil temperature is 1.6^{0}C warmer compared with air temperature. From November to March the soil temperature is below 0^{0}C and from April temperature raises from 5 –9^{0}C and it reaches 15-18^{0}C in May.

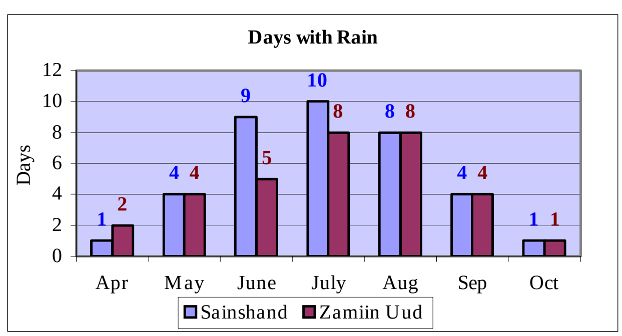
Table A3.5 Soil Temperature (max, min and average)

Stations	Indicator	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sainshand	Average	-20	-16	-4	8	17	25	27	24	15	5	-8	-18
	Max	8	23	36	48	59	69	69	53	45	27	22	10
	Min	-39	-40	-32	-23	-11	0	6	0	-6	-23	-30	-38
Zamiin Uud	Average	-19	-16	-3	9	18	26	28	25	16	5	-7	-18
	Max	8	25	35	49	56	64	63	59	49	39	26	15
	Min	-39	-43	-35	-20	-8	-1	8	0	-5	-20	-31	-43

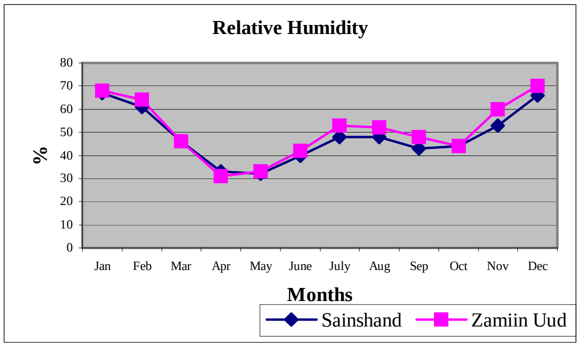
Precipitation:

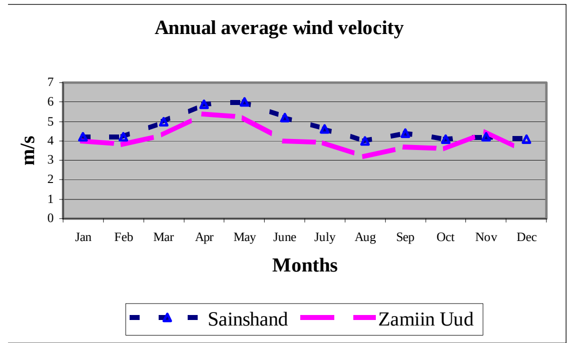
Annual precipitation is 90-130 mm and mainly falls in July and August. Normally 2.2 – 3.0 mm per rain and sometimes is as high as 3.0 –4.0 mm.





Relative humidity:
Average annual humidity is 40 – 55%. Minimum humidity occurs during April because of higher air temperature, dry soil and melting snow.





Wind:

There are no major mountains areas for Dornogobi for blocking the wind. Most wind is from north and northwest so it lies in the path of the DSS.

Table A.3.6 Frequency of Wind Direction (%) in Shainshand

Months	N	N-E	E	S-E	S	S-W	W	N-W	Days with no wind
Jan	18.5	4.9	1.7	2.2	9.2	5.3	16.5	42.2	27.5
Feb	21.8	9.0	3.5	1.9	8.3	3.9	15.9	35.7	25.0
Mar	18.9	11.6	6.3	4.9	10.6	6.2	11.6	29.9	18.3
Apr	19.6	10.8	5.6	5.2	8.7	7.2	15.3	27.6	13.1
May	20.0	12.1	6.7	5.1	9.7	7.5	13.8	25.1	11.6
June	22.5	14.3	9.1	8.2	10.5	7.4	13.8	19.3	11.9
July	20.3	17.1	10.7	8.1	11.8	6.5	6.7	17.6	13.7
Aug	19.6	14.7	11.0	8.9	15.2	7.2	7.9	15.6	16.6
Sep	16.1	10.1	6.3	5.8	12.9	8.0	7.8	29.3	20.5
Oct	16.7	8.7	4.0	5.3	13.6	8.5	11.0	29.1	24.7
Nov	15.6	8.8	3.6	3.6	13.0	7.2	14.1	30.3	24.7
Dec	15.3	4.0	2.2	3.1	11.6	4.8	17.9	29.3	27.6
Average annual	**18.7**	**10.5**	**5.9**	**5.2**	**11.3**	**6.6**	**13.4**	**28.4**	**19.6**

The main wind direction in Shainshand is from west and north west.

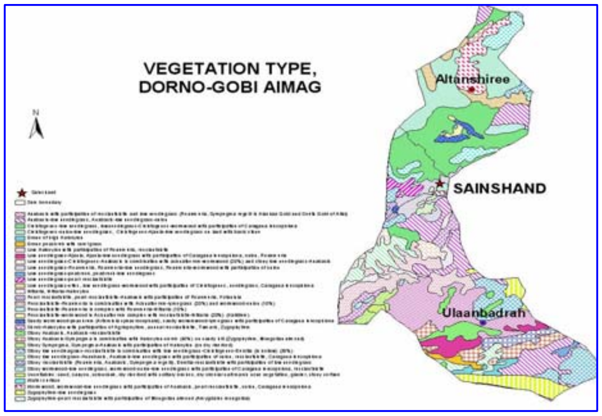
Duststorm:
The duration of dust storm is different between stations: in Shainshand 44% of total recorded dust storm lasts for less than 2 hours and about 4% lasts more than 12 hours. In Zamiin-Uud about 20 % continues between 4-6 hours. Dust storms that continue more than 12 hours are less common (4-9%). Dornogobi province experiencing dust storm for 26- 321 hours per year and of which 26-80 hours occur only in April and May. Regarding timing, 60- 67% of dust storm occur between 0900 to 1800 and 21.7 –26.3 % are in the afternoon between 1500 – 1800.

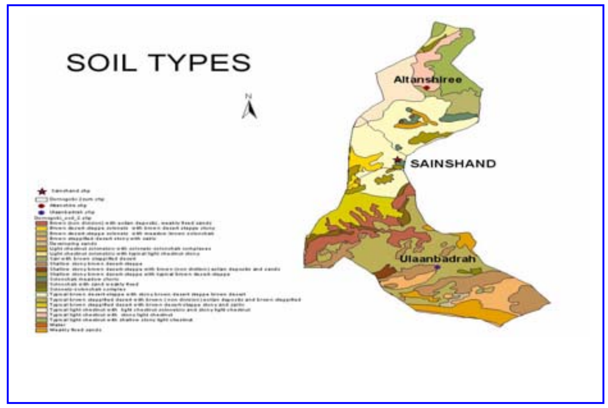
The vegetation and soil condition of Dornogoby site is shown in the maps below.

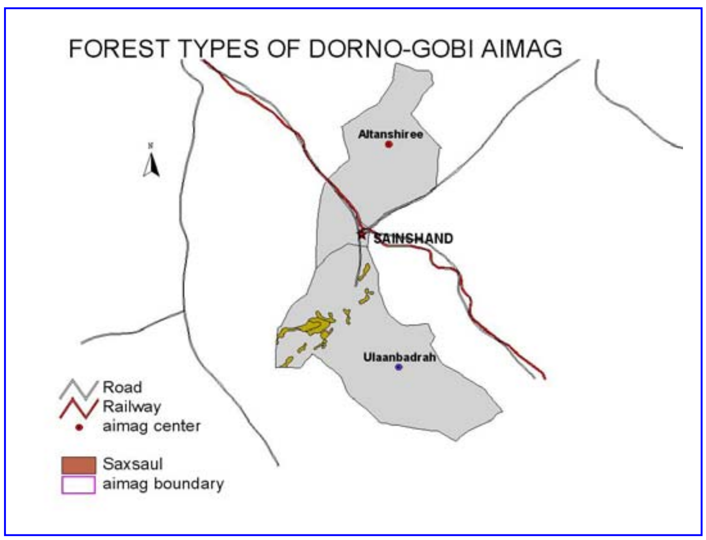
Haloxylon is mainly encountered on sands. Insular patches of steppe-like deserts support mainly *Anabasis breviflora, Reamuria sognorica* and *Nanophyton grubovil* and are mainly found on the beds of depressions. (the Valley of Lakes, the depression of Great Lakes).

The total projected cover of the above communities is about 10-15%. In the south the conditions become drier steppe-like deserts give way to deserts on grey-brown soils. They cover almost whole of the territory of the Dzhungar, Trans-Altai and Alshan Gobi. Vegetation communities are dominated by Central Asian semi-brushes like the above mentioned and other species typical of the given sub-zone *(Salsola larificola, Ephedra przeulalskii, Hjinia regelil and Nitraria sphaerocarpa).*

Haloxylon spp. generally develop scattered and low communities. Perennial grasses are sparse. The projected cover is normally within 5-10%







Five (5%) percent of Dornogobi site is covered by forest. Forest type is gobi saxsaul (*Haloxylon* spp.) forest .

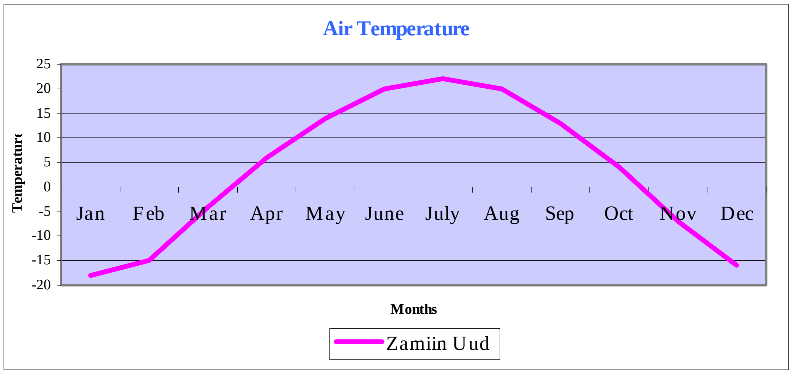
5. Zamiin Uud site

Location:

Latitude: 43^0.4$'$ Longitude: 111^0
Altitude: 800 m above sea level

Climate

Air temperature:
Dornogobi province has 7 months where the air temperature is above zero.The coldest period is January. In Zamiin-Uud temperature gets – 20 centigrade where other areas will have only –15 to –18^{0}C. In April temperature gets warm in 2.3 to 7.5 ^{0}C.



Soil Temperature:

Average annual soil temperature is 1.6^{0}C warmer comparing with air temperature. From November to March the soil temperature is below 0^{0}C and from April temperature raises from 5 –9^{0}C and it reaches 15-18^{0}C in May.

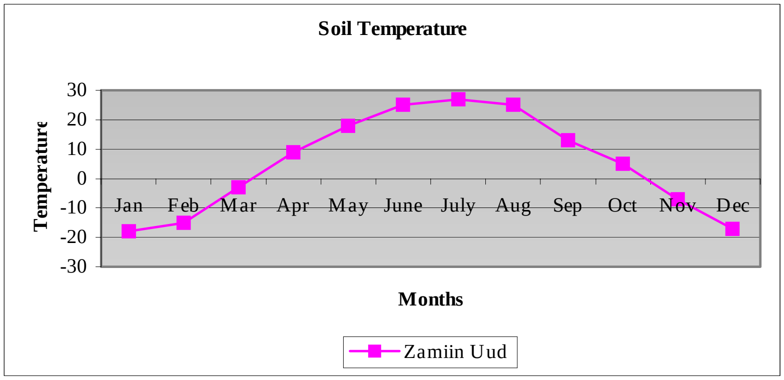
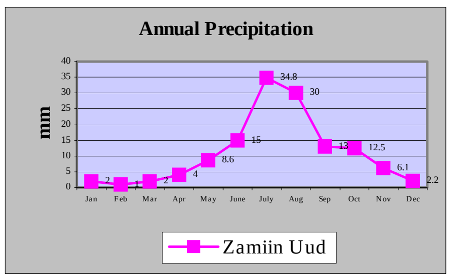


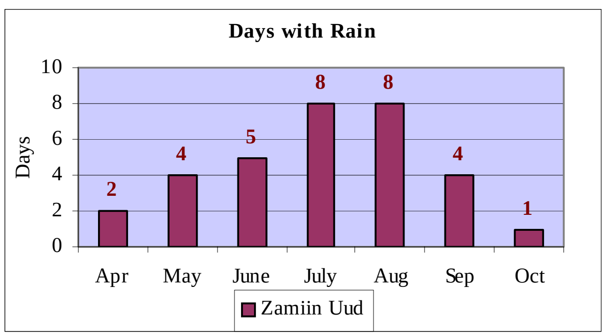
Table A3.7 Soil Temperature (max, min and average)

Stations	Indicator	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sainshand	Average	-20	-16	-4	8	17	25	27	24	15	5	-8	-18
	Max	8	23	36	48	59	69	69	53	45	27	22	10
	Min	-39	-40	-32	-23	-11	0	6	0	-6	-23	-30	-38
Zamiin Uud	Average	-19	-16	-3	9	18	26	28	25	16	5	-7	-18
	Max	8	25	35	49	56	64	63	59	49	39	26	15
	Min	-39	-43	-35	-20	-8	-1	8	0	-5	-20	-31	-43

Precipitation:

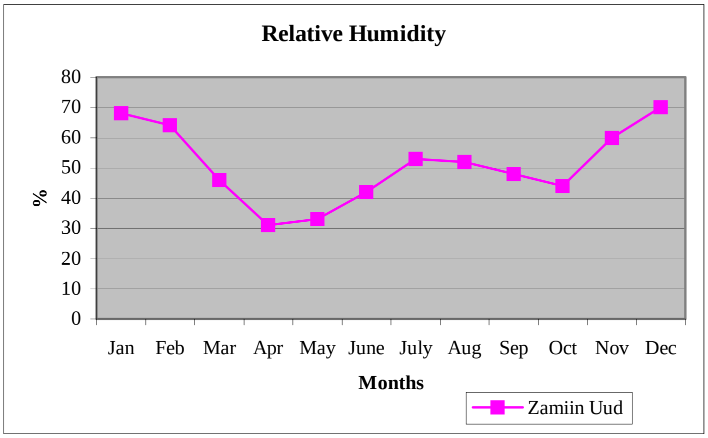
Annual precipitation is 90-130 mm, mainly in July and August. Normally 2.2 – 3.0 mm per rain and sometimes as high as 3.0 –4.0 mm.





Relative humidity:

Average annual humidity is 40 – 55%. Minimum humidity is occurring during month of April because of the increase in air temperature, the dry soil and melting snow.



Vegetation and soil types

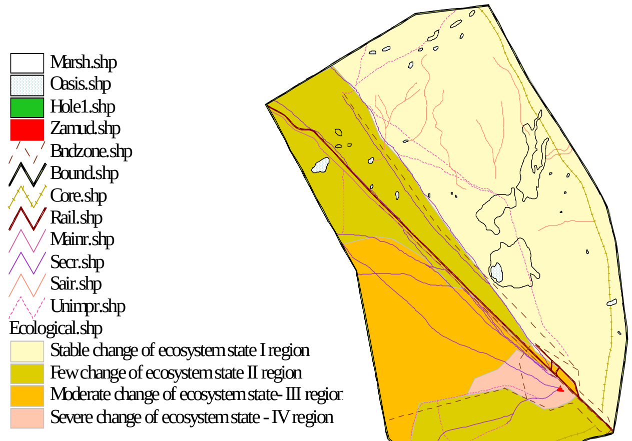
There is a map of ecological and economical assessment of Zamun Uud soum on scale 1:50,000. There are 10 vegetation associations and 8 pasture land types. The dominant pastureland type is a *Caragana* spp. Association

A map of soil type, soil erosion and degradation and it's distribution was prepared at a scale of 1:50,000. About 95,5% of total land has been occupied by agriculture and pasture land. Pasture land of Zamun Uud soum is 3,283.0 ha and the calculated sheep carrying capacity is 6985 head. A land use map on a scale of 1: 50,000 and land registration and inventory have been prepared.

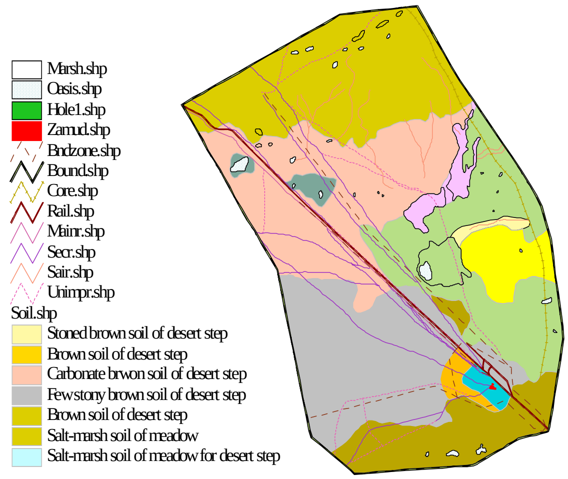
The current water supply system of the Zamun Uud soum center was analyzed. Maps of water quality and hydro- geology on scale 1:50,000 and estimated water resource volume in the Soum center were preapred. Water quality in Zamun Uud soum is poor (unsuitable for the drinking by people) and there is need to find new water resources and/or improve water quality using chemical methods.

- Basing on investigation sand movement and its distribution we have recommended some activities for combating of sand movement such as following :

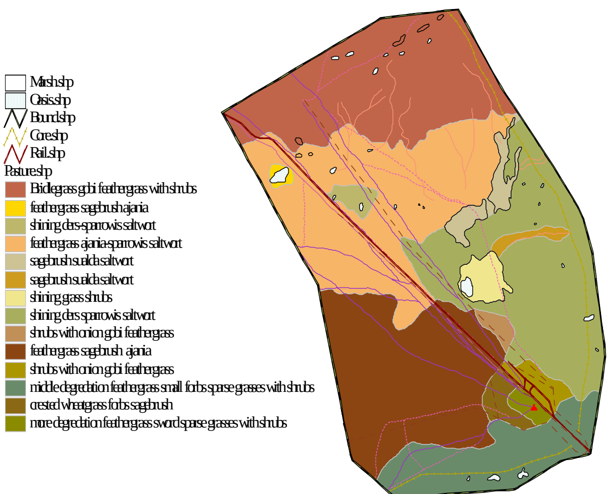
  1. To protect soil and vegetation in wind break zone.
  2. To prevent subsequent sand movement using mechanical and biological methods such as building of fences and planting trees and grasses
  3. To improve planning and construction of buildings in the soum center due to freely pass sand movement through settlement.
  4. To remove sand dunes away from selected zones and use sand for building construction and another purpose.



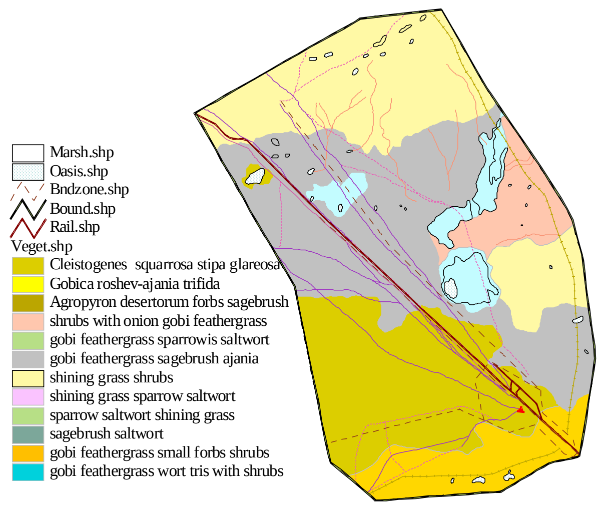
Ecological valuation map



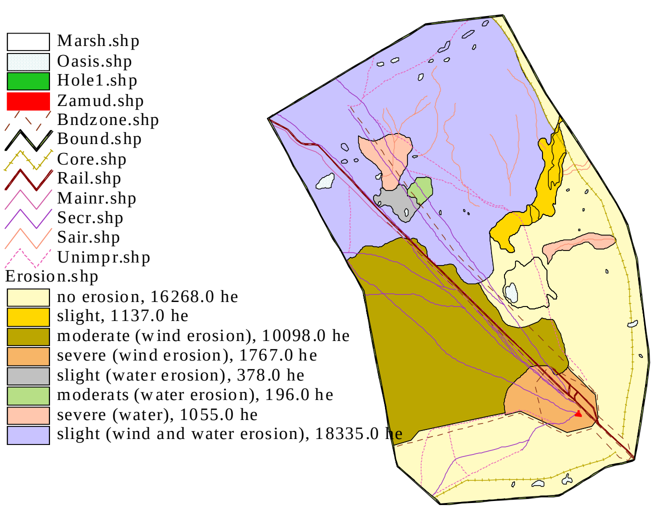
Vegetation map



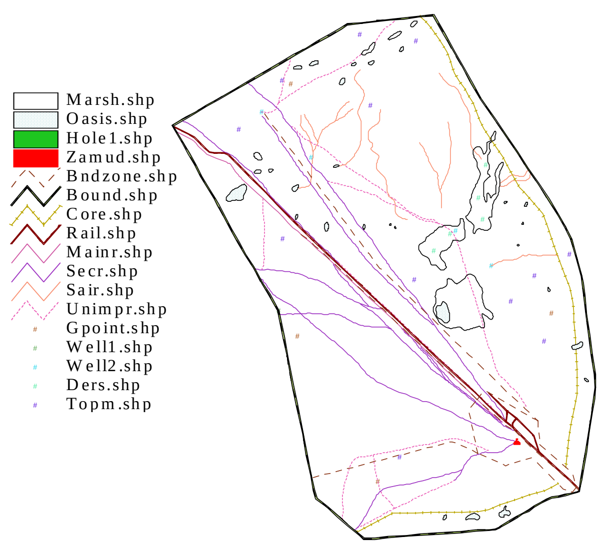
Pasture map



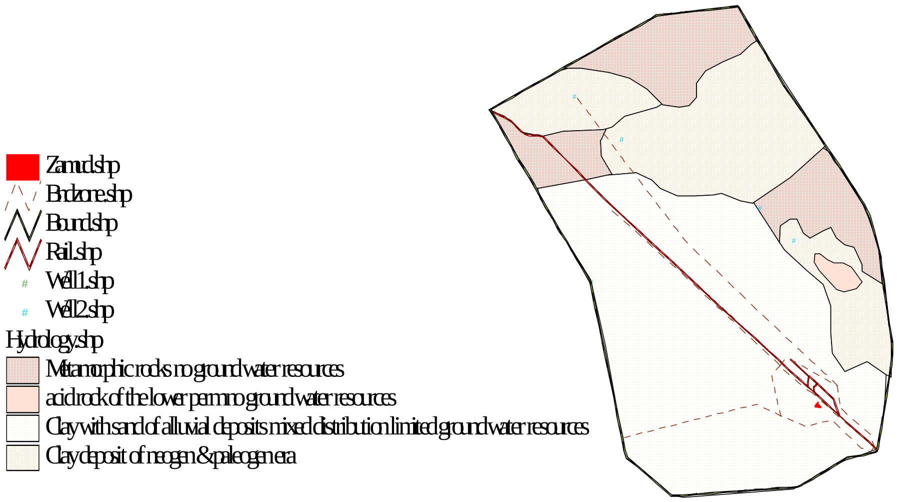
Soil Map



Soil erosion map



Land use map



Hydrogeology map

APPENDIX 5

SOCIO-ECONOMIC ANALYSES FOR FOUR FOCUS AREAS IN MONGOLIA

1. General

Mongolia is located in the central part of Asia and borders with Russia along 3445 km in the north and with China along 4676.9 km in the south. Mongolia comprises 15,641,000 km^2 of land. It is 2392 km from the western to the eastern frontier and 1259 km from north to south. It is administratively divided into 21 *aimags* (provinces). *Aimags* are divided into *soums* which are further divided into *bags*.

Mongolia's economy is small, with a GDP of US$ 950 million. This is equivalent to US$ 398 per capita. Agriculture is vital for the entire country as agricultural production contributes significantly to trade. Agriculture's share of GDP was 33.4% in 2000 followed by wholesale and retail trade, with 23.4%. No other sector contributed more than 9.5% to GDP.

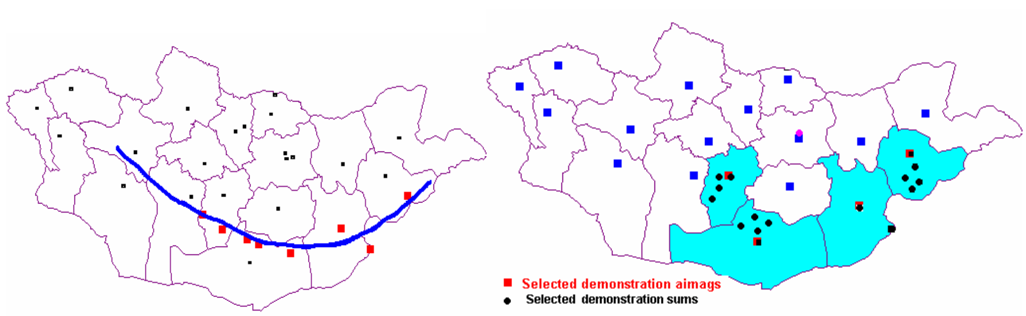
2. Socio-economic Considerations

2.1 Selection of Focus Areas

Four focus areas were selected by the groups of specialists nominated from MOE, including researchers, local community representatives, government officials and project team consultants. The selection was based on the following criteria:

- Located in main belt areas of the DSS storms
- Previous experiences and initiatives connecting with combat desertification and afforestation activities
- Mostly located in the Gobi area and located on the eastern side of Mongolia
- Close to the PRC to improve project management and coordination possibilities
- Future economical important zones as economic free zone and capital city
- Comparatively good infrastructure specially road and transportation

Figure A5.1 Locations of Selected Areas by *Aimag* and *Soums* in Relation to DSS Pathways and Source Areas



2.2 Socio- economic Influences on DSS

It is hard to define the way the socio-economic situation directly influences DSS but it could have the following influences listed in Box A5.1 although no research is made on these matters:

Box A5.1 Potential Interactions between Various Phenomena and DSS in Mongolia	
Directly influencing DSS	Indirectly Influencing DSS
Natural ecological phenomena • Global warming- • Pasture management system • Livestock privatization • Land tenure in rural areas • Bad road / infrastructure • Uses of pasture, wells, and water sources • Bad technology of crop farming - "Zero tillage" *Gold mining and its rehabilitation, restoration management*	• Poverty - unemployment • Urban movement

Due to Global warming, there has been drier climate, which exacerbated drought and zud occurring almost yearly in Mongolia. There is less rain in summer and the winters have become colder. These changes have reduced biomass and density of vegetation. Since 1999, the summer condition has gotten worse (Table A5.1)

Table A5.1 Worsening Drought Situation in Southern Mongolia, 1997-2002

Year	No. of *soums* which had good summer	No. of *soums* with dry condition	No. of *soums* with drought
1997	19	-	-
1998	18	1	-
1999	10	9	-
2000	1	18	-
2001	5	10	4
2002	-	6	13

As the climate has become drier, the soil has become more degraded so biomass is low and cover is sparse. The steppe areas and the Gobi *soums* have become more desertified. This environment became conducive to plagues brought about by harmful rodents[1].

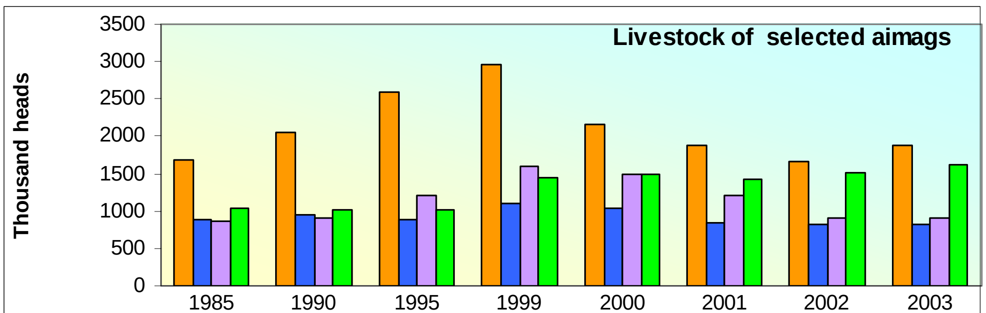
[1] By October 2002, these rodents have caused the degradation of 78.9% all *soums* and 20 % of pasture land [1.4 million ha].

These natural changes have adversely influenced the livelihoods of many people living in the countryside. The number of livestock has decreased sharply, so living condition of most of the herders and their families became worse and the standard of living is nearing the poverty line[2].

2.3 Socio-economic Considerations of the Selection of Focus Areas

All 4 selected focus areas are located in the eastern side of Mongolia where the main economic contributions are from the agriculture sector (mainly livestock husbandry). The proposed joint cross-border project include Zamiin Uud (in Dorngobi *aimag*) where trade and commerce are the active sectors.

Figure A5.2 Trend in Livestock Population in the Focus Areas



	1985	1990	1995	1999	2000	2001	2002	2003
Uberkhangai	1675,7	2061,6	2595,0	2956,6	2159	1869,1	1665,4	1878,2
Dornogobi	896,6	943,5	886,2	1110,2	1036,6	838,3	825,8	831,7
Umnugobi	855,7	910,9	1203,5	1608,9	1489,6	1209,6	909,1	907,3
Sukhbaatar	1028,1	1004,7	1015,6	1450,6	1492,5	1429,1	1516,1	1622,6

Table A5.2 Livestock in the Focus Areas

	1985	1990	1995	1999	2000	2001	2002	2003
Total of 4 aimags	4456,1	4920,7	5700,3	7126,3	6177,7	5346,1	4916,4	1622,6
State total	22485,6	25856,9	28580,9	33568,8	30227,4	26075,2	23897,6	25307,8
% of total livestock	19,8	19,0	19,9	21,2	20,4	20,5	20,6	6,4

[2] The Government of Mongolia determined the poverty line in 1991 for the first time. The National Statistical Office (NSO) conducted the first Living Standard Measurement Survey (LSMS) with the support from the World Bank (WB) in 1995 and the second LSMS with UNDP in 1998. The current poverty line was the revised one in 1999 based on the experience of these surveys.

Table A5.3 General Statistics of the Focus Areas

Items	Total State	Dornogobi	Ovorhangai	Omnogobi	Sukhbaatar	Subtotal	(%)
Territory ('000 km^2)	1, 564.10	109.5	62.9	165.4	82.3	420.1	27%
Number of *soums*	340	14	19	15	13	61	18%
Number of *bags*	1671	51	108	54	65	278	17%
Population	2475,4	520	113,9	47,2	56,1	737,2	30%
Population density (/km^2)	1.58	0.47	1.81	0.29	0.68	3.25	0.8
Name of city	Ulaanbaatar	Sainshand	Arvaikheer	Dalanzadgad	Baruun Urt		
From *aimag* to UB[1] (km)		463	430	553	560		
Percentage of urban population (%)	57.4	52.3	18,3	28,4	20,7	*	*
Rural population (%)	42.6	47.7	81.7	71.6	79.3	*	*
Number of households (000)	568.6	12.7	28.3	11.9	13.1	66.0	12%
Urban	311,965	6,635	4,243	3,245	2,700	16,823	5%
Rural	256,660	6,048	24,035	8,628	10,365	49,076	19%
No female headed households	61,765	1,504	2,685	2,078	1,170	7,437	12%
No of herdsmen household	175,911	3,933	7,814	6,482	7,573	25,802	15%
Number of herders	389,765	9,068	38,213	14,160	18,612	80,053	21%
Economically active.	901.7	20	47.7	21.0	24.4	113.1	13%
Employees (000)	870.8	19.6	45.5	20.6	23.7	109.4	13%
Unemployment	30,877	427	2,137	435	687	3,686	12%
Unemployment rate (%)	3.4	2.1	4.5	2.1	2.8	11.5	

1/ Ulaanbaatar
Source: Statistical Yearbook 2000 , 2003 of Mongolia

3. Dornogobi *Aimag*

Dornogobi *aimag* (land area - 48.700 km^2) is located in the southern part of Mongolia. . Dornogobi has 51,100 thousand residents in 12 thousand households. The capital city is Sainshand 463 km from Ulaanbaatar. It is connected to Ulaanbaatar by railway and an unpaved road[3]. Sainshand is also the administrative center of Dornogobi.

Zamiin Uud is the southern-most *soum* of Dornogobi *Aimag* situated along the Mongolia-China border. It is 4.5 km from Erlian (Erinhot) City of Inner Mongolia Autonomous Region in the PRC. It was established in 1956, and was named "Zamiin Uud railway station". The main economic activity is trade and cross border activity and it is where the main international road and rail border-crossing point is located. Zamiin Uud is the biggest border crossing and an important entry/exit point for trade.

Zamiin Uud is a small *soum* of about 48,000 ha in area and has a population of over 7,110 residents and a floating population of up to 2,000 on some days (The PRC township of Erinhot across the border has a population of some 70,000 people). Zamiin Uud is situated 780 km from Ulaanbaatar and 230 km from the *aimag* center of Sainshand .

[3] A new highway is under construction and will be finished in 2006

About 39% of the *Aimag* budget is self-generated, from taxes and fees (i.e. land use tax, customs tax, vehicle tax, income tax, and tax on animals) and the rest comes as a subsidy from the central government.

Table A5.4 Population of Zamiin uud

Years	Number of Households	Population	Of which		Of which	
			Male	Female	Urban	Rural
2000	1385	6127	2976	3151	6031	96
2001	1559	6253	3037	3216	3160	93
2002	1703	6681	3288	3393	3314	32
2003	1850	7112	3464	3602	7066	46

Source: Zamiin Uud Administration information

Zamiin Uud had 1850 households in 2003; 80% of the total population are children, and adults under 35 years.

While the income of the Soum is based on service sector activities (cross-border trade, rail and road traffic), its existence is threatened by increasing sand movement (particularly during the last 10 years), which disrupts rail and road traffic and life of the people. Mechanical measures such as concrete barriers nave not been of much help to reduce the impact of sand movement

The Soum has developed a 10 year action plan to plant trees far reducing controlling the spread of desertification, but its implementation is constrained by lack of funds, man-power and technological support So far, since 1998, some 30 ha have been planted, mainly with Elm *{Ulmus* sp) and Chinese poplars. The planed area is fenced and protected from grazing, resulting in increased appearance of local shrubs such as Caragana. Since the plants need watering during the initial years, the activity is rather expensive. The scale of planting is so small to have any impact against the Wide front of sand movement. The situation calls for an adequately large scale effort, including research on appropriate species and method of tree planting and maintenance to establish an effective system of desertfication control. Mongolia is a signatory of the UN Convention to Combat Desertfication and should be in a position to share experiences of countries which are actively working in this area. .

The most threatening issue facing the *aimag* is serious desertification and sand movement Both domesticated (livestock) and wild animals (eg. wild ass) are said to be highly in excess of the carrying capacity of the land. No scientific study, however, has been done to assess the problem. Fuelwood collection from the already depleted saxual (*Haloxylon ammodendron)* forests (of about 10,000 ha) is adding to the sand movement problem.

So far, no plans have been implemented to establish a system of pasture management (e.g. rotational grazing) or pasture improvement nor are there any comprehensive plans under consideration. (Also, there is no pasture expert within the administration of the Aimag). Some small scale projects of JICA and UNDP have been implemented as means improving pasture well and desertification. To address the increasing desertification and worsening climate, the *Aimag* government is expecting some assistance from Government.. Because of financial shortages the government is not doing much but local authorities understand the importance of trees in desertification control and pastureland management. The Government of the *aimag* is working in close contact with PRC and have visited some plant nurseries and regularly buy seedlings from PRC

4. Sukhbaatar Aimag

Sukhbaatar aimag (82,300 km^2) is located in south- western part of Mongolia, There is a frontier with PRC on the South Dornogovi on the west, Khentii on the West and Dornod on the north-east. The city Baruun urt is located km 560km from Ulaanbaatar city. There are 13 sums and 67 bags of the local authority. Population density is 0.67 person /km^2. Sukhbaatar has a resident population of 51,100 and 12,000 households. Main economic income is from agriculture.

Table A5.5 Socio-economic baselines of Selected *soums* of Sukhbaatar A*imag*

Items	Sukhbaatar aimag	Baruun urt city	Asgat sum	Dariganga sum	Ongon
Territory	8228715	54260	719800	481407	646837
Agricultural area	7760583	-	718595	405860	600623
Area of township	19976	5283	582	806	543
Area of infrastructure	5614	158	311	298	481
Number of bag	67	9	4	4	5
Distance to aimag (km)	0	0	48	168	160
Population density	0,67	0,80	0,26	0.59	0.58
Rural residents in 2000	41033		1891	2694	3959
Number of households in 2001	12657	3405	459	726	879
Household size (person)	4.3	4.2	4.3	4.5	4.5
Number of households with livestocks	10121	1558	441	672	781
Herders households	7454	648	318	501	588
Number of herders	18243	1335	754	1118	1462
Livestock ('000 in 2001)	1,429,138	119515	80285	86741	153853
Of which Camel	12093	405	639	541	1114
Horses	182908	15111	13781	10530	16611
Cattle	137929	10220	63555	7789	14815
Sheep	708017	60394	35914	46786	84127
Goats	388191	33385	23596	21095	37186
Females	172381	15659	10814	10262	16232

Source: Sukhbaatar statistical yearbook 2002, - published latest version

The crop production has been developed since 1956, at that time 15 ha of land was sown to potato and other vegetables. In 2001, 47.2 ha of land was sown to potato and vegetables and 132.1 tonnes of produce was harvested.

5. Uberkhnagai Aimag

Uberkhangai aimag (62,900 km^2) was established in 1931 and is located 420 km from Ulaanbatar city by sealed road. Uberkhangai has 112,000 thousand residents and 1,650,000 livestock animals with 28,000 households. It is sparsely populated and is under developed. Herding is the main activity. The population has been stable over the past few years.

The area has rich gold, coal and other natural reserves. The main economic production activities are agriculture and livestock husbandry. USAID funded “Gobi Initative for economic growth” project is implementing many small projects supporting agriculture and livestock sector. This project supports pasture management and water supply serves and covers with 1103 herders of 602 households 58 herders group from 17 sums.

Table A5.6 Some Key Statistics for Uberkhangai *Aimag*

Items	Statistic
Territory of aimag	62,900 km^2
No.of soums	19
Population of aimag	113,900
No. of households in airmag	28,300
Population of Arviheer	21,600
Population density	1.81/km^2
% Rural residents in 2000	81.7%
Household size	4.2 persons
Distance to Ulaanbatuur	430 km
No. of herders	38,312
No. of herder households	17,814
No. of animals/herder household	94
No.of livestock	1.7 million (15 per capita)

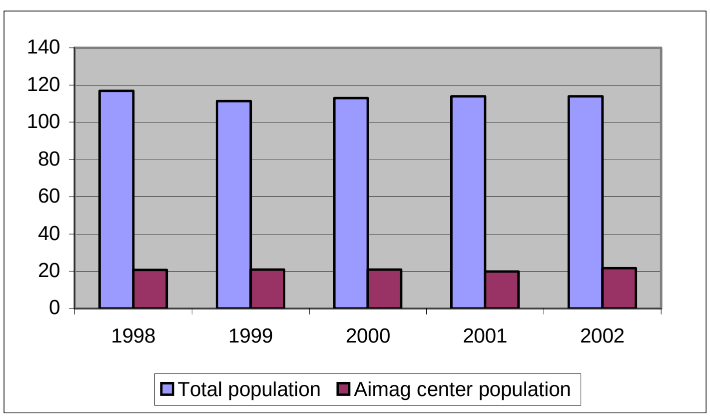


Figure A5.3 Population in Uberkhangai aimag

Table A5.7 Growth/decline of livestock in Uberkhangai *aimag*

	Types of animals	1999	2000	2001	2002	2003
1	Camel	19,300	16,500	14,700	13,300	
2	Horse	288,000	178,100	141,000	115,100	
3	Cattle	296,000	174,800	99,300	75,300	
4	Sheep	1,423,100	1059,000	911,100	805,900	
5	Goat	930,400	730,600	703,000	655,700	
	Total	**2,956,600**	**2,159,000**	**1,869,100**	**1,665,400**	**1,918,832**

Table A5.8 Number and percentage of households with livestock

Year		Up to 100	100-200	201-500	501-1000	Over 1000
2001	#	15653	4324	1677	131	22
	%	71.8	19.8	7.7	0.6	0.1
2002	#	14902	3945	1627	93	11
	%	72.4	19.2	7.9	0.5	0.1

Figure A5.4 Growth/decline of livestock owners

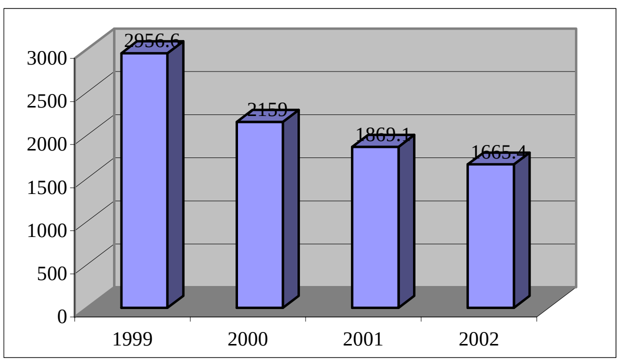
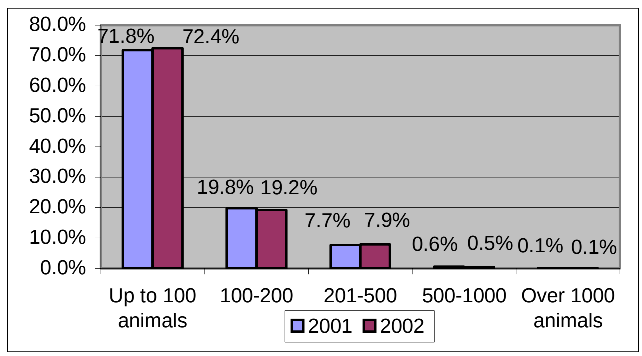


Figure A5.5 Percentage of livestock



Source: Uberkhangai statistical yearbook 2003 - published latest version

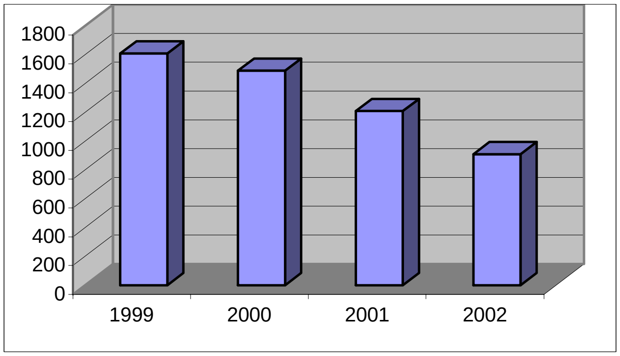
6. Omnogobi Aimag

Omnogobi *aimag* (165,400 km^2) is located in Southern part of Mongolia 553 km from Ulaanbatar. It has 15 soums and a population of 47,200. Population growth of the aimag has been fairly stable since 1998. The capital city is Dalzanagad (population 13,966). Population density is low (0.29 persons/ km^2) and the rural population is 72%. There are 11,900 households of which 7,600 are herders. Total livestock population is about 1 million. The average number of livestock per household is 139 and per capita 19.3. Water wells are critical to the herding economy and at present there 4,898 wells in the aimag.

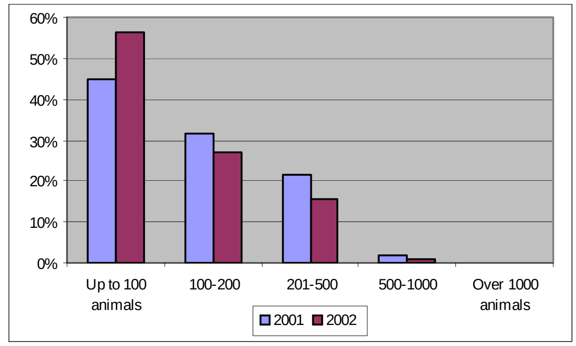
Table A5.9 Population Growth of Omnogobi Aimag

	1998	1999	2000	2001	2002
Total population	46,200	46,900	46,900	47,300	47,200
Aimag center population	12,631	12,803	12,686	13,420	13,966

Growth/decline of livestock

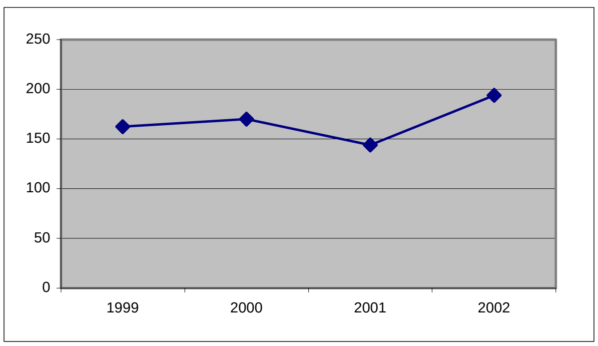


Percentage of households with livestock



Crop Farming

Growth of sown area



Growth of crops

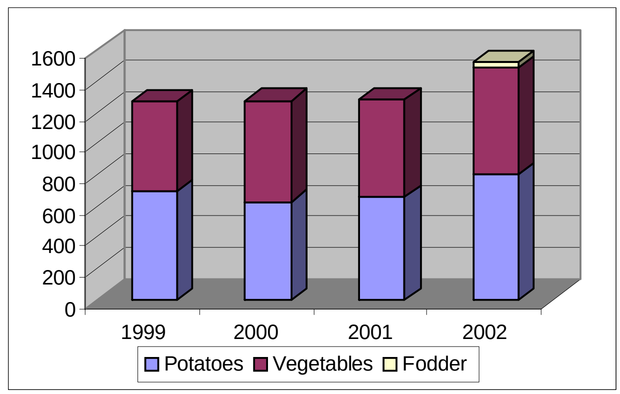


Table A5.9 Socio-economic Data of Focus Areas

Attribute	Dornogobi	Ovorhangai	Omnogobi	Sukhbaatar	Total
Territory (‘000 km^2)	109,5	62,9	165,4	82,3	15641
Number of sums	14	19	15	13	340
Number of bags	51	108	54	65	1671
Population (thousands)	520	113,9	47,2	56,1	2475,4
Population of density	0,47	1,81	0,29	0,68	1,58
Name of capital city	Sainshand	Arvaikheer	Dalanzadgad	Baruun Urt	Ulaanbaatar
Distance between aimag and UB (km)	463	430	553	560	0
Percentage of resident population urban %	52,3	18,3	28,4	20,7	57,4
rural%	47,7	81,7	71,6	79,3	42,6
Number of households (‘000)	12,7	28,3	11,9	13,1	568,6
urban	6635	4243	3245	2700	311965
Rural	6048	24035	8628	10365	256660
Number of female headed households	1504	2685	2078	1170	61765
Number of herdsmen household	3933	7814	6482	7573	175911
Number of herders	9068	38213	14160	18612	389765
Births	987	2366	977	1133	46922
Deaths	322	786	359	358	15857
Natural increase	665	1780	618	775	31065
Economically active population	20	47,7	21	24,4	901,7
employees (thousand)	19,6	45,5	20,6	23,7	870,8
Unemployment	427	2137	435	687	30877
unemployment rate	2,1	4,5	2,1	2,8	3,4
Aimags share in GDP (2001)	1,30%	1,90%	1,60%	1,60%	100
Number of facilities for community service					
Water supply					
Household using distributed water	5533	9535	4949	5925	232037
Environment					
Annual average temperature	5	3	6,4	2,5	
Number of days with rainfall					
Rainfall (mm)	109,8	119,5	75,4	203,7	
Days	56	87	62	95	
Climate precipitation	116,7	245,2	127,1	201,8	
Jan	-17,8	-14,7	-14,9	-21,5	
July	22,8	15,3	21,1	19,9	
Number of forest fires		5		2	323
Forest harvest volume (‘000 m^3)		15,2	1,8		568,3
Revenue of local Government (mln/tg)	2520,8	3119,7	1555,2	1501,2	102604,8
Expenditure of local Government	4825,5	6161,1	3886,8	4298	164330,9
Subsidies from the central Government	1938,2	2534,9	2091	2463	49237,1
Total number of livestock(thousand head)	825,8	1665,4	909,1	1516,1	23897
Camel	28,2	13,3	72	12,4	253
Horse	74,8	115,1	42,2	188,8	1988,9
Cattle	37,3	75,3	6,9	140,4	1884,3

Sheep	340,4	805,9	227,7	711	10636,6
Goat	345	655,7	560,4	463,5	9134,8
Number of breeding stock	347,9	691,9	423,4	634,6	10479,3
Sown areas (hectares)	39,1	3512,2	193,9	1270	285719,2
Cereals		3258,6		1100	263045,6
Potatoes	18	168,1	119,8	46,8	10232,9
Vegetables	20,1	83	66,4	23,2	7095,7
Fodder crops	1	2,5	7,7	100	2953,7
Harvested total crops (‘000 tons)		775,9		926	125861,5
Potatoes	65,2	952,2	803,8	175,4	51887,9
Vegetables	169,6	426,3	679,2	96,5	39721
Fodder crops		10,5	33,9	80	3526,9
Yield of cereals, potatoes (per hectare)					
Cereals		4		8,4	5,7
Potatoes	37,3	58,3	67,6	38	56,4
Gross hay harvest (‘000 ton)	2,3	13	3,9	13,1	767
Hand made fodder (of fodder unit)	0,2	4,1	0,7	0,8	26,9