

COMBATING DESERTIFICATION

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1. Introduction

In 1994 “The United Nations Convention to Combat Desertification ”(hereafter abbreviated as ‘CCD’) provided a clearer definition of “desertification”, elaborating on the causes and scope: “desertification indicates land degradation in arid, semi-arid and dry sub-humid regions caused by many factors including climate changes and human activities... ‘Land degradation’ indicates biological or economical productivity and complexity reduction or loss of rain-fed land, water-irrigated land, rangeland, pastureland, forest and woodland in arid, semi-arid and dry sub-humid regions due to land utilization or one force or several forces combined. These include: (1) wind erosion and water erosion cause soil material loss; (2) soil physical, chemical and biological character or economical character deterioration, and (3) long-term loss of natural vegetation”; “‘arid, semi-arid and dry sub-humid’ indicate the areas where the ratio between annual precipitation and potential evapotranspiration is in the range 0.05 to 0.65, but polar areas and sub-polar areas are excluded”.

Based on the United Nations’ information, at present desertification has already affected one fifth of the world’s population and one third of global terrestrial land. Desertification has brought serious catastrophe to the global environment and people’s lives and very survival in many developing countries. It has become an important factor as a cause of poverty and a hindrance to economic and social sustainable development.

China is one of countries seriously impacted by desertification. In NW China, the north part of Central-north China and the western part of NE China, there is a large arid,

semi-arid and sub-humid region. Here the eco-environment is extremely fragile. With daily-increasing population pressure, the land desertification situation is becoming increasingly severe. Serious damage is being done to the local environment, socioeconomic development and people's lives and existence.

Chinese people have a long history of combating desertification, and the central government has attached great importance to it since the early 1950s. A large-scale planned project to combat desertification throughout China was started at the beginning of the 1990s. In 1991 and 1993, the State Council convened the Lanzhou and Chifeng conferences for preventing and combating desertification. After the Lanzhou conference, the State Council approved "1991-2000 National Combating Desertification Overall Planning Key Outlines", and decided to bring preventing and combating desertification into national economic and social development planning. Later, the Ministry of Forestry compiled "1990-2000 National Combating Desertification Project Overall Planning" based on "Overall Planning Key Outlines". In 1994, the Central government authorized the Ministry of Forestry to be in charge of the national combat against desertification, and set up the Coordinating Group to Combat Desertification. For increasing capacity to combat desertification, the China Desertification Monitoring Center, China Training Center to Combat Desertification and China Research and Development Center to Combat Desertification were successfully established. China's Executive Committee was established as the governmental supervision agency in 1994. Since the seventh five-year plan period, various science and technology projects for tackling key problems related to combating desertification have been completed, and the government has already put combating desertification as a key project in the ninth five-year plan period of the National Scientific Research Plan.

Under joint efforts of all related institutions, desertification rehabilitation in China has been incorporated into the National Social and Economic Development Plan and great achievements have been made. In desertified area, vegetation rehabilitation, rangeland construction and soil conservation have made considerable progress. Many successful practical techniques and experiences as well as models of development and management, have been created. These include biological fixation of shifting sands, sand fixation along railways, arable land construction through flattening dunes with floods, aerial sowing of grass and trees in sandy land, rice cultivation on sand dunes, integrated management of small watersheds, rational rotational grazing, and livestock industry linked to grass yield. Several artificial oases have been created in arid and semi-arid areas. In marginal areas, sand dunes have been stabilized and more crop-farming activities have been quickly developed. The eco-environment is clearly improving in many areas, social economy is developing, and local people's living standard has greatly improved.

2. Classification and index of desertification used in China

2.1. Classification system of desertification in China

The classification system primarily includes the classification of land use, the classification of desertification patterns and classification of climate type.

There are six categories of land use:

- Arable land;
- Rangeland and pastures;
- Woodlands;
- Resident settlements and industry/transport facilities and mining areas;
- Water area;
- Non-reclaimed lands.

There are five categories of desertification pattern, based on the major external forces leading to desertification:

- Desertification caused by wind erosion and eolian processes;
- Desertification caused by water erosion and alluvial processes;
- Desertification caused by freezing and melting processes on cold plateaus;
- Desertification caused by soil salinization, alkalization and waterlogging;
- Desertification caused by other interacting factors (resultant factors).

On one hand, all desertification patterns are manifested in the land use types, and consequently the particular manifestations of desertification in land use types are presented, for the purposes of further description of the direct threats of desertification to human life. On the other hand, the desertification processes will be described from the point of view of their damage to land and people (regardless of the classification systems for desertification and not related to the area of desertification).

The manifestations of desertification in the main land use types are divided into the following components:

- Degraded rangelands;
- Degraded arable lands, and
- Deforested woodlands;

The classification of desertification by climate type uses the Thornthwaite Method, which is used worldwide to calculate potential evapotranspiration. In some regions, however, for example in Tarim Basin and Alxa Plateau, meteorological stations are sparsely distributed, and a multivariate regression equation is used for interpolation based on standard variables such as longitude (LONG), latitude (LAT), altitude (ALT) and moisture index (MI).

Based on CCD, arid, semi-arid and dry sub-humid areas mean those regions where the ratio between annual precipitation and evapotranspiration is between 0.05 and 0.65. Based on this index, the indicators of the classification of climate type of desertification are listed in Table1 and Figure 1.

Climate Type	Moisture Index (MI)
Extreme arid area*	$MI \leq 0.05$
Arid area	$0.05 < MI < 0.20$
Semi-arid area	$0.02 < MI < 0.50$
Dry sub-humid area	$0.50 < MI < 0.65$

Humid area*	MI>0.65
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*Means the climate scope without possible occurrence of desertification

Table 1. Indicators of classification of climate type of desertification

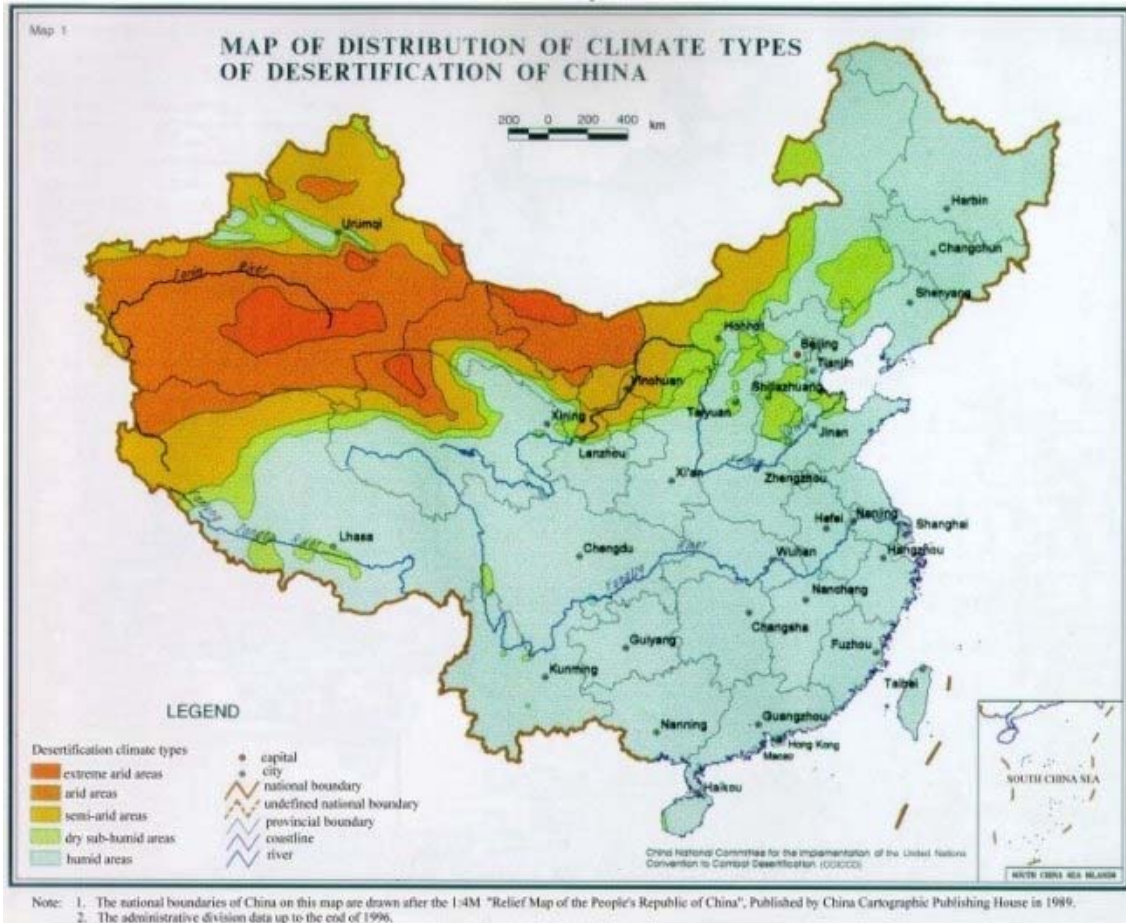


Figure 1 Map of Distribution of climate types of desertification in China

2.2. Grading index of various desertification patterns

2.2.1. Grading of severity of desertification

In order to indicate objectively the severity of desertification in China and to operate in a comparative way in implementation of the classification, the following three grading classes have been adopted.

- Slight desertification;
- Medium desertification, and
- Severe desertification.

2.2.2. Grading index of various desertification patterns

Desertification caused by wind erosion

The integrated analysis and transformation are compiled on the main bases of the maps, literature and database of the final results of the National Integrated Survey of Desert, Gobi and Desertification Affected Land in China, with reference to the information of the National Remote Sensing Survey of Soil Erosion in North China. The severity of desertification caused by wind erosion is as follows:

- Slight: Vegetation coverage is >30%, sand movement is less obvious and land surface is covered by stable or basically stable sand dunes or sand fields, and cultivated fields created from sandy land.
- Medium: Vegetation coverage is between 10% and 30%, and is evenly distributed. Average plant community contains 750 individual tree or bushes per ha. Wind blow-out and sand drift is controlled by the plant community. However, sand movement ripples are prevalent on sand dunes or sandy fields.
- Severe: The surface is composed of Gobi; vegetation coverage is less than 10%; mobile dunes, sand sheets and denuded interdune areas are inter-distributed; sand dunes are stabilized by non-biological means; the surface landform is composed of denuded residuals, unfertilized fields, Yardang landforms, clay mounds and wind blow-outs.

Desertification caused by water erosion

Grading indicators from relevant institutions dealing with soil and water conservation are shown in Table 2.

Severity	Erosion Modulus (t/km².a¹)	Mean annual loss Depth (mm)
Slight	1000-2500	2
Medium	2500-8000	2-6
Severe	>8000	>6

Table 2. Indicators for grading the severity of desertification caused by water erosion

Desertification caused by frozen and melting processes on cold plateaus

Grading indicators from relevant institutions dealing with soil and water conservation are shown in Table 3.

Severity	Locations of the occurrence of desertification
Slight	Extreme highlands, high mountain, gentle slope meadow and flooded depression and ridge area on plateau.
Medium	Extreme highlands, high and cold hill and desert steppe.
Severe	Extreme highlands, high mountains, high and cold mountain deserts and cold deserts.

Table 3. Indicators for grading the severity of desertification caused by freezing and melting processes on cold plateaus

Soil salinization

Soil salinization means the secondary soil salinization caused by flood irrigation in arid, semi-arid and dry sub-humid areas. Soil salinization is defined as one component of desertification. The severity of soil salinization is divided into following three classes as listed in the Table 4

Type	Salt content in the soil (0-30cm deep) (%)		Reclaim possibility
	West Region (Xinjiang)	East Region (Inner Mongolia)	
Slight	0.5-1.0	0.1-0.3	With favorable conditions to be reclaimed by simple improvement only
Medium	1.0-1.5	0.3-0.7	Water conservancy project and improvement measurement are required
Severe	1.5-2.0	0.7-1.0	Reclaim condition is poor and integrated measures are needed.

Table 4: Soil salinization classification and grading indicators

2.2.3. Indicators of degradation of several main land-use types

Rangeland degradation

(A). Indicators of rangeland degradation

The indicators of rangeland degradation can be determined by the following four aspects:

- Reduction of production of edible fodder;
- Decline of nutrition components and palatability of fodder;
- Degradation of micro-environment of rangeland;
- Acceleration of development of low-energy grade of rangeland, shortening of food chain and simplification of plant composition.

(B). Grading criteria of rangeland degradation

- **Slight degradation:** Plant community composition has not greatly changed, but individual quantities of different species have been obviously changed. In general, biomass of different species has been reduced. Species with high palatability and low trample tolerance have decreased or disappeared, and consequently the species with low palatability and high trample tolerance have increased. The fodder yield and vegetation coverage has declined by one third. Geo-botany has obviously reduced or partially disappeared.
- **Medium degradation:** Community species and pioneer species have been replaced by trample-resistant species and drought tolerant dwarf shrubs and herbs. Mesophyte composition with low trample-resistance has disappeared. However, most aboriginal species are still present in the community. The grass community is

sparsely scattered as low growth. The edible biomass and vegetative coverage have been reduced by 50%. Land surface is partially exposed with scattered denudation and the soil is compacted. In low-lying and wet depression areas, the salt content in soil has obviously increased.

- **Severe degradation:** The original plant community has disappeared, and species composition has been simplified so that there are many single-species patches. The dominant community is composed of dwarf weeds and trample-resistant bushes. Vegetation cover and fodder palatability have greatly decreased; the grass community has been reduced and shortened; coverage and edible fodder yield have decreased by more than one third, and topsoil has been exposed. Obvious micro-denudation land forms have developed on the surface. Organic matter in soil has reduced. The surface is obviously salinized and land has been covered with spots. The surface vegetation has disappeared or only sparse weeds remain. The land has been exposed by salinization, with zero values when the soil has been completely salinized.

Arable land degradation

Arable land degradation means the reduction of productivity or quality of the arable land under the impact of soil erosion and secondary salinization. These degraded arable lands were classified as second grade arable land, third grade arable land, and non-cropping land, according to the classification of the Map of Land Resources of China at a scale of 1:1 million. Second grade arable land is gentle sloping land characterized by slight erosion and slight degradation, and its utilization is reduced. Third grade arable land means moderately degraded arable land on a steep slope, characterized by moderate erosion and/or salinization, and its utilization for cropping is forbidden. Non-farming arable land with a slope of more than 15 degrees is classified as degraded land, subject to serious erosion, large area of salinized soil and thick sand deposition (see Table 5).

Grade	Slope and soil	Wind/sand impacted land	Saline and alkaline land	Remediation measures
Slight	Slope degree < 7 degrees, slight erosion of water, existence of soil A horizon	Slight wind erosion, soil A horizon present		Simple protection measurements needed
Medium	Slope degree 7-15; Loss of soil A horizon, gully processes starting	Medium wind erosion, loss of soil A horizon, 0-30 cm sand accumulation	Medium secondary salinization	Complicated protection approach needed
Severe	Slope degree >15, serious gully processes operating	Severe wind erosion sand accumulation exceed 30cm, sand mounds occurred	Secondary salinized soil unsuitable for farming, readjust landuse pattern, on land approach needed	

Table 5. Indicators of arable land degradation

Rainfed cropping farmland on ridge with chestnut soil, rainfed cropping farmland on ridge with yellow cinnamon soil, rainfed cropping farmland on ridge with dark castanozem and the rainfed farmland on ridge with light dark chernozem have been classified as slightly degraded slope arable land types. The rainfed cropping farmland with saline meadow soil on plain land and saline wet soil on plain land have been classified as slightly degraded salinized land types. Rainfed cropping farmland with chestnut soil on plain land and rainfed cropping farmland with podzol on plain land have been classified as slightly degraded wind/sand impacted lands type.

The rainfed cropping farmland with castanozem soil on hilly and the rainfed cropping farmland with the yellow cinnamon soil on hilly land have been classified as the medium degraded slope arable land type. Irrigated cropping farmland with seriously salinized wet soil on flooded land and the rainfed cropping farmland with salinized and alkalized meadow soil on flooded land have been classified as slightly degraded salinized and alkalized land types. The rained with sand chestnut on plain land and the ranfed cropping farmland with sand gray chestnut soil on plain land have been classified as the medium-degraded wind/sand impacted land types.

Rainfed arable land on ridges and hills of loess upland and rainfed arable land on low loess hills have been classified as severely degraded slope land types. The rainfed arable land with muddy sandy loam on loess hill and rainfed cropping farmland with sandy loam on plain land is classified as severely degraded wind/sand impacted land type.

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Bibliography

China National Committee for the Implementation of the United nations Convention to Combat Desertification (CCICCD).(1997). *China Country Paper To Combat Desertificatioion*. China Forestry Publishing House, 40pp+7maps. [This is a basic document which provides information and data of desertification in China at national level.]

Ci Longjun (1994). The impact of globe change on desertification in Chins. *Journal of Natural Resources* 9(4), 289-303pp. (in Chinese w/English abstract). [This paper is the first one about the interaction of global change and desertification in China, it describes different scenarios of desertification after global warming.]

Ci Longjun (1998). Mechanism of desertification and sustainable strategies to combat desertification in China. *Quaternary Sciences* (2), 97-107pp. (in Chinese w/English abstract). [The paper gives basic theories of desertification especially under China's situation and suggests some significant strategies of

combating desertification in China.]

Ci Longjun (1999). *Desertification and Rehabilitative Strategies in China*. 21pp. [This is a paper presented in the IUCN/WCPW-EA-3 Seoul Conference 7-11th Sept. 1999, Seoul, Korea.]

Ci Longjun and Wu Bo (1997). A systematic analysis of the man-made influence in modern desertification process. *Journal of Natural Resources* 12(3), 211-218pp.(in Chinese w/English abstract). [This is a paper deals the human impacts to desertification in China.]

Liu Yuping and Ci Longjun (1998). The evaluating indicator system of grassland desertification in Mu Us Sandy land. *Journsl of Desert Research* 18(4), 366-371pp. (in Chinese w/English abstract). [A case study on evaluation desertification in grassland of a sandy land area in Inner Mongolia.]

Wang Junhou and Sun Siheng (1996). The classification of desertification and its quantitative assessment system. *Arid Environmental Monitoring* 10(3), 129-137.(in Chinese w/English abstract). [This is a paper about desertification assessment using quantitative methods.]

Wu Bo and Ci Longjun(1998). The developing situation and expanding courses of desertification in Mu Us sandy land since the 1950s. *Quaternary Sciences* (2), 165-172+2plates. (in Chinese w/English abstract). [A dynamic study on the process of desertification in a sandy land area of Inner Mongolia.]

Biographical Sketch

Longjun Ci, a professor of Landscape Ecology and Combating Desertification, graduated from postgraduate class, Beijing Forestry University in 1958 and got her Ph.D. from Cornell University, USA in 1991. At present she works in the State Administration of Forestry to serve as Director-General of National Bureau to Combat Desertification and Vice-President of Chinese Academy of Forestry, and also holds many concurrent posts, such as adjunct professor and doctoral candidates supervisor of Beijing Forestry University, Vice-President of Chinese Landscape Ecology Society and others. Professor Ci has been engaged in combating desertification for over 40 years and has taken part in many important scientific surveys, research projects and establishment of various experimental stations. She has led and completed 10 major research projects. She has published three books and more than 40 papers, both in China and abroad.