

Assessment and Mapping of Desertification

Nikolai Kharin

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NIKOLAI KHARIN
CENTER ON PROBLEMS OF
ECOLOGY AND PRODUCTIVITY
OF FORESTS, RUSSIAN AC. SCI,
MOSCOW, RUSSIA

The United Nations Convention to Combat Desertification defines desertification as

"LAND DEGRADATION IN ARID, SEMI-ARID AND DRY SUBHUMID AREAS RESULTING FROM VARIOUS FACTORS, INCLUDING CLIMATE VARIATIONS AND HUMAN ACTIVITIES".

More than 110 countries of the world have drylands which are prone to desertification. According to UNEP, the annual economic losses from desertification in the whole world totals US \$42 billion.

Desertification is one of so called Accumulated Ecological Problems (AEP). AEP include such problems as acid rain, desertification, drought, climate change, etc. Each of these problems is a result of a long accumulative process which can't be identified by the people at once.

The process of desertification initiated in the deserts can expand, like a cancer, to the bordering areas. For example, particles of dust and salt blown off from the dry, exposed floor of the Caspian Sea, are transported by wind over great distances.

Hundreds million of people in the countries affected by desertification suffer directly from shortage of food and environmental quality. Several millions of ecological refugees, (a category of people not recognized by UN agencies!), seek asylum in neighbouring countries. So, the problem of desertification has been transformed to social and political problem.

MEASURES ON DESERTIFICATION CONTROL

Concept	Degree of land degradation		
	From non degraded to slightly degraded	Moderately degraded	Severely degraded
Preventing measures	Conservation and rational exploitation		
Correcting measures		Rational exploitation combined with partial melioration	
Measures on full rehabilitation of degraded land			Melioration of the whole area
Supporting measures	Capacity building, training, research etc.		

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Mean NDVI (May 1992) for different land cover types
of Kalmykia

Classes of NDVI	Landscapes – analogues		
	Accumulative maritime clay plain	Aeolian plain	Delta of the Volga
>0.60	Swamps with dense vegetation		Hydrophyllous vegetation and swamps
0.60 – 0.54	Meadow and swamp Vegetation		Meadow and swamp Vegetation
0.54 – 0.48	Meadow vegetation	Meadow vegetation	Meadow vegetation
0.48 – 0.42	Slightly degraded meadow and steppe vegetation		Slightly degraded meadow and steppe Vegetation
0.42 – 0.36	Moderately and slightly degraded vegetation (dwarf semi-shrub communities)		
0.36 – 0.30	Communities of <i>Artemisia lerchiana</i> , <i>A. pauciflora</i> , slightly degraded		
0.30 – 0.24		Communities of <i>Artemisia Lerchiana</i> , <i>Agropyron fragile</i> , slightly degraded	Fragments of steppe vegetation (<i>Artemisia lerchiana</i> , <i>Agropyron fragile</i> , slightly degraded)
0.24 – 0.18		Moderately degraded Steppe vegetation (<i>Artemisia lerchiana</i> and <i>Stipa capillata</i> + <i>Artemisia Lerchiana</i> communities)	Fragments of steppe Vegetation (<i>Artemisia lerchiana</i> and <i>Stipa capillata</i> + <i>Artemisia lerchiana</i> communities) moderately

0.18 – 0.12		Severely degraded Steppe with <i>Bromus tectorum</i> , <i>B. squarrosus</i> , <i>Eremopyrum triticeum</i> , <i>Artemisia lerchiana</i>	degraded) Fragments of sandy steppe with <i>Bromus tectorum</i> , <i>B. squarrosus</i> , <i>Eremopyrum triticeum</i> Severely degraded
0.12 – 0.06		Very severe degraded steppe with <i>Leymus rascemosus</i> , <i>Calligonum aphyllum</i> and <i>Artemisia arenaria</i>	Fragments of steppe With <i>Leymus rascemosus</i> , <i>Calligonum aphyllum</i> and <i>Artemisia arenaria</i> . Severely degraded
< 0.06	Soil devoid of vegetation	Moving sands	Moving sands

DESERTIFICATION ASPECTS

IR Inherent Risk

CS Current Status

CR Current Rate

HP Human Pressure

AP Animal Pressure

DH Desertification Hazards

$$DH = IR + CS + CR + HP + AP$$

DESERTIFICATION ASSESSMENT SCALE

Zero	Slight	Moderate	Severe	Very severe
	Slight	Moderate	Severe	Very severe
	Slight	Moderate	Severe and very severe	

The area of the drylands of Asia

(Kharin, Tateishi & Harahsheh, 1999)

Class names	Area, km2	Percentage
Semi-arid	3,040,189	25.49
Arid	7,294,219	61.14
Extra-arid	1,194,563	10.01
Mountains (within the drylands)	401,148	3.36
Total	11,930,119	100.00

Desertification of land use types of Asia, km2 (Kharin, Tateishi & Harahsheh, 1999)

Land use/ Land degradation Type	Land degradation areas – km ²				Percentage	
	Slight	Moderate	Severe	Subtotal	Percentage of subtotal	Percentage of total
Forest, woodland / Vegetation degradation	0	61,765	257,333	319,098	78.13	3.25
Forest, woodland / Water erosion	6,041	32,198	12,521	50,760	12.43	0.52
Forest, woodland / Wind erosion	0	38,563	0	38,563	9.44	0.39
Subtotal	6,041	132,526	269,854	408,421	100	4.17
Rangeland & meadow / Vegetation degradation	1,636,595	2,634,915	1,191,224	5,462,734	68.31	55.72
Rangeland & meadow / Water erosion	86,021	321,795	0	407,816	5.10	4.16
Rangeland & meadow / Wind erosion	190,582	1,026,945	861,628	2,079,155	26.00	21.21
Rangeland & meadow / waterlogging	7,363	27,206	12,258	46,827	0.59	0.48
Subtotal	1,920,561	4,010,861	2,065,110	7,996,532	100.00	81.56
Dry agriculture / Water erosion	32,405	251,114	16,232	299,751	44.36	3.05
Dry agriculture / Wind erosion	216,432	155,130	4,477	376,039	55.64	3.84
Subtotal	248,837	406,244	20,709	675,790	100.00	6.89
Irrigation agriculture / salinization	191,697	337,378	175,240	704,315	100.00	7.18
Dried up sea floor / salinization	0	10,335	9,307	19,642	100.0	0.20
Total	2,367,136	4,897,344	2,540,220	9,804,700	0	100.00

THE CRITERIA FOR ASSESSMENT OF THE VEGETATIVE COVER DEGRADATION

Assessment and mapping desertification in the framework of this project was based on application of low resolution space images. NOAA/AVHRR data were found to be useful for the analysis of desertification. Normalized Difference Vegetation Index (NDVI) was computed by the formula :

$$NDVI = (NIR - RED) / (NIR + RED)$$

Where :

NIR – reflectance in near infrared spectral band
(channel 2 of AVHRR)

RED – reflectance in red spectral band
(channel 1 of AVHRR)

Two types of NOAA/AVHRR data were used :

- 21 – 31 May (1992 – 1994), 4 arc-minute resolution NDVI data (8 km ground resolution)
- April 1992 – March 1993, 30 arc – second resolution NDVI data (1 km ground resolution)

Interpretation of small scale image was conducted by the following procedure:

1. Unsupervised classification of 4 arc-minute NDVI images,
2. Land cover classification by 30 arc-second monthly NDVI data,
3. Visual interpretation of different classes of imagery within landscapes - analogues

Status criteria	Desertification classes		
	Slight	Moderate	Severe and very severe
Plant community	Climax or slightly changed	Long existing Secondary	Ephemeral secondary
Percentage of climax species	>75	75 – 25	<25
Decrease of total plant cover, %	<25	25 – 75	>75
Loss of forage on rangeland, %	<25	25 – 75	>75
Loss of current increment of wood %	<25	25 – 75	>75

The criteria of assessment wind erosion in sandy desert

Assessment factors	Class limits		
	Slight	Moderate	Severe and very severe
Area covered with moving sand dunes, %	15 – 30	30 – 70	>70
Sod cover, %	30 – 50	10 – 30	<10
Vegetation density, %			
Shrubs	10 – 15	5 – 10	<5
Herbaceous vegetation	40 – 65	10 – 40	<10

The criteria for assessment of water erosion

Assessment factors	Class limits		
	Slight	Moderate	Severe and very severe
Types of water erosion	Sheet Erosion (single cavi- ties)	Sheet erosion (up to 10 cavities per 1 km ² , single gullies)	Gully erosion (more than 10 cavities per 1 km ²)
Ablation of surface soil layer, cm	<5	5 – 20	>20
Vegetation density, %			
Trees and shrubs	<20	20 – 50	>50
Herbaceous vegetation	<20	20 – 50	>50

The criteria for assessment of water logging

rangelands

Assessment factors	Class limits		
	Slight	Moderate	Severe and very severe
Density of hydrophilous vegetation, %			
a. <i>Tamarix ramosissima</i> , <i>Alhagi persarum</i>	<30	-	-
b. <i>Tamarix ramosissima</i> , <i>Alhagi persarum</i> and <i>Karelinia caspia</i>	-	30 – 70	-
c. <i>Phragmites australis</i> , <i>Glycyrrhiza glabra</i> and <i>Alhagi persarum</i>			>70
Depth of fresh or low mineralized ground	5 – 10	2 – 5	<2
Water			
Soil humidity regime	Automorphic	Semi-hydro-morphic	Hydro-morphic

of irrigated farmlands

Assessment factors	Class limits		
	Light	Moderate	Severe and very severe
Degree of salinization			
a) Total solid residue, %	0.210 – 0.400	0.400 – 0.600	>0.600
b) Cl, %	0.01 – 0.030	0.030 – 0.100	>0.100
c) Na+, %	0.023 – 0.046	0.046 – 0.092	>0.092
Mineralization of ground water, g/l	3 – 6	6 – 10	10 – 30
Mineralization of irrigation water, g/l	0.5 – 1.0	1.0 – 1.5	<1.5
Decrease in row cotton yield (% of the zero level)	<15	15 – 40	40 – 80
Seasonal salt accumulation			
a) Percentage	0.11 – 0.20	0.20 – 0.30	0.30 – 0.60
b) Metric tons per 1 ha	16 – 30	30 – 45	45 – 90
Degree of pollution of irrigation water (ratio of content of toxic chemicals to their allowed concentration)	1.0 – 6.0	6.0 – 11.0	>11.0

The criteria for assessment of salinization

In "The World Atlas of Desertification" (1992) boundaries of arid lands are delineated by the Aridity Index (AI) calculated by the equation :

$$AI = P/PET$$

where : P - precipitations, in millimeters

PET - potential evapotranspiration, in millimeters

The zonation of arid lands by AI was done in the Atlas by the following criteria:

- Hyperarid lands ($P/PET < 0.05$)
- Arid lands ($0.05 < P/PET < 0.20$)
- Semiarid lands ($0.20 < P/PET < 0.50$)
- Dry sub-humid lands ($0.50 < P/PET < 0.65$)

Classification of the drylands of Asia

(N. Kharin, G. Kalenov, V. Volovik, 1993)

- Semi-arid lands, low and high plains with precipitation 250 – 400 mm/year, with semi-desert shallow soils and semi-desert vegetation,
- Arid lands, low and high plains with precipitation 250 – 50 mm/year, with desert soils and desert vegetation,
- Extra-arid lands, low and high plains with precipitation less than 50 mm/year with fragments of primitive soils and sparse desert vegetation.