Land Use Types in Mongolia and Results of Land Use Condition Monitoring

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ABSTRACT

The goal of our work was to assess human impact to main land use types of Mongolia and study land use change trend and main influence/impact types of land degradation. In this paper we are presented some result of our land condition monitoring activity from 1998 to 2006 which were covered most territory of Mongolia - 147,895,400 hectares.

Mongolian land use type classes by the land cover classification: 81.2 % is rural land, 5.1 % is urban land, 8.2 % is Forest land and shrub covered area, 1.4 % is Surface water, 4.1 % is Unused, Unsuitable and Conservation area .

Land use has changed since 1970: settlement, natural protected land and mining areas are increased, cultivated land is decreased. National Land Monitoring on the agricultural /pasture and arable land/ land, Natural parks, Urban areas showing from 21 until 57.2 per cent of the area s of those land use types degraded which is in future will severe problem in land protection and presenting weak land use controls and management.

Keywords*: land use change, land use condition monitoring, land degradation*

INTRODUCTION

By the increasing demand of land for agriculture, concentration of urban land in central region, development of mining industry and land privatization, the conditions of Mongolian land usages are getting more unsuitable for use.

The goal of our work was to assess human impact to main land use types of Mongolia and study land use change trend and main influence impact types of land degradation.

In this paper we are presented some result of our land condition monitoring activity from 1998 to 2006 which were covered most territory of Mongolia - 147,895,400 hectares. In the new Mongolian land law (1994) it is stated:

The State must regularly control negative land usages and avoid negative influence to population. State land authority must organise "land use condition control and state certification (monitoring)" activity in all kinds of land use in the territory of Mongolia (Chapter6).

Due to this activity it is very important to monitor land usage and assess degradation of land and test new methodologies in the certain area and develop the monitoring activities for common purpose.

Methods

The study was made in two steps.

1. Identification of main land uses types and change trend evaluation. We used instruction of land survey (Administration on Land Affaires Geodesy and Cartography, 1995) and land use inventory.
2. Field trip reference areas to observe and test indicators on chosen areas. For assessment of degradation we used the following indicators:

- Vegetation general canopy cover, dominant species canopy cover, invader plants canopy cover per cent presented in 1 m^2 surface. Height of plants in cm.
- Plant bio mass production. Yield in dry matter- kilograms/ha
- Vegetation association structure. Invaders, decrease, increase of member plants in the association (Karamysheva, 1981; Rachkovskay, 1995).
- Bio indicator of degradation. Plants determining pasture degradation. We found 27 plant species growing aggressively in the degraded places.
- Soil stability indicators and evaluating score. We used standard American equipment and methodology (Pellant *et al*., 2000).

We used for degradation impact assessment three kinds of methods. The first is Soviet-Mongolian scientists developed method for ecosystem degradation evaluation in Mongolia (Gunin *et al*., 1989). The method is based on several vegetation indicators such as bio mass, association structure change, canopy cover, height, bio-indicator plants, etc.

The Second was rangeland health monitor's soil stability indicator method (Pellant *et al*., 2000). American Upland rangeland monitoring is including 17 indicators and has too detailed worksheet and procedure. Therefore we chose only soil stability indicators, which are not clearly included in the Soviet-Mongolian method.

The Last one was land use condition control and state certification introduction method (Administration on Land Affaires Geodesy and Cartography, 1995). In this introductory content more attention is paid to the mapping and erosion identification and grading in different types of land.

Results

The results of our study were consisted in two parts: land use types and trend of change and result of land use condition monitoring.

1. Mongolian land use types and trend of change

Mongolia as a continental country which biggest resource of land has a 1.16 percent of the total land resource of the world / Table 1 /.

Table1. World and Mongolian land resource

/ Million square km /

	Total area	Oceans	Continents	Total land resource	Agricultural land
World	510.20	361.06	149.14	133.92	45.53
Mongolia	1.56	-	1.56	1.56	1.21
Per cent of Mongolia in the world (%)	0.31	-	1.04	1.16	2.66

Last 30 years Mongolian population land resource demands become more pressing every year. Even in Mongolian country side where access of land is plentiful, from 1970 to 2000 land recourse demands had double increased (Purevtseren, 1995) /Table 2/.

Table 2. Mongolian population land resource demands in XX century

Years	Population density in 1 km^2	Land resource per one citizen /in hectares /
1919	0.41	242
1940	0.47	211
1960	0.60	164
1970	0.79	125
1980	1.05	94
1990	1.34	74
2000	1.52	65

In the beginning of the XX century Mongols used their land just 8-10 types. Today it comes more than 140 land use types (Myagmartseren, 2004).

The territory of Mongolia - percent of land classes by the land cover classification 83.46 % is **rural land ,** 0.49 **% is urban land ,** 11.69 % is **Forest land and shrub covered area,** 1.06 % is **Surface water,** 3.3 % is **Unused, Unusable and Conservation area** /Table 3/**.**

Table3. Main Land Types in Mongolia
(Areas in thousand hectares)

	Total area	Land Use Types					
		Agriculture	Urban	Road and rail network	Forest	Water bodies	Special purpose
/km^2/	156411.6	115455.7	441.1	353.8	14689.0	967.7	24504.3
%	100	74.0	0.2	0.2	9.0	0.6	16.0

From the state land use cadastre inventory and National Land Information Database we can see land use changes in 30 years. Land use change trend is dividing into two periods from 1975-1990 and 1990-2005, which had been presented by quite different social and economic constraints and stimulations to diverse type of land usage (Table4).

Table 4. Land use change in the period 1975- 2005
(Areas in thousand hectares)

Year / Land use types	1975	1990	2005	Change in period 1975-1990 -,+	Change in period 1975-2005 -,+
Pasture	120990.4	119304.6	111229.7	-1,685.8	-9760.7
Arable land	748.5	1281.6	697	+533.1	-51.5
Fallow, abandoned agricultural land	196.9	84.4	478.4	-112.5	+281.5
Town and Settlements	464.6	501.0	466	+36.4	+1.4
Mining area	46.8	58.9	97	+12.1	+50.2
Road	61.1	203.8	278.2	+142.7	+217.1
Natural Parks	132.5	5282.7	20864.8	+5,150.2	+20732.3
Utility	-	4.5	50.1	+4.5	+50.1
Military	2543.3	2593.2	218.1	+49.9	-2325.2
Forest land	15171.5	14403.1	14748.1	-768.4	-423.4
Water bodies	1619.2	1630.5	667.8	11.3	-951.4
Total	156411.8	156411.8	156411.8		

General land use changes in two periods are: agricultural sector development and destruction, rapid urbanization (rural areas population's migration to urban areas) and transformation of nomadic livestock husbandry to semi-sediment husbandry which is go behind overgrazing and desertification, global warming and human impact which have been presented by reduction of forest and surface water areas (Figure 1,2).

Figure 1

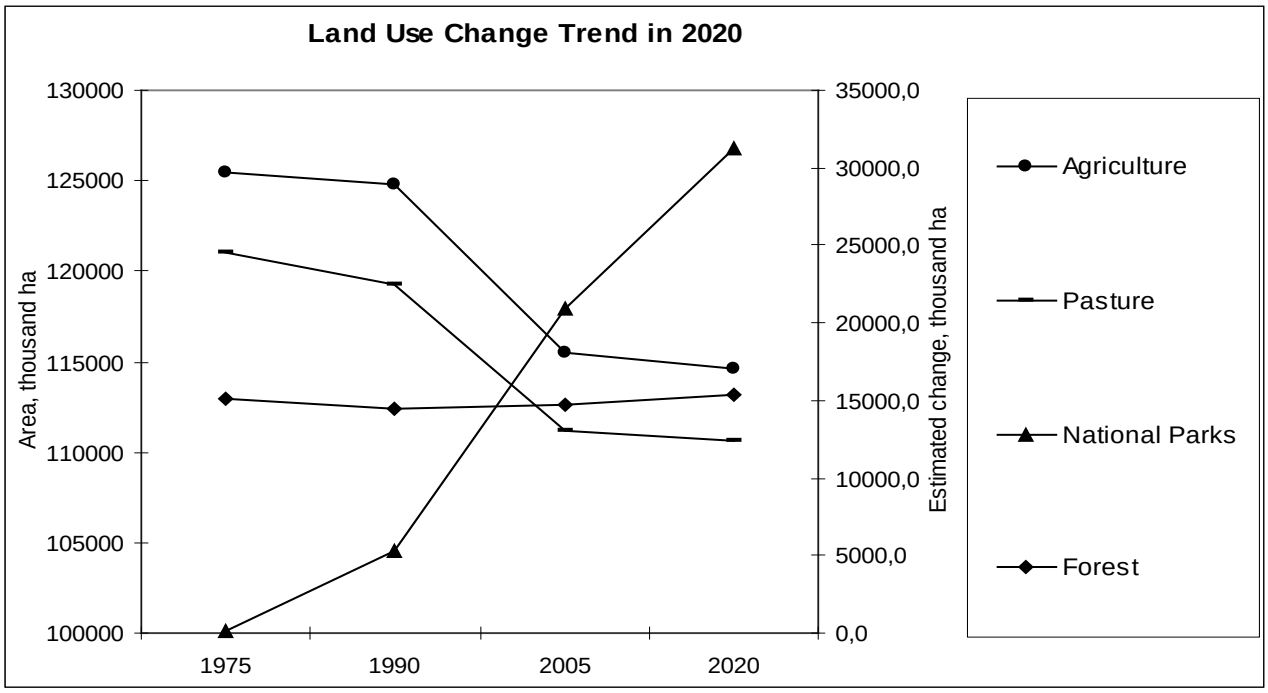
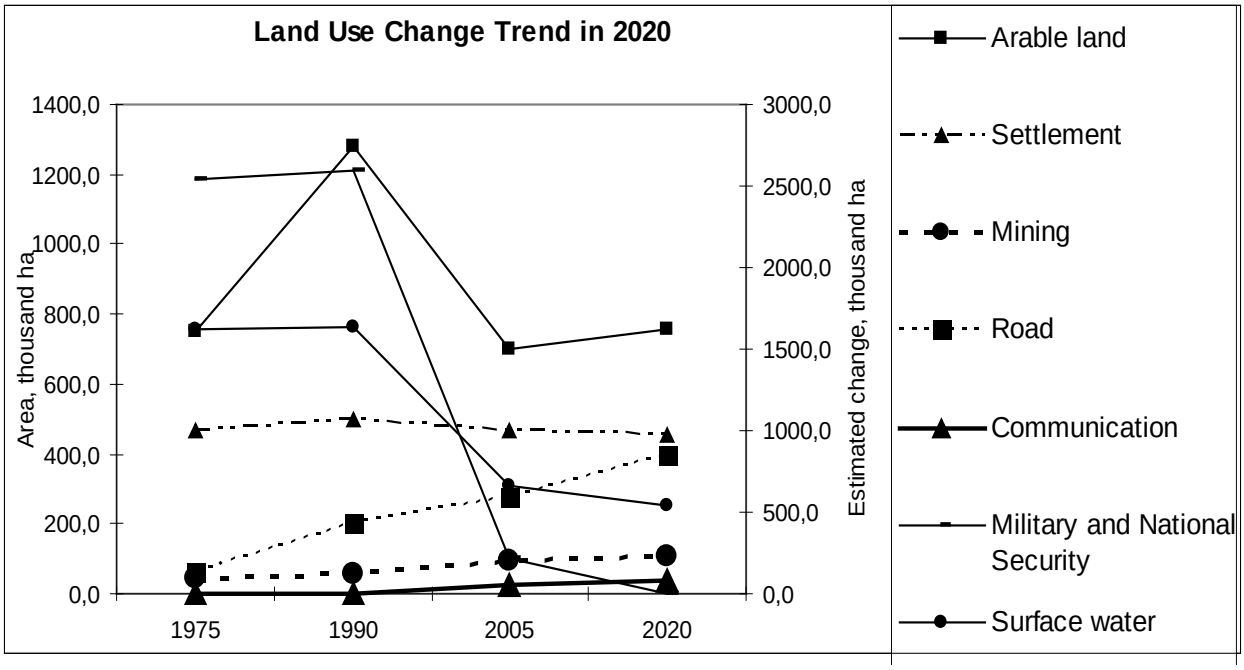


Figure 2



From the above figures we could find main change trend and based on that trends we are estimated future land use change to 2020 using formula (I-III) and estimated probable land area (Table 5).

$$y = a + bx \quad \text{(I)} \qquad \Rightarrow b = \frac{n\sum x_i\, y_i - \sum x_i \sum y_i}{n\sum x_i^{\,2} - \left(\sum x_i\right)^2};\ a = \bar{y} - b\bar{x} \Rightarrow \quad a = \frac{\sum x_i}{n} - b\frac{\sum x_i}{n} \text{(II)}$$

y_i - land use type , ha x_i - year

$$y = \left(\left(\frac{\sum x_i}{n} - b\frac{\sum x_i}{n}\right) + \left(\frac{n\sum x_i y_i - \sum x_i \sum y_i}{n\sum x_i^{\,2} - \left(\sum x_i\right)^2}\right)\right) x_i \quad \text{(III)}$$

Table 5. Trend of change and estimated area of land use types (Areas in thousand hectares)

	Land Use Change			Estimated change		
	1975	**1990**	**2005**	Using mid term change trend in 2020	Using short term change trend in 2020	Average trend in 2020
Total agriculture	125475,3	**124747,5**	**115532,6**	111975,8	117356,1	114666,0
Pasture	120990,4	**119304,6**	111229,7	107414,2	113872,3	110643,3
Arable land	748,5	**1281,6**	697,0	637,0	875,5	756,3
National Park	132,5	**5282,7**	20864,8	29492,3	33065,9	31279,1
Forest	15171,5	**14403,1**	**14748,1**	14350,8	16442,3	15396,6
Total urban	464,6	**501,0**	**466,0**	478,6	433,1	455,9
Mining	46,8	**58,9**	97,0	117,8	91,6	104,7
Road	61,1	**203,8**	278,2	398,1	400,6	399,4
Communications	0,0	**4,5**	50,1	68,3	84,8	76,6
Military and National Security	2543,3	**2593,2**	218,1	190,5	0,0	0,0
Surface water bodies	1619,2	**1630,5**	**667,8**	354,4	738,6	546,5

The estimated land use until 2020 are: the reduce of the agricultural areas and surface water bodies; rapid development of settlement land, road, mining industry. In generaly land use change trend and estimated areas presenting futur problems related to the agricultural reform, land protection and urban palnning.

2. Result of Land Use Condition Monitoring

In this paper we are presented some result of the state land condition monitoring activity from 1998 to 2006 which were covered most territory of Mongolia - 147,895,400 hectares.

In agricultural land usage most area is using under pasture grazing and it is around 87 per cent of agricultural territory. Result of pasture land condition monitoring were showed by land evaluation zones and 61.9 % area of the pasture are in normal conditions and 20.8 % are degraded (overgrazing, soil eroding, desertification etc.) and 20.1 % are at non usage due to the marginal location, non irrigation, less infrastructure or unsuitable for livestock grazing (table6).

Table6. Pasture land conditions by the land evaluation zones

(Areas in thousand hectares)

No	Land evaluation zones	Pasture area In total	In Usage				Non usage and unsuitable area	
			In normal conditions		Degraded			
			Hectares	%	Hectares	%	Hectares	%
1	Khangai & Khentey mountain	25916,2	16634,1	64.8	6098,4	23.8	1705,4	6.6
2	Altay mountain	18916,5	12142,9	64.2	3567,5	18.9	2451,6	13.0
3	Gobi	47172,1	29359,3	62.2	11096,4	23.5	12495,3	26.5
4	Steppe	18924,8	10627,3	56.2	2399,4	12.7	5662,3	29.9
Total		**110929,6**	**68763,6**	**61.9**	**23161,8**	**20.8**	**22314,6**	**20.1**

In different land evaluation zones of Mongolia has different types of land degradation and mainly overgrazing, grasshopper and vole spread influence and desertification are reason of pasture degradations in all zones (table7).

Table 7. Main pasture degradation impacts
(Areas in thousand hectares)

Degradation impact	Khangai & Khentey mountain		Altai mountain		Gobi		Steppe	
	hectares	%	hectares	%	hectares	%	hectares	%
Road network	170202	0.7	37777	0.2	271387	0.6	37168	0.20
Mining and industry	1089	-	4628.0	-	96.0	-	20.0	
Over grazing	4796175	**18.3**	2976376	15.6	7080263	14.9	2065243	10.8
Pollution	57082.0	0.2	7714.0	-	43911.0	0.09	28468.0	0.1
Line erosion	122375	0.5	17797	0.1	251977	0.53	16581	0.1
Desertification	294352	1.1	203244	1.1	2340361	**4.96**	6192	-
Water flood	42737	0.2	30343	0.2	127733	0.3	47923	0.2
Damage of vole and grasshopper	614441	2.4	289673	1.5	980696	2.1	197767	**1.0**
	6098453	23.8	3567551	18.9	11096424	23.5	2399363	12.7

In addition Mongolian pasture land has own unique characteristics and quality: not depending geographic location (Yunatov, 1942.) more and less composition of shrubs and soil surface stones has everywhere (table8).

Table 8. Pasture land quality
(Areas in thousand hectares)

Land evaluation zones	Pasture total area	Pasture types							
		Pasture with shrubs		Pasture with tussocks		Pasture with stones and pebbles		Clear pasture	
		hectares	%	hectares	%	hectares	%	hectares	%
Khangai & Khentey mountain	25916,2	4816081	18.8	2003,2	7.8	9909,1	38.6	7359,7	28.7
Altai mountain	18916,5	4892,8	25.9	499,8	2.6	6504,6	34.4	5272,5	27.9
Gobi	47172,1	18073,2	38.3	2520,7	5.3	14199,5	30.1	8220,5	17.4
Steppe	18924,8	5247,7	27.7	1277,3	6.7	3125,6	16.5	8321,9	44.0
Total	110929,6	33029,8	29.7	6301,1	5.7	33738,8	30.4	29174,7	26.3

By the land inventory (1998) most of arable lands are abandoned or getting fallow land. In 1989 our country has 1209500 hectares arable land and in the end of 90's only using 14.3 percentage of these resources has been in usage. Main reason of the abandoned arable land is poor and not effective management and financial situations since most state enterprises privatized and unexpectedly end of state investment (Jigjidsuren and Purevtseren, 1998). Due to the old technologies used in agriculture was an origin of soil erosion and unproductively quality of soil. Where indicator of soil degradation were newly appeared sand layer on top of soil (table9).

Table 9. Arable land degradation

Economic zones	Parcel number	Total arable land	Condition							
			In Normal condition		Degraded arable land / by surface sand layer height in cm/					
			Hectares (ha)	%	1-8 cm		8-15 cm		15 cm >	
					ha	%	ha	%	ha	%
Western	174	16836,5	12107,0	71,9	366.8	2.1	384,68	2,3	-	-
Khangay's	1370	99398,1	48368,9	48,6	30433.0	30.5	7731	7,8	12867,0	12,9
Central	4609	437108,3	187946,2	42,9	164109.1	37.5	43307,4	9,9	38240,4	38,5
Eastern	278	41653,5	5810,1	13,9	4059.1	9.7	4002,2	9,6	27782,1	66,7
Total	6431	594996,5	254232,3	42,7	198978.2	33.4	55425,4	9,3	78889,5	13,3

The study showing only 42.7 per cent of arable land has been in normal condition and rest of land is degraded.

The Natural Park Network areas study showing 22.98 per cent of the total area were influenced by human activity and degraded which is in future will seroiuse problem in land protection and presenting weak land use controls and administration (table 10).

Table10. National Park's grassland degradation

Classification	Grassland area						
	Total area /thousand hectares/	Main impacts in area (hectares)					
		Road impact	Mining	Pollution	Overgrazing	Desertification	Soil erosion
Strictly protected	2657,1	1393	563.3	0	62545.3	91306.26	194
Natural park	3039,3	1495.3	6408.2	6944	462758.2	222683	628
Natural monument	28,2	217.5	295.6	0	825.6	441.5	0
Natural reserves	1560,3	14452.11	15	21	176055.8	31071.2	6935.3
Total	**7284,9**	**17557.91**	**7282.1**	**6965**	**702184.9**	**345501.96**	**7757.3**

DISCUSSION

We need more detailed research to identify which factor most influencing land degradation. In our study we can't say if limit of carrying capacity or weather warming and several years' weather change is most influencing. To make a detail study we need a protected area which is not under usage during long a time period. Also we need long duration monitoring to be verifying factors' size and impact. Soil stability research was made only in 2000. Earlier studies did not include soil study. Therefore we can't compare soil character which was very important in our study. In our view soil character is more constant during weather change than vegetation indicators. We recommend using both vegetation and soil stability indicators for rangeland. Reference areas result show big differences between 1975, 1990 and 2005. Without detailed result there are unclear reasons of vegetation indicator changes. Another complicated problem is how to manage carrying capacity of land use. Therefore we need a study of number and intensity of land use and degradation level in certain areas.

CONCLUSIONS

The territory of Mongolia percent of land classes by the land cover classification 81.2 % is **rural land ,** 5.1 **% is urban land ,** 8.2 % is **forest land and shrub covered area,** 1.4 % is **surface water,** 4.1 % is **unsuitable and conservation area .**

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