THE KOREAN JOURNAL OF QUATERNARY RESEARCH Vol. 18. No. 2(2004) 59~63

Floodplain Soil Properties of Tuul River, Nearby Ulaanbaatar City

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I. Introduction

Floodplain is most dynamic ecosystem, where nature-anthropogenic impact has a big influence on nature elements. Degradation of land cover, soil erosion, water-soil pollution, climate change, decrease of ground and surface water recourses responding very clear in floodplains.

Aim of our research is floodplain soil properties, heavy metal, and bacteriological pollution in case study of Tuul river floodplain, nearby Ulaanbaatar city. Since 1990-s, with transition to the market economy, brought big social-economic changes in Mongolia: population of Ulaanbaatar city increased up to the 1 million in year 2004. This conditions cause a disturbance of nature environment. Other hand, harsh natural climate condition and geographical position of the city, that is surrounded mountains, have an impact on the accumulation of pollutants in the air, plants and soils of the city as well. Tuul river floodplain is lowest place of city where all pollutants accumulated. After flood, on the floodplains accumulated sediments from upper

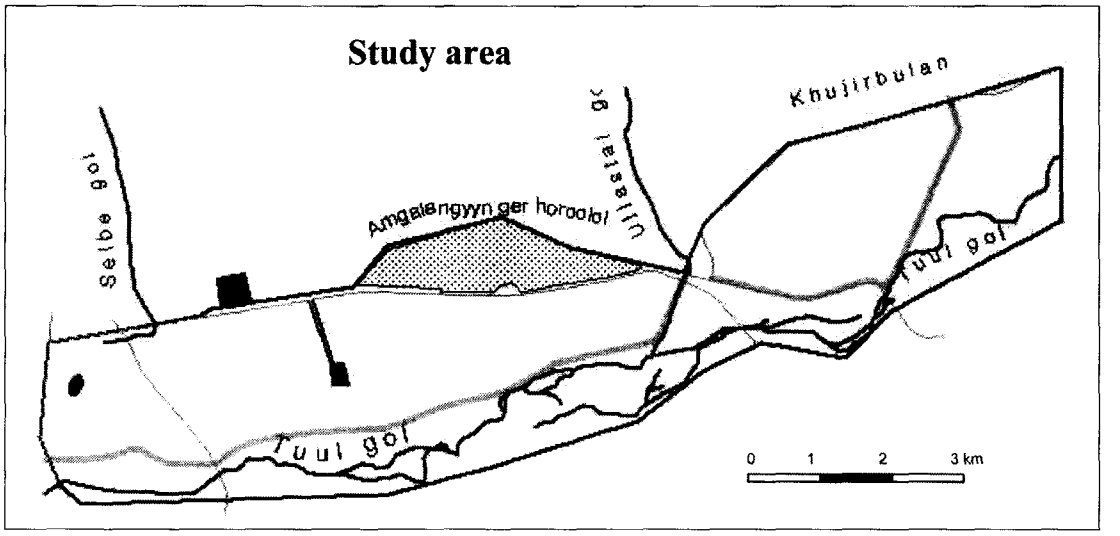

Figure 1. Study area

catchments areas. Alluvial soil is main reservoir of wastes and pollutants, not aloud to penetrate down to the ground water. Not much data available concerning with soil properties study area [1, 2, 3, 4].

Study area located in south part of Ulaanbaatar, north side of Tuul river extends from Gachuurt to the Orgil covering more than 40-50 km^2 area (Figure 1). On this area situated 92 wells of Central Water Sources and water transmission pipelines. Last big flood covering all floodplains occurred 1966. In the 1970 build up flood dam (red line on the Figure 1) with 3 m heights along the Tuul river northern shorelines. Since this time not any floodwater covered northern parts of dam. Nature process of floodplains was regulated. Which cause decline of soil fertility.

Since 1990-s anthropogenic pressure on nature environment of Ulaanbaatar city increasing, especially on floodplains: illegal cut of trees and bushes, take out gravel and sands from floodplains as a building material, and through out solid waste, rubbish. This stipulated assess of environment condition and comprehensive research of nature elements.

II. Materials

Field investigation was carried out end of July 2004. Make a soil profiles and take a mixed topsoil samples (simply random) from different parts of study area. Determined bulk density, particle density, texture, humus, exchangeable Calcium Magnesium, pH, available Phosphorus, Potassium, Carbonate and Dissolved ions. For estimation of heavy metal pollution defined total content of Cadmium (Cd), Lead (Pb), Zinc (Zn), Nickel (Ni), Cupper (Cu), Cobalt (Co), Chrome (Cr), Mercury (Hg) and for the microbiological conditions defined Bacteria and Colititr.

Soil. On the floodplains distributed Alluvial derno, Alluvial meadow and Alluvial boggy soils according by Mongolian soil classification

Table 1. Soil chemical properties

Site	Depth cm	Humus %	pH H_2O	Exchangeable		Available		CO_2 %	Salt content %	Dissolved ions, meq/100g					
				Ca^{2+}	Mg^{2+}	P_2O_5	K_2O			HCO_3^-	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na^++K^+
				meq/100g		mg/100g									
RW-1 (36)	0-0,5	4,12	8,4	12,5	19,7	10,8	97,1	0,54	0,09	1,1	0,2	0,05	0,7	0,25	0,4
	0,5-10	2,70	8,3	27,3	4,2	6,5	52,5	0,96	0,07	0,8	0,2	0,05	0,6	0,2	0,25
	15-25	0,78	8,0	8,9	5,8	3,2	5,6		0,05	0,5	0,1	0,12	0,4	0,2	0,12
	90-120		6,7												
RW-2	0-0,5	2,64		13,5	15,8	1,5	16,8	0,16	0,05	0,3	0,2	0,27	0,2	0,1	0,47
	0,5-6	2,76	7,1	18,7	4,8	0,8	1,2		0,05	0,5	0,1	0,06	0,5	0,1	0,06
	6-25	1,22	7,3	19,8	5,8	1,6	0,0		0,08	0,75	0,1	0,11	0,5	0,2	0,26
	25-60	0,07	7,1	9,2	6,2	1,0	0,0		0,12	0,3	0,3	2,09	0,55	0,2	1,94
	60-80		6,8						0,05	0,2	0,1	0,64	0,3	0,1	0,54
	90-110		6,7												
RW-3	0-10	1,05	6,7	3,9	4,8	2,6	5,6		0,01	0,2	0,1	0,22	0,1	0,1	0,32
(N-8	10-28	1,25	7,7	5,0	4,4	0,7	1,2		0,04	0,4	0,1	0,004	0,4	0,05	0,05
Hujirbulan)	28-40	0,90	7,4	4,1	2,4	3,3	0,0		0,06	0,2	0,1	0,19	0,2	0,1	0,19

Table 2. Soil physical properties

Site	Depth cm	Particles size by mm, (%)							Particle density g/cm³	Bulk dencity g/cm³
		1-0.25	0.25-0.05	0.05-0.01	0.01-0.005	0.005-0.001	<0.001	<0.01		
RW-1 (36)	0-0,5	4,3	22,0	20,1	12,2	22,9	17,5	52,6	2,44	
	0,5-10	7,3	18,7	19,0	9,3	24,3	21,4	55,0	2,47	1,06
	15-25	52,2	22,3	7,3	3,3	6,4	8,5	18,2	2,56	
	90-120	43,4	35,7	10,2	2,7	3,4	4,6	10,7	2,65	
RW-2	0-0,5	4,3	32,8	29,0	8,6	12,5	12,8	33,9	2,51	
	0,5-6	3,9	28,6	28,6	9,2	12,8	16,9	38,9	2,49	1,10
	6-25	3,0	33,9	22,5	10,0	18,8	11,8	40,6	2,59	1,28
	25-60	0,8	39,7	25,8	8,6	17,2	7,9	33,7	2,69	1,22
	60-80	13,1	56,6	16,4	1,7	6,3	5,9	13,9	2,79	
	90-110	47,7	38,8	5,5	3,3	1,0	3,7	8,0	2,73	
RW-3 (N-8 Hujirbulan)	0-10	16,0	25,7	29,2	14,9	8,5	5,7	29,1	2,62	1,35
	10-28	12,3	61,7	13,5	2,2	4,8	5,5	12,5	2,71	1,37
	28-40	42,1	43,3	7,3	1,6	1,7	4,0	7,3	2,68	
	40-60	59,1	30,0	3,9	1,5	3,3	2,2	7,0	2,69	

[Dorjgotov 2003]. But result of human and nature impact nature soil properties changed, dominated Alluvial derno gravel stepped soils. Reduced meadow and boggy soils.

Soil profile RW-1 established in the bottom of dry channel, 1.5 km north from Tuul river, 300 meter south-west from Narantuul market, nearby Well N36. Meadow (*Carex duriuscul, Artemisia adamsii*). Canopy cover 60-70%. On the surface accumulated 0.5 cm thin clay crust, below A - humus layer with 10 cm thick, gray-brown colored, clay, few gravels, effervescing by 10% HCl. B - transit horizon 10-25 cm, silt gravel, below 25 cm gravel alluvium. ***Soil: Alluvial derno.*** Humus content in the top soils 4.12%, soil reaction alkaline pH 8.4-8.0 down becoming neutral, exchangeable Calcium Magnesium varied 27.3 -19.7 meq/100g, available Phosphorus (P_2O_5= 10.8-6.5mg/100g), and Potassium (K_2O=97.1 -52.5mg/100) high, in the top soils revealed (CO_2) carbonate accumulation up to 0.54-0.96%. Sum of dissolved salts 0.5-0.9%, dominated Calcium bicarbonate content (Table 1). Soil texture in the upper parts very fine (52.6-55.0 % physical clay), in down becoming sandy silt gravelly. On the soil surfaces accumulated clay from high places (Table 2).

Soil profile RW-2 established in the central floodplain, 0.5 km north from Tuul river, nearby Well N47. Vegetation coverage 30-40%. Grass-sedge stepped meadow (*Stipa Krylovii, Artemisia adamsii*). On the surface gravel, below accumulated 0.5 cm thin clay crust, Ad - Derno layer with concentration of roots 6.0 cm thick, light-brown colored, clay, below A - humus layer (6-25 cm thick), light-brown, clay without gravel, B transit horizon (25-100 cm) very thick without gleyic features, silt, from 100 cm down gravel alluvium. ***Soil: Alluvial meadow stepped.*** Humus content in the top soils 2.64-2.76%, soil reaction neutral pH 7.1-7.3 down becoming slight acid, exchangeable Calcium Magnesium varied 19.8

Table 3. Soil heavy metal content (ppm)

Site	Depth cm	Cd	Pb	Zn	Ni	Cu	Co	Cr	Hg
RW-1 (36)	0-0,5	0,10	**45,8**	54,2	15,4	**61,0**	8,0	**152**	<0,2
	0,5-10	0,80	**51,6**	44,9	10,4	51,0	5,0	**318**	<0,2
	15-25	0,82	20,2	61,3	**88,4**	36,0	5,1	82	<0,2
RW-2	0-0,5	1,10	13,2	77,1	6,8	33,0	4,3	**128**	<0,2
	0,5-6	0,20	11,0	50,5	12,1	40,7	5,7	**119**	<0,2
	6-25	0,68	8,7	46,7	20,5	35,3	5,9	73	<0,2
RW-3 (N-8 Hujirbulan)	0-10	0,22	5,0	25,9	7,3	27,0	3,2	29	<0,2

-13.5 meq/100g, available Phosphorus low (P_2O_5= 1.5-0.8mg/100g), and Potassium (K_2O=16.8 mg/100) low. Sum of dissolved salts 0.05-0.08%. In the topsoil' s dominated silt (33.9-38.9 % physical clay), in down becoming sandy silt gravelly. In depths of 6-25 cm accumulated fine silt fraction and dissolved salts. Topsoil crust has a toxic high level of Magnesium. Possible cause of air pollution or solid waste.

Soil profile RW-3 established in the central floodplain of Hujirbulan, 1.5 km north-east from Tuul river, nearby Well N8. Vegetation coverage 30-40%. Grass-sedge stepped meadow (*Stipa Krylovii, Artemisia adamsii*). On the surface occur lichen. A - humus layer 10 cm thick, silt, B transit horizon (10-28 cm) without gleyic features, from 40 cm down gravel alluvium. ***Soil: Alluvial meadow stepped.*** Humus content in the top soils very low 1.05-1.25 2%, soil reaction neutral slight alkaline pH 6.7-7.7, exchangeable Calcium Magnesium very low 5.0-3.9 meq/100g, Sum of dissolved salts 0.01-0.06%. This soil has a very low fertility.

Flood dam build up in1970-s stopped floodwater cover in northern parts of floodplain. Which cause decline of alluvial soil fertility and increased impact of steppezation process. Alluvial soil morphological feature becoming similar as a zonal Kastanozem soil without any gleyic features.

Soil heavy metal contents varied (Table 3). On the top soils profile RW-1 accumulated high concentration of Lead (Pb 45.8-51.6ppm), and Chrome (Cr 152-318 ppm). This is influence Narantuul market. Nearby solid waste of accumulation places some heavy metal contents increased more than MAC (Maximum Allowed Concentration). Chrome concentration possible caused by result of skin development residues wastes. In the top soils (RW-1, RW-2) occur more Bacteria and Colititr than average of UB [1]. exceeding standard content. Down profile decreased. Soil bacteriological pollution specially nearby solid waste places show comparatively high values (Table 4). Soil of eastern parts (RW-3) of floodplain less polluted than a central parts.

Soil and plant cover of floodplains strong degraded by 60 %, medium 30, low degradation 10 %. In strong degraded places canopy cover is 10- 40 %, dominated basically *Artemisia Adamsii, Carex duriuscula.* Topsoil or humus layer some places disappeared on the surface exposed alluvial gravel sediment. Medium degraded places canopy cover is 40-60 %, forbs-grass-sedge communities representing, top soil has a 10-20 cm

Table 4. Soil microbiological date

Site	Depth cm	Bacteria /1 ml.g/	Colititr
RW-1 (36)	0-0,5	320000	0,01
	0,5-10	280000	<0,001
	15-25	120000	1
	90-120	200000	0,1
RW-2	0-0,5	600000	<0,001
	0,5-6	60000	1
	6-25	180000	0,1
	25-60	280000	1
	90-110	35000	1
RW-3 (N-8 Hujirbulan)	0-10	46000	1
	10-28	160000	1
	28-40	180000	1
Average UB 1993-2000 [1]		195660±52472	0.04±0.02

thickness. Low degraded places canopy cover is 60-90 %, forbs-grass-sedge meadow dominated, and alluvial soil has a 20-30 cm thick humus layer, with clear gleyec properties.

III. Conclusion

- Flood dam build up in1970-s stopped floodwater cover in northern parts of floodplain. Which cause decline of alluvial soil fertility and increased impact of steppezation process.
- Illegal take out of gravel sediments for the building material and cut of bushes, trees intensified degradation of soil plant coverage, become an negative impact for the lowering groundwater table and penetration of surface pollutants down to the ground waters.
- Solid waste rubbish some places on floodplains polluted soil cover and increase risk of ground water pollution.
- Extended growth of ger settlement, house construction in Amgalan, Shar had, Uliastai, Hujirbulan, Gachuurt, south of Dund gol river, Orgil places make direct and indirect negative impact on environment.

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