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Investigating Relationship between Marly Lands Properties and Types of Water Erosion in the Part of Tasouj Region

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ABSTRACT

The research was performed on Marly lands of Tasuj located at 45° 18' 20" to 45° 32' East and 38° 20' to 38° 24' 30" North, 110 km Northwest of Tabriz, capital of East Azarbayjan and Urumiya Lake. The purpose of this study was identifying and studying the influence of physical factors of soil in erosion types (rill, gully, inter-rill and sheet) of Marl. From any water erosion, 10 soil samples and totally 40 soil samples were selected and analyzed experimentally. Then, all variables were compared using ANOVA and Duncan's test. Results of the study indicate there is meaningful difference between silt properties and particle density ($P<0.05$). These parameters are effective on formation, change and intensity of soil erosion types. However, statistical analysis showed there was no significant difference between values of clay, sand, fine sand, and bulk density.

KEYWORDS: Water Erosion, Marls, Tasuj, Physical Properties of Soil

1. INTRODUCTION

Soil is one of the natural resources of any country. Today, soil erosion is considered as a threat for well-being and life of human [1]. From 5.6 billion hectares of degraded lands on earth, 2 billion hectares were due to soil destruction. From 2 billion destroyed lands, 56% was due to water erosion and 28% due to wind erosion; in another word, 84% of soil degradation is due to water and wind erosion, and the remaining 16% are caused by physical and chemical degradation [2]. In Iran, soil erosion is one of the fundamental problems, especially in agriculture, natural resources and the environment sectors [3]. In different parts of Iran, various types of erosion have been observed [4]. Marl soils are the most erodible soils against erosion, and share the most part of deposition in arid regions, where different types of surface, rill, gully and tunnel erosion occur. Studying physical and chemical features of Marls and different types of erosion, Ghadimi Aroos Mahaleh et al. [5] found sheet erosion is common in non-splashed Marls, and gully and rill erosion in splashed Marls.

In general, erosion is an inevitable phenomenon that can't be completely eliminated, but it can be exacerbated or reduced by human activities [6]. This study aims to investigate some physical features influencing different types of water erosion to implement appropriate protection strategies through prediction of variety of water erosion in Marl lands of Tasuj.

REVIEW OF LITERATURE

On a review of erodible soil processes, Barzegar et al. [7], considers soil shear strength against shear force and rain drop runoff as main factor. Ramazanpour et al. [8] studied different types of soil erosion and measured physical properties such as amount of clay, silt, sand, fine sand, fine clay percentage to total clay, particle density, bulk density, mean weight diameter of soil aggregates, plasticity and soil activity. Comparing average physical parameters in different erosion indicate there is a meaningful difference in clay, fine clay, mean weight diameter of soil aggregates and soil activity ($P<0.05$), while other parameters were not meaningful. In their study on Marls of Aji Chay watershed and estimating physical and chemical parameters, Salmasi et al. [9] found there is meaningful difference between different types of erosion, percentage of sand and plaster of samples. Studying on Gap valley watershed of Ganaveh port, Rahi [10] concluded that one of the influential factors on gully erosion of study area is existence of lots of minerals in the soil. On their study in Marls of west Azerbaijan, Sokouti et al. [11] suggest there is meaningful statistical difference regarding the rate of clay between different types of gully, rill and surface erosion.

Investigating relationship between amount of erosion and soil properties, Peyvasteh et al. [12] concluded the amount of silt, exchangeable sodium percentage and organic matter content are among the important and effective features of soil erosion rates. Oldemen et al. [13], suggest water erosion is a key process of soil degradation in different parts of the world. Smith [14] stated reviewing different soil features and percentage of clay, silt and sand composition on creating erosion show no logical relationship between them and erosion form.

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Wakinidi and Ben-Hur [15], suggest that erosion sensitivity of soil depends on various chemical and physical properties along with soil profile features such as soil depth and its effect on plant growth. Oades [16] stated that sand particles are very large in terms of connectivity due to the increasing permeability of soil by sandy material, which results in reducing erosion.

The effect of erosion on physical properties of soil

Since the physical properties of soil, such as structure, texture and bulk density are related to each other, changing each parameter will change all factors. Therefore, it's better to explain the effects of soil erosion by the combined effect. The main combined effect of erosion on physical properties of soil is reduction of water supply capacity. Revealing clay-rich subsoil after erosion leads to increasing the volume of pores per soil unit and reducing them. Consequently, capacity of total water storage will increase and usable moisture content will reduced. But, when the subsoil compared to the main surface soil is sandy, the volume of pores per unit volume will decrease and consequently the volume of total storage water and the moisture will decrease, furthermore, permeability increases and runoff decreases. The total of these changes will decrease water supply and reduce production power [17]. Therefore, reducing soil organic material, degradation of soil structure and selective transport of fine particles reduce usable water.

Study area

General position of study area: Tasuj is located in geographical location of 45° 18' 20" to 45° 32'east and 38° 24' 30" to 38° 20' north, 110 kilometers apart from north-west of Tabriz and north of Urmia Lake. The area consists of 10 sub-basins toward Tasuj, Angoshtjan and Amestjan rural areas; from north it is limited to the Ridge of Mishou Dagh Mountains, from east to Mount Alamdar, from west to Amsatjan and Chehregan rural areas and from south to plain edge of Lake Urmia of Iran.

Geological features of the area: Eftekharnejad offered a comprehensive classification for the building blocks and spreading sedimentary basins of Iran, according to which Tasuj is located in Mishou-Soltanieh Zone. In this classification, acidic volcanic associated with Precambrian deposits (Kahar Formation), Soltanieh, Barut, Zagvn, Lalun formation with sandstone and Chile facies (like Alborz), lack of strata of Ordovician to Permian (probably due to uplift of horst species) are specifics of Mishou-Soltanieh Zone.

Most of deposits from different geological periods are extended in the mountainous area near the Tasuj River and northern parts of the region, including geological formations of the Precambrian to the present sediments [18].

Geo-morphological features

Main factors affecting geomorphology of the area include:

1. Effect of different organic phases during the geologic periods, especially Savin phase
2. Effect of major faults and fractures such as Tasuj fault, Sharafkhaneh fault and numerous large and small faults
3. Effect of Tasuj, Angoshtjan and Amestjan Rivers, especially in flood times and in erosion sensitive areas
4. Falls and lapses in the fringe areas of rivers
5. Igneous infiltrators in the eastern region
6. Erosion sensitive formation such as Qom formation
7. Processes and climatic fluctuations in the past and present

2. MATERIAL AND METHODS

Under study area have many Marl formation. In summary, the following steps were conducted in this study:

- Collecting explanatory, descriptive, quantitative and qualitative information of study area using resources available in related research stations and visiting study area
- Identification of Marl limits in the study area
- Identification of erosion type
- Sampling from intended Marl domains
- Transferring samples to laboratory and experimental studies

After visiting the area and identifying different types of erosion, soil samples were taken from sheet, rill, inter-rill and gully erosions. Sampling was from 0-30 cm depth and almost identical gradient conditions for each type of erosion. Then, samples were transferred to laboratory for physical tests.

Evaluated properties

For experimental study, first soil samples were dried in vitro and open air. After hitting, passed through a 2-mm sieve and were stored in specific plastic containers for doing tests. For testing bulk density (ρ_b), produced clods were stored in metal storage containers. Physical tests include determining soil texture (percentage of Sand,

silt, clay), particle density (ρ_s), bulk density (ρ_b), stability of soil structure (AS), Atterberg's limits (liquid limit (LL), plastic limit (PL), plasticity index (PI)), and percentage of sand samples.

3. RESULTS

Results of physical feature tests and texture class of under study soil sample are presented in Tables 1. Comparison of mean under study properties are presented in Table 3.

Variance analysis of measuring properties

Variance analysis indicates there is meaningful 1% difference between stability of soil structure, liquid limit, plastic limit, and plasticity index. However, there is a meaningful difference between properties of silt, and particle density ($P<0.05$). While, there is no meaningful difference between properties of clay, fine sand, sand, and bulk density (Table 2). In each column, averages with at least one common letter are lacking meaningful different ($P<0.05$), based on Duncan's test.

Table 1. Results of physical parameter measuring

Different types of erosion	No.	ρ_s (gr cm-3)	ρ_b (gr cm-3)	LL (%)	PL (%)	PI (%)	AS (%)	Silt (%)	Sand (%)	Clay (%)	Fine Sand (%)
Rill	1	2.63	1.52	26.5	19.05	7.45	32.73	54	22	24	4
	2	2.63	1.56	25.6	19.58	6.02	28.8	52	24	24	5
	3	2.64	1.52	26.7	19.6	7.1	24.58	53	24	23	5
	4	2.62	1.45	25.65	19.15	6.5	20.44	50	22	28	4
	5	2.61	1.57	24.7	17.42	7.28	11.89	48	28	24	6
	6	2.62	1.5	25.8	19.38	6.42	25.6	54	24	22	5
	7	2.61	1.46	25.2	18.8	6.4	17.5	48	27	25	6
	8	2.63	1.48	26.8	19.78	7.02	19.6	50	24	26	5
	9	2.64	1.52	25.4	18.16	7.24	29.5	56	23	21	5
	10	2.62	1.56	26.8	19.34	7.46	26.7	54	26	20	5
Gully	11	2.64	1.53	26.67	19.53	7.14	31.49	52	24	24	5
	12	2.65	1.58	25.22	18.8	6.42	34.7	44	28	28	6
	13	2.64	1.52	26.14	18.7	7.44	33.83	52	20	28	4
	14	2.61	1.5	26.9	19.61	7.29	28.22	54	24	22	5
	15	2.65	1.4	26.38	19.72	6.66	34.59	48	24	28	5
	16	2.65	1.57	26.4	19.89	6.51	35.5	45	27	28	6
	17	2.62	1.54	26.8	19.56	7.24	24.3	53	22	25	4
	18	2.61	1.52	26.7	19.22	7.48	25.7	53	25	22	5
	19	2.64	1.57	25.16	19.28	6.32	31.5	46	28	26	6
	20	2.62	1.5	24.5	18.05	6.45	27.5	48	25	27	5
Inter-rill	21	2.66	1.48	26.89	19.51	7.38	32.5	50	18	32	4
	22	2.65	1.52	25.8	19.39	6.41	30.5	54	20	26	4
	23	2.63	1.61	26.7	19.01	7.69	33.57	48	26	26	5
	24	2.65	1.4	24.5	18.78	5.72	31.4	52	18	30	4
	25	2.64	1.59	27.0	19.62	7.38	34.72	48	26	26	5
	26	2.64	1.63	26.2	18.74	7.46	29.5	47	28	25	6
	27	2.65	1.53	25.91	19.53	6.38	32.3	56	20	24	4
	28	2.64	1.45	24.7	18.88	5.82	31.6	52	18	30	4
	29	2.66	1.6	26.91	19.5	7.41	35.0	47	28	25	6
	30	2.65	1.59	24.58	18.72	5.86	33.0	52	19	29	4
Sheet	31	2.61	1.5	24.5	18.77	5.73	30.0	56	16	28	3
	32	2.58	1.45	19.3	16.8	2.5	21.14	30	56	14	11
	33	2.65	1.53	26.4	18.88	7.52	1.4	56	14	30	3
	34	2.66	1.56	24.7	19.24	5.46	1.6	52	16	32	3
	35	2.61	1.47	19.36	16.79	2.57	5.7	34	54	12	11
	36	2.61	1.45	19.24	16.84	2.4	5.8	32	56	12	11
	37	2.61	1.58	24.71	18.87	5.84	1.5	48	16	36	3
	38	2.62	1.43	19.61	16.81	2.8	1.9	30	55	15	11
	39	2.65	1.54	26.42	19.1	7.32	1.3	46	18	36	4
	40	2.66	1.56	25.8	18.7	7.1	1.8	56	14	30	3

ρ_s=Particle density, ρ_b=bulk density, AS=stability of soil structure, LL=liquid limit (Atterberg's limits), PL= plastic limit, PI=plasticity index.

Table 2. Variance analysis of physical features in erosion types on under study area

Item				Average	Square		
Change sources	**df**	**ρ_S**	**LL**	**PL**	**PI**	**AS**	**silt**
Erosion type	3	0.001*	21.719**	3.040**	9.270**	1323.244**	120.733*
Test error	36	0.000	3.091	0.579	1.421	40.082	39.772
Change coefficient		0	1.743	1.007	4.682	6.728	3.217
% (C.V)							

* significant in P<0.05; ** significant in P<0.01; ρ_s=Particle density, LL=liquid limit (Atterberg's limits), PL= plastic limit, PI=plasticity index, AS=stability of soil structure,

Table 3. Comparison of average under study properties in erosion types on under study area

Erosion	ρ_S (g cm^{-3})	LL (%)	PL (%)	PI (%)	AS (%)	silt (%)
Rill	2.625 ^{b}	25.915 ^{a}	19.053 ^{a}	6.889 ^{a}	23.734 ^{b}	51.900 ^{a}
Gully	2.633 ^{ab}	26.016 ^{a}	19.236 ^{a}	6.895 ^{a}	30.733 ^{a}	49.500 ^{ab}
Inter-rill	2.647 ^{a}	25.919 ^{a}	19.168 ^{a}	6.751 ^{a}	32.409 ^{a}	50.600 ^{a}
Sheet	2.626 ^{b}	23.004 ^{b}	18.060 ^{b}	4.924 ^{b}	7.214 ^{c}	44.000 ^{b}

ρ_s=Particle density, LL=liquid limit (Atterberg's limits), PL= plastic limit, PI=plasticity index, AS=stability of soil structure.

4. DISCUSSION AND CONCLUSION

The maximum and minimum amount of liquid limit (LL) was observed in rill (27.00%) and sheet erosion (19.24%), respectively. According to table 3, the average score of gully, inter-rill, rill and sheet erosion is 26.016, 25.919, 25.915, and 23.004, respectively. Comparing the averages indicate there is meaningful difference between rill, gully, inter-rill and sheet erosions (p<0.05).

The maximum and minimum amount of plastic limit (PL) was observed in gully (19.89%) and sheet erosion (16.79%), respectively. According to table 3, the average score of gully, inter-rill, rill and sheet erosion is 19.238, 19.168, 19.053 and 18.060, respectively. Comparing the averages indicate there is meaningful difference between rill, gully, inter-rill and sheet erosions (p<0.05).

The maximum and minimum amount of plasticity index (PI) was observed in inter-rill (7.69%) and sheet erosion (2.4%), respectively. According to table 3, the average score of gully, inter-rill, rill and sheet erosion is 6.895, 6.889, 6.751 and 4.924, respectively. Comparing the averages indicate there is meaningful difference between rill, gully, inter-rill and sheet erosions (p<0.05).

Following results were obtained after reviewing and evaluating physical parameters of soil and their effect on water erosion of under study area:

- In all erosion types except rill and gully erosion, EC has meaningful difference (p<0.05)
- There is meaningful difference in SAR parameter of inter-rill, rill, gully and sheet erosion (P<0.05)
- In all types of erosion, there is meaningful difference in ESP (p<0.05)
- Particle density show meaningful difference between inter-rill, rill, and sheet erosion (P<0.05)
- There is meaningful difference in AS parameters of gully, inter-rill, rill and sheet, erosion (P<0.05)
- There is meaningful difference in LL parameters of rill, gully, inter-rill, and sheet, erosion (P<0.05)
- There is meaningful difference in PL parameters of rill, gully, inter-rill, and sheet, erosion (P<0.05)
- There is meaningful difference in PI parameters of rill, gully, inter-rill, and sheet, erosion (P<0.05). It's worth to note that PI, LL and PL parameters indicate similar changes
- There is meaningful difference in silt parameters of rill, gully, inter-rill, and sheet, erosion (P<0.05)

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