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THE MOISTURE RETENTION CHARACTERISTICS AND HYDRAULIC CONDUCTIVITY OF ALLUVIAL (ENTISOL) AND BROWN HYDROMORPHIC (ALFISOL) SOILS OF KERALA

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The amount of energy status of the water within the soil influence the soil physical properties more than any other factor as they affect the movement of water into and within the soil, the moisture storing capacity of soils and the availability of soil moisture to higher plants.

Physical properties of soil affect the movement, retention and availability of water to plants. Hydraulic conductivity of soil is the most important single parameter required for any drainage design. Very little field information exists on the patterns of soil water movement in the tropics.

Infiltration is an example of the phenomenon of water movement in porous media. Quantitatively infiltration rate is defined as the volume of water passing into the soil per unit of area per unit of time. Various factors such as soil cover and vegetation, physiographic factors, soil characteristics, climatological factors, water characteristics, time water stays on the soil surface and cultural practices modify the rate of water entry into soils.

Materials and Methods

Sites were located at Vizhinjam, Alleppey and Triprangode in coastal alluvium, Karamana and Pullazhi in riverine alluvium and Vellayani, Nedumangad and Naduvattom in brown hydromorphic group to collect the profile samples. At each of the location profile pits were dug and the soil samples were collected representing the different horizons in each profile. Undisturbed samples were collected with the help of core samplers (16 gauge M. S. pipe of diameter 5.2 cm cut to a length of 5 cm, one end sharpened to facilitate easy penetration into the soil) for the bulk density measurements (Dakshinamurti and Gupta, 1968), particle density was determined using psychnometer method (Black, 1965) and mechanical composition of the soils from each horizon was determined by the International Pipette method as outlined by Piper (1942). General physical properties ofthe soils are given in Table 1 and 2.

The moisture retention characteristics of the soil samples were estimated by the pressure plate (1/3 bar) and pressure membrane (1, 5, 10 and 15 bars) apparatus by adopting the method described by Richards (1954). Available moisture was calculated as the difference between the percentage of moisture retained at 1/3 and 15 bar (Dastane, 1972). Water holding capacity of the soils was determined using Keen-Raczkowski cups by the method described by Wright (1934).

All the undisturbed and disturbed cores were saturated with water by capillary rise. Hydraulic conductivity of the saturated cores was determined by constant head method (Black 1965) wherein a constant flux was obtained under a small positive head of 2 cm in each case. Darcy's equation, which when stated verbally indicates that the flow of a liquid through a porous medium is in the direction of and at a rate proportional to the driving force acting on the liquid (being the hydraulic gradient) and also proportional to the property of the conducting medium to transmit the liquid, was employed to calculate hydraulic conductivity of saturated soil cores. Thus, if q, represented flux, ΔH, the hydraulic head difference L, the length of the soil core, then K, the hydraulic conductivity is given by the following relationship,

$$q = -K \frac{\Delta H}{L} \qquad \cdots(1)$$

$$\text{ie, } K = -\frac{qL}{\Delta H} \qquad \cdots(2)$$

If 'q' is measured in terms of cm/sec, L in cm and ΔH also in terms of cm, then the dimension for hydraulic conductivity is length per times, i. e, cm/sec in cgs units. Each experiment was conducted atleast thrice and the average value was attributed to the type of water used to determine the hydraulic conductivity.

The infiltration rates were determined under field conditions, following the double ring infiltrometer method (Dakshinamurti and Gupta, 1968). Four estimations were conducted at each spot and the mean values of the steady state infiltrabiiity (Hillel, 1971) calculated.

Results and Discussion

At zero soil water potential, the highest amount of water was held in the brown hydromorphic soils followed by riverine alluvium and coastal alluvium (Borden *et al.* 1974).

The amount of water held at 1/3 atmosphere is conventionally taken as the field capacity of the soil. In the case of coastal alluvium soils much variation in field capacity was not observed, varying from 5.82 to 6.29 per cent. Field capacity varied from 8.29 to 21.24 per cent in the case of the riverine alluvium soils and no regular trend was observed with depth down the profile. Similarly, field capacity varied from 22.17 to 26.90 percent in brown hydromorphic soils (Tran-Vinh and Nguba, 1971) without any regularity in variation with depth (Table 3).

The amount of water held at 1, 5, 10 and bars also showed trends similar to field capacity in relation to the typeof soils and soil depth. Available water was observed to be extremely poor in coastal alluvium soils, which varied from 2.79 to 3.34 per cent in the whole group. The profile at Karamana of riverine alluvium group exhibited a poor status in relation to available water whereas profile at Kola was better in this regard under riverine alluvium. In the brown hydromorphic soils it varied from 10.78 to 13.41 per cent for the whole group (Wahab ef *af.* 1976). In the soils studied the available water was highest in the brown hydromorphic soils followed in order by soils of riverine alluvium and coastal alluvium groups.

In coastal alluvium soils the correlation co-efficient of clay content with particle density, bulk density, porosity and volume expansion were 0.618, 0,135, 0.659, —0.795 respectively (Table 7). Correlation co-efficients between clay and moisture retention at maximum water holding capacity, 1/3 bar tension, 1 bar tension, 5 bar tension, 10 bar tension, 15 bar tension and available water were 0.577, —0.162, —0.40, —0.541, —0.469, —0.214, and —0.0327 respectively,

In the case of riverine alluvium soils the correlation coefficients of clay content with particle density, bulk density, porosity, volume expansion, maximum water holding capacity, moisture retention at 1/3 bar, 1 bar, 5 bars, 10 bars, 15 bars and available water were 0.812*, 0.498, 0.733*, 0.963*, 0.732*, 0.977**, 0.979**, 0.974**, 0.974**, 0.973** and 0.978** respectively.

Brown hydromorphic soils showed 0.780*, —0.549, 0.822**, 0.915**, 0.575, 0.795*, 0.620, 0.643, 0.444, 0.850** and 0.464 of the correlation co-efficient respectively between clay content and particle density, bulk density, porosity, volume expansion, maximum water holding capacity, moisture retention at 1 3 bar 1 bar, 5 bar, 10 bar, 15 bar and available water.

The moisture retentions at different tension are influenced by the different soil primary particles. In the correlation between soil primary particles and moisture retention at different tensions (Table 5) highly significant negative correlation was observed between the coarse sand and moisture retention at 0 bar, 1/3 bar, 15 bar and available water. In the case of fine sand and moisture retentions at different tensions no significant correlation was noted· Significant correlation was found between silt and moisture retentions at 1/3 bar and 15 bar tensions, but no significant correlation was observed between silt and moisture content at zero bar tension and avilable water. The clay and moisture retention at different tensions showed highly significant positive correlations (Table 5).

The moisture retained at 0 bar tension is well predicted by the linear regression model, given in Table 6. Similar regression models were found to be good fit to the moisture retention data at 1/3 bar and 15 bar and available water, the respective equations are presented in Table 6. The predictability of these equations are very high as indicated by the highly significant 'R' values.

The results indicate very high values for saturated hydraulic conductivity under both disturbed as well as undisturbed conditions in most of the samples, the exception being the soils of the brown hydromorphic group. The profile at

Table 1

Mechanical composition of profile samples

Soil group & location	Profile No.	Sample No.	Depth (cm)	Mechanical composition (per cent) Coarse sand	Fine sand	Silt	Clay	Textural class
1	2	3	4	5	6	7	8	9
Coastal alluvium								
Vizhinjam	I	1	0-20	61.0	20.0	10.6	8.4	Loamy sand
		2	20-85	68.7	11.4	9.9	10.0	Sandy loam
		3	85-140 +	69.9	10.8	9.4	9.9	Loamy sand
Alleppey	II	4	0-22	69.7	13.1	4.2	13.0	Sandy loam
		5	22-64	62.7	22.2	8.3	6.8	Loamy sand
		6	64-150 +	60.3	20,2	10.8	8.7	Loamy sand
Triprangode	III	7	0-20	60.7	17.6	11.0	10.7	Sandy loam
		8	20-72	71.9	11.8	9.9	6.4	Loamy sand
		9	72-128	69.0	13.5	9.1	8.4	Loamy sand
		10	128-160 +	78.4	13.8	3.3	4.5	Sand
Riverine alluvium								
Karamana	IV	11	0-19	61.8	13.8	5.3	19.8	Sandy loam
		12	19-37	64.0	14.5	6.5	15.0	Sandy loam
		13	37-68	67.7	14.9	5.5	11.9	Sandy loam
		14	68-150 +	65.5	12.6	9.8	12,1	Sandy loam

1	2	3	4	5	6	7	8	9
Pullazhi (kole)	V	15	0–[illegible]	82.5	82.5	5.2	[illegible]	Sandy clay loam
		1[illegible]	[illegible]–45	[illegible]	81.1	6.2	[illegible].5	Sandy clay loam
		17	45–100	81.1	81.1	[illegible].8	[illegible]	Clay [illegible]
		18	100–150+	29.7	[illegible]	10.5	[illegible]7.5	[illegible]
Brown hydromorphic								
Vellayani	VI	19	0–15	[illegible].3	18.8	15.1	48.[illegible]	Clay
		[illegible]	15–[illegible]	[illegible].6	1[illegible]	[illegible]	48.[illegible]	Clay
		[illegible]	68–105+	[illegible]	1[illegible]	16.9	57.[illegible]	Clay
Nedumangad	VI	[illegible]	0–[illegible]	1[illegible].5	15.7	1[illegible]	55.6	Clay
		[illegible]	2[illegible]–58	11.5	[illegible].1	6.[illegible]	75.8	Clay
		[illegible]4	58–110+	14.7	5.1	7.1	88.1	Clay
Nadu[illegible]ttom	[illegible]	25	0–15	12.[illegible]	18.7	[illegible]7	51.0	Clay
		[illegible]	15–45	10.4	11.4	[illegible]4.8	5[illegible].4	Silty clay
		[illegible]7	45–150+	8.8	12.7	85.1	4[illegible].4	Silty clay

Table 2

Volume/mass relationship of alluvial and brown hydromorphic soils of Kerala

Group and Location	Profile No,	Sample No.	Depth (cm)	Volume/mass relationships		
				Particle density (g/cms)	Bulk density (g/cm³)	Total porosity (%)
Coastal alluvium						
Vizhinjam	I	1	0-20	2.68	1.59	40.67
		2	20-85	2.75	1.60	41.82
		3	85-140 +	2:78	1.61	42.09
Alleppey	II	4	0-22	2 64	1.62	38.64
		5	22-64	2.60	1.61	38.08
		6	64-150 +	2.63	1.62	38.40
Triprangode	Mi	7	0-20	2.59	1.54	40.54
		8	20-72	2.41	1.55	35.68
		9	72-128	2.49	1.58	36.55
		10	128-160 +	2.45	1.60	34.69
Riverine alluvium						
Karamana	IV	11	0-19	2.44	1.35	44.67
		12	19-37	2.34	1.38	41.03
		13	37-68	2.35	1.42	39.59
		14	68-150+	2.26	1.40	40.68
Pullazhi (kole)	V	15	0-20	2.43	1.42	41.56
		16	20-45	2.70	1.41	47.78
		17	45-100	2.65	1.46	44.91
		18	100-150 +	2.67	1.45	45.69
Brown hydromorphic						
Vellayani	VI	19	0-15	2.45	1.15	53.06
		20	15-68	2.52	1.19	52.78
		21	68-105 +	2.57	9,18	54.09
Nedumangad	VII	22	0-21	2.43	1.03	57.61
		23	21-58	2.71	1.08	60.15
		24	58-110 +	2.82	1.11	60.64
Naduvattom	VIII	25	0-15	2.48	1.28	48.39
		26	15-45	2.61	1.32	49.43
		27	45-150 +	2,62	1.37	47.71

Kole area under riverine alluvium group exhibited relatively lower values for saturated hydraulic conductivity. In general, the saturated hydraulic conductivity values were higher for the undisturbed soil samples as compared to the disturbed ones even though they both had the same bulk densities. This can be attributed to the fact that the undisturbed soils contained gravel and had continuous pores, whereas the disturbed soils were the sieved samples in which the continuity of pores had been broken.

Coastal alluvium exhibited relatively higher values for saturated hydraulic conductivity. Profile at Karamana under riverine alluvium group also showed a high value of saturated hydraulic conductivity. However, profile at kole land **of** the same group exhibited very low values. Brown hybromorphic soils exhibited lower values of saturated hydraulic conductivity in all horizons. It may be noted that saturated hydraulic conductivity decreased with depth in this soil group.

Generally high saturated hydraulic conductivity is observed for the Kerala soils is in confirmity with the findings of Wilkinson (1975) Lal (1976), Wilkinson and Aina (1976), Haridasan (1978), Lal and Cummings (1979) and Vamadevan (1980), all of whom have reported similar results for the soils developed under humid tropical conditions.

The correlation coefficients between clay content and hydraulic conductivity in coastal alluvium, riverine alluvium and brown hydromorphic soils were 0.311, —0.886** and [illegible] for undisturbed soils and 0.380, —0.883** and—0.456 for the disturbed soils respectively (Table 7).

Infiltration studies were conducted *in situ* in all soils, coastal alluvium soils were found to have the highest infiltration rates which varied from 16.0to 19.8 cm/h. These soils being coarser in texture are bound to exhibit relatively higher infiltration rates. Profile at Karamana of the riverine alluvium group also give high value for infiltration rates viz., 16.8 cm/h whereas profile at kole of the same group yielded a very low value of 0.1 cm/h. The behaviour of these two profiles in respect of their flow characteristics is very distinctive. Brown hydromorphic soils were found to have relatively lower infiltration rates which varied from 0.2 to 0.4 cm/h, suggesting thereby the low water intake capacity.

The infiltration rates of these soils were comparatively high. A comparison of the values of the saturated hydraulic conductivity of the undisturbed samples in the laboratory with those of limiting infiltration rates shows that the former are invariably higher than the tatter. This is because, field conditions cannot be stimulated perfectly in the lab. As suggested by Lal (1979 a) it is aiways advisable to rely on the infiltration rates determined in the field for purposes of irrigation. drainage, salinity control etc. High rates of infiltration as observed in this study have been reported for other humid tropical region soils by workers such as Kamerling (1975) Lal (1976) Wolf and Drosdoff (1976) and Lal and Cummings (1979),

Table 3

Moisture retention characteristics of alluvium and brown hydromorphic soils of Kerala

Soil group and location	Profile No.	Sample No.	Depth (cm)	Moisture retention at different tension in bar (Per cent water content by weight) 0	1/3	1	5	1 0	15	Available water
1	2	3	4	5	6	7	8	9	10	11
Coastal alluvium										
Vizhinjam	I	1	0- 20	25.86	5.99	3.59	3.20	2.98	2.89	3.10
		2	20- 85	26.25	6.29	3.63	3.38	3.10	2.95	3.34
		3	85-140 +	26.10	5.82	3.60	3.24	3.01	2.98	2.84
Alleppey	II	4	0- 22	23.46	5.89	3.67	3.22	3.09	3.06	2.83
		5	22- 64	23.52	5.92	3.71	3.32	3.14	3.08	2.84
		6	64-109+	23.70	5.90	3.61	3.23	3.18	3.11	2.79
Triprangod	III	7	0- 20	2622	5,92	3.54	3.09	2.99	2.95	2.97
		8	20- 72	22.88	5.87	362	3,27	3.05	2.93	2.94
		9	72-128	23,05	5.89	3.68	3.32	3.15	2.96	2.93
		10	128-160+	21.47	6.12	3.70	3.39	3.23	3.12	3.00

1	2	8	4	5	6	7	8	9	10	11
[illegible]rine alluvi										
Kanmano	IV	11	0- 19	34.22	8.99	8.88	5.47	4.87	4.24	5.75
		12	19- 87	80.14	26.74	5.21	4.78	4.18	8.82	4.82
		18	87- 88	28.5	26.61	5.09	4.48	4.22	8.80	4.81
		14	85 52+	29.81	8.29	5.04	4.48	4.10	8.78	4.5[illegible]
Puliazhi (Kole)	V	15	0- 20	81.78	21.24	18.42	14.8[illegible]	11.78	9.20	12.04
		18	20- 45	85.85	20.78	17.58	14.27	11.24	9.01	11.75
		17	45-100	82.54	19.28	18.88	18.80	10.87	8.72	10.58
		18	100-150+	82.95	20.95	17.21	14.08	10.80	8.80	11.45
Brown hydromorphic										
Vellayani	VI	19	0- 15	48.28	28.75	18.90	15.87	11.68	11.28	12.47
		20	15- 88	58.80	22.17	18.48	15.88	11.59	11.08	11.08
		21	68-1[illegible]	49.18	25.02	21.77	18.08	18.78	18.21	11.81
Nedumangad	VII	22	0- 21	59.02	22.27	18.07	18.92	14.47	12.06	10.91
		28	21- 58	59.78	28.88	19.21	16.91	13.28	12.85	11.01
		24	5[illegible] 10+	60.40	28.20	22.28	18.82	14.08	18.49	18.41
Nedu[illegible]	VIII	25	0- 15	41.04	22.85	18.74	18.34	18.5	12.5	16.78
		28	15- 45	40.78	78.84	19.81	18.41	12.98	12.91	11.75
		27	45-150+	53.48	22.45	20.12	17.72	18.84	11.08	11.39

Table 4

Saturated hydraulic conductivity of the alluvial and brown hydromorphic soils of Kerala

Soil group & Location	Profile No.	Sample No.	Depth (cm)	Saturated hydraulic activity cm/h Undisturbed samples	Saturated hydraulic activity cm/h Disturbed samples	Infiltration rate cm/h
Coastal alluvium						
Vizhinjam	1	1	0-20	49.78	43.89	18,4
		2	20-85	45.74	40.13	
		3	85-140 +	40.36	38,40	
Alleppey	II	4	0-22	46.62	45.49	19.8
		5	22-64	47.47	46.89	
		6	64-150	42.81	41.40	
Triprangode	III	7	0-20	42,01	38.02	16.0
		8	20-72	45.36	39.90	
		9	72-128	41.09	34.12	
		10	128-160 +	36.28	32.13	
Riverine alluvium						
Karamana	IV	11	0-19	44.69	43.17	16.8
		12	19-37	40.91	40.14	
		13	37-68	32.87	30.29	
		14	68-150+	34.13	32.87	
Puliazhi kole	V	15	0-20	0.94	0.88	0.1
		16	20-45	0.62	0.76	
		17	45-100	0.75	0.60	
		18	100-150 +	0.79	0.58	
Brown hydromorphic						
Vellayani	VI	19	0-15	1.18	0.91	0.3
		20	15-68	0.08	0.07	
		21	68-105 +	0.06	0.04	
Nedumangad	VII	22	0-21	0.82	0.72	0.2
		23	21-58	0.34	0.30	
		24	58-110 +	0.09	0,04	
Neduvattom	VIM	25	0-15	0.86	0.82	0.4
		26	15-45	0.25	0.23	
		27	45-1 5O+	0.30	0.86	

Table 5

Correlation coefficient of soil primary particle and moisture retention

Soil particles	Moisture retention at different tensions and available water			
	0 bar	1/3 bar	15 bar	Available water
Coarse sand	−0.83822**	-0.75177*	−0.97998**	−0.94173**
Fine sand	−0.31768	−0.07089	−0.08108	−0.13615
Silt	0.33724	0.55354*	0.52571*	0.43350
Clay	0.84130**	0.70085**	0.91647**	0.86985

*Significant at 5% level
**Significant at 1 % level

Table 6

Multiple regression between soil primary particles and soil moisture retention characteristics

Moisture retention	Regression equation	
0/bar tension	$Y_1 = 72.14629 - 0.48653^{**} X_1 - 0.5972^{**} X_2 - 0.612 X_3 + 0.04223 X_4$	0.872**
1/3 bar tension	$Y_2 = 22.3979 - 0.28750 X_1 + 0.00447 X_2 + 0,3315 X_3 + 0.09783 X_4$	0.586**
15 bar tension	$Y_3 = 14.85533 - 0.15972^{**} X_1 - 0.03637 X_2 - 0.06069^{*} X_3 + 0.01843 X_4$	0.973**
Available water	$Y_4 = 11.24905 - 0.13293^{**} X_1 + 0.9583^{*} X_2 - 0.07810 X_3 + 0.04879 X_4$	0.935**

Y_1 = 0 bar tension
Y_2 = 1/3 bar tension
Y_3 = 15 bar tension
Y_4 = Available water

X_1 = Coarse sand
X_2 = Fine sand
X_3 = Silt

* Significant at 5% level
** Significant at 1% level

Table 7

Simple correlations between soil parameters

Sl. No.	Relationship between	Correlation coefficient (r)	No. of pairs
	Coastal Alluvium Group		
1	Clay—Particle density	0.618	10
2	Clay—Bulk density	0.135	10
3	Clay—Porosity	0.659*	10
4	Clay—Volume expansion	-0.795**	10
5	Clay—Maximum water holding capacity	0.577	10
6	Clay—Moisture retention at 1/3 bar	-0.162	10
7	Clay—Moisture retention at 1 bar	-0.40	10
8	Clay—Moisture retention at 5 bar	-0.541	10
9	Clay—Moisture retention at 10 bar	-0.469	10
10	Clay—Moisture retention at 15 bar	-0.214	10
11	Clay—Available water	-0.0327	10
12	Clay—Hydraulic conductivity (undisturbed)	0.311	10
13	Clay—Hydraulic conductivity (disturbed)	0.380	10
	Riverine Alluvium Group		
1	Clay—Particle density	0.812*	8
2	Clay—Bulk density	0.498	8
3	Clay—Porosity	0.733*	8
4	Clay—Volume expansion	0.963**	8
5	Clay—Maximum water holding capacity	0.732*	8
6	Clay—Moisture retention at 1/3 bar	0.977*	8
7	Clay—Moisture retention at 1 bar	0.979**	8
8	Clay—Moisture retention at 5 bar	0.974**	8
9	Clay—Moisture retention at 10 bar	0.974**	8
10	Clay—Moisture retention at 15 bar	0.973**	8
11	Clay—Available water	0.978**	8
12	Clay—Hydraulic conductivity (undisturbed)	-0.886**	8
13	Clay—Hydraulic conductivity (disturbed)	-0.883**	8
	Brown Hydromorphic Group		
1	Clay—Particle density	0.780*	9
2	Clay—Bulk density	-0,549	9
3	Clay—Porosity	0.822**	9
4	Clay—Volume expansion	0.915**	9
5	Clay—Maximum water holding capacity	0.575	9
6	Clay—Moisture retention at 1,3 bar tension	0.795*	9
7	Clay—Moisture retention at 1 bar tension	0.620	9
8	Clay—Moisture retention at 5 bar tension	0.643	9
9	Clay—Moisture retention at 10 bar tension	0.444	9
10	Clay—Moisture retention at 15 bar tension	0.850**	9
11	Clay—Available water	0.464	9
12	Clay—Hydraulic conductivity (undisturbed)	-0.296	9
13	Clay—Hydraulic conductivity (disturbed)	-0.456	9

Significant at 5% level   icant at 1 % level

Summary

The maximum water holding capacity, field capacity, moisture retained at tensions of 1 , 5, 10 and 15 bar were highest in brown hydromorphic soils and those diminished in the order of riverine alluvium and coastal alluvium soils. Available water was highest in the brown hydromorphic soils followed by riverine alluvium and coastal alluvium. The saturated hydraulic conductivities of the soils were relatively high. The hydraulic conductivities of the undisturbed soils were found to be more than that of the disturbed samples even for the same bulk densities. Infiltration rates of all the soils were relatively high.

സംഗ്രഹം

മണ്ണിന്റെ പരമാവധി ജലസംഭരണ ശക്തി, സാമാന്യ ജലസംഭരണ കഴിവ്, 1, 5, 10 ബാർ ശക്തികളിൽ ജലം മണ്ണിൽ പിടിച്ചു rolfileaf.i^crrxm" , fflemlewrSo വാടൽ ഗുണാങ്കം മുതലായവ ഏററവും കൂടുതലായി കണ്ടത് തവിട്ടു നിറത്തിലുള്ള ഹൈഡ്രോമോർഫിക് മണ്ണുകളിലാണ്. ഇവയൊക്കെ കുറയുന്നത് നദീതട എക്കൽമണ്ണ്, തീരപ്രദേശ എക്കൽമണ്ണ് എന്ന അനുക്രമത്തിലാണ്. ചെടികൾക്ക് ലഭ്യമാകുന്ന ജലത്തിന്റെ അളവ് ഏററവുമധികം കണ്ടത് raioi1§j നിറത്തിലുള്ള ഹൈഡ്രോമോർഫിക് fflsmjcfcglejosm°. പിന്നീട് ഈ പ്രത്യേകതരം മണ്ണിന്റെ ശേഷികരം നദീതട എക്കൽമണ്ണ്, തീരപ്രദേശ എക്കൽമണ്ണ് എന്ന ക്രമത്തിൽ കുറഞ്ഞു വരുന്നു. ഈ മൂന്നു തരത്തിലുള്ള മണ്ണുകളിൽ പൂരിത ഹൈഡ്രോളിക് കണ്ടക്ററിവിററിയും ഇൻഫിൽറററേഷൻ നിരക്കും സാധാരണയിൽ നിന്നും കൂടുതലായി കാണപ്പെട്ടു. ഹൈഡ്രോളിക് കണ്ടക്ററിവിററി യാതൊരു ഇളക്കവും വരുത്താതെ മണ്ണു സാമ്പിളുകൾ സാമാന്യം ഇളക്കം തട്ടിയ അതേ മണ്ണു സാമ്പിളുകളേക്കാൾ (ഒരേ മൊത്ത സാന്ദ്രതയിൽ) കൂടുതലായി കണ്ടു.

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