Using the Neural Network for the Interpretation of Hydraulic Phenomena in some Soils East of Idko Lake- Egypt

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ABSTRACT

This work aims to find an interpretation for the hydraulic phenomena that characterized some soils east of Idko Lake. These soils retain soil water for a long time with slow flux within the soil profile, although the performance of drainage net is good. So, the cultivated crops need less frequent irrigation than those cultivated in different areas. Add to this, the wilting phenomenon for plants will be occurred at extra irrigation.

Six soil profiles were selected to represent the study area. Eighteen soil samples (3 layers per profile, 0-25, 25-50, and 50-75 cm) were collected to determine the main soil physical, hydrophysical, and chemical properties. The RETC (RETention Curve) computer program was used to predict the hydraulic properties of the soil samples.

The study area is characterized by fine-textured soil. The predicted values of saturated hydraulic conductivity using RETC program were 0.72, 0.36 and 0.36 cm/hr for the three layers, respectively. The values of air entry suction were 435, 769, and 588 mbar for the three layers, respectively. So, air enters the soil after F.C at 330 mbar that is unusual. The hydraulic capacity is very low (0.00028, 0.00018 and 0.00021 cm^{-1} in the three soil layers, respectively) and the hydraulic diffusivity is very high. The inflexion points were calculated and F.C values were 0.31, 0.33 and 0.31 at 1205.38, 1738.69 and 1518.37 mbar, for the three layers, respectively.

The second layer has bad physical and hydrophysical properties, so this layer looks like hard pan and impacted on all properties of the first layer especially air and water flux. Water table depth is ranged between 90 and 105 cm. It is recommended that soil texture of the second layer must be improved through deep ploughing and addition of sand in order to enhance air diffusion to prevent the wilting of plants.

INTRODUCTION

Physical and hydrophysical properties of the soil can be used as an indicator for the soil degradation. Chin et al. (1993) show that decreasing soil bulk density to be near 1 Mg m^{-3} was indicator for reduce soil macropores and increase micropores (matrix pores). High saturation points indicated that the soil has fine texture, high micropores percentage and poor soil aeration. Increasing air entry suction indicated to the soil has fine texture and has high ability to store water. High exchangeable sodium percentage (ESP) causes clay dispersion, poor soil structure and poor drainage (El Gendy et al., 2000).

Nowadays, different models are used for predicting the hydraulic properties of the soils based on neural network such as Rosetta, and RETC. Rosetta implements pedotransfer functions (PTFs) based on artificial neural networks. These PTFs predict water retention and saturated hydraulic conductivity from soil textural data, bulk density and one or two water retention points. A hierarchical set of models permits maximum flexibility to make optimal use of available data. Additionally, Rosetta allows the prediction of unsaturated hydraulic conductivity parameters from predicted and fitted retention parameters. Rosetta was developed by Schaap, et al. (1998). The RETC (RETention Curve) computer program is used for describing the hydraulic properties of unsaturated soils. The program may be used to fit several analytical models to observed water retention and/or unsaturated hydraulic conductivity or soil water diffusivity data. These programs depend on some soil physical properties such as sand %, silt %, clay%, soil bulk density, water content at 0.33 and 15 bar. The RETC code is a descendent of the SOHYP code previously documented by van Genuchten (1978). New features in RETC include (i) a direct evaluation of the hydraulic functions when the model parameters are known, (ii) a more flexible choice of hydraulic parameters to be included in the parameter optimization process, (iii) the possibility of evaluating the model parameters from observed conductivity data rather than only from retention data, or simultaneously from measured retention and hydraulic conductivity data, and (iv) user friendly program preparation.

Galal et al. (2002) used the pedotransfer functions to predict the points of soil moisture retention curves of El Fayuom soils. They used also the soil routine analysis to predict and evaluate the output of these functions via van Genuchten model of soil moisture retention curve.

This study aims to find an interpretation that these soils retain soil water for a long time with low moisture flux within the soil profile, although the drainage net is empty most of the time from drainage water. So, the cultivated crops need less frequent irrigation than those cultivated in different areas to avoid the wilting phenomenon for plants and high dropping in the crop yield due to extra irrigation.

MATERIALS AND METHODS

The studied soils forming an Idko farm at El-Bosaily in the north-western part of the Nile Delta, Idko district, Behira governorate. It is bounded to the north by Alex.-Rashid road, to the south by Debono village, to the east by El-Bosaily tard drain and to the west by Idko Lake.

Eighteen soil samples were collected from six soil profiles (3 layers per profile, 0-25, 25-50, and 50-75 cm) to determine the soil physical, hydrophysical, and chemical properties. These properties of the soils were determined according to Page et al. (1982) and depicted in tables 1 and 2. RETC program had been used to predict saturated hydraulic conductivity (Ks), soil moisture retention curves, unsaturated hydraulic conductivity (K(θ)), hydraulic diffusivity, and hydraulic capacity(C). RETC program (version 6.0) carried out according to van Genuchten, Simunek, Leij and Sejna (US Salinity Laboratory. USDA. ARS, Riverside, CA, 92507). Statistical analysis for the output of RETC program for the three soil layers (t test in pairs) had been done using "(SY-Stat, 1990)" program.

Table 1: Some physical and hydrophysical properties of the soil samples

Profile No.	Sample No.	Depth, Cm	Sand, %	Silt, %	Clay, %	BD,*m³ Mg	θ^{xx}_v at 0.33 bar	θ_v at 15 bar
	1	0-25	25.00	32.50	42.50	1.18	45.15	22.85
1	2	25-50	27.50	20.00	52.50	1.10	52.10	25.33
	3	50-75	10.00	26.25	63.75	1.15	53.90	25.91
	4	0-25	27.50	30.00	42.50	1.24	46.00	23.10
2	5	25-50	16.25	18.75	65.00	1.24	55.33	26.95
	6	50-75	30.00	20.00	50.00	1.28	48.39	24.44
	7	0-25	13.75	27.50	58.75	1.18	49.22	23.65
3	8	25-50	22.50	17.50	60.00	1.18	52.15	25.33
	9	50-75	45.00	27.50	27.5	1.38	31.91	17.85
	10	0-25	21.25	30.00	48.75	1.24	47.60	25.15
4	11	25-50	20.00	25.00	55.00	1.24	50.95	27.00
	12	50-75	32.50	22.50	45.00	1.38	46.18	24.18
	13	0-25	26.25	31.25	42.50	1.24	44.00	21.00
5	14	25-50	15.00	26.25	58.75	1.20	49.95	24.18
	15	50-75	11.25	27.50	61.25	1.18	53.00	25.89
	16	0-25	20.00	25.00	55.00	1.18	47.11	21.45
6	17	25-50	10.00	26.25	63.75	1.10	53.00	25.60
	18	50-75	12.75	21.75	65.75	1.15	57.60	27.50
	1	0-25	22.29	29.38	48.33	1.20	46.51	22.87
Average	2	25-50	18.54	22.29	59.17	1.18	52.25	25.73
	3	50-75	23.54	24.25	52.21	1.25	48.50	24.30

BD* = bulk density

θ_v = moisture content on volume bases

Table 2: Some chemical properties of the soil samples

Profile No.	Sample No.	Depth, Cm	EC, dS/m	$CaCO_3$, %	pH	Soluble Cations, meq/L					Soluble Anions, meq/L				SAR	ESP,%
						Ca^{++}	Mg^{++}	Na^{+}		K^{+}	CO_3^{--}	HCO_3^{-}	CL^{-}	SO_4^{--}		
	1	0-25	1.19	2.00	8.96	1.80	0.80	2.70	6.58	0.27	-	5.00	5.40	1.50	6.58	8.5
1	2	25-50	1.72	2.00	8.78	1.30	1.30	13.00	11.40	0.31	-	3.80	9.80	3.60	11.40	15.7
	3	50-75	2.66	3.20	8.66	2.70	1.50	21.25	15.96	0.40	-	5.40	6.00	15.20	15.96	22.5
	4	0-25	1.39	2.30	8.62	1.00	1.60	10.00	8.77	0.32	-	2.40	7.60	3.90	8.77	11.8
2	5	25-50	6.30	3.50	8.49	3.80	6.20	52.00	23.26	0.86	-	3.20	38.00	21.80	23.26	33.1
	6	50-75	10.31	3.50	8.39	5.40	7.70	92.00	35.81	0.96	-	4.00	88.50	16.60	35.81	52.1
	7	0-25	1.21	2.50	8.70	1.80	1.20	7.30	5.98	0.20	-	3.80	4.20	4.10	5.98	7.6
3	8	25-50	1.41	2.00	8.82	1.00	1.00	11.00	11.00	0.26	-	4.20	4.40	5.50	11.00	15.1
	9	50-75	1.00	2.20	8.88	1.80	0.60	7.00	6.36	0.20	-	4.60	3.20	2.20	6.36	8.2
	10	0-25	7.65	6.50	8.26	8.00	20.00	45.00	12.03	1.12	-	1.60	50.50	24.40	12.03	16.6
4	11	25-50	24.20	2.50	8.22	10.40	29.00	200.50	45.17	1.42	-	3.00	210.00	29.00	45.17	66.0
	12	50-75	19.10	4.00	8.78	17.40	22.30	149.50	33.56	1.16	-	2.20	165.00	23.80	33.56	48.7
	13	0-25	0.80	1.70	8.85	1.30	1.10	4.50	4.11	0.51	-	4.00	3.30	0.70	4.11	4.9
5	14	25-50	1.35	3.50	9.09	1.20	2.00	9.60	7.59	0.31	-	5.80	4.00	3.70	7.59	10.0
	15	50-75	1.58	3.40	8.57	1.60	0.80	12.00	10.95	0.31	-	6.20	5.20	4.40	10.95	15.0
	16	0-25	1.20	3.70	9.06	1.40	19.60	10.60	9.30	0.29	-	4.40	6.00	3.50	9.30	12.6
6	17	25-50	2.00	1.80	9.00	3.00	18.75	18.75	11.86	0.40	-	4.20	12.90	7.40	11.86	16.4
	18	50-75	1.80	1.50	8.89	3.20	25.00	25.00	15.81	0.43	-	4.00	17.30	9.70	15.81	22.3

SAR = Sodium absorption ratio , ESP = Exchangeable sodium percentage

RESULTS AND DISCUSSIONS

Data in charts (1, 2 and 3) include the input to RETC program, which are sand%, silt%, clay%, soil bulk density, moisture contents at 0.33 and 15 bar of the three soil layers. These parameters of the three soil layers (0-25, 25-50 and 50-75 cm) were taken as average of the six profiles, which represented the studied soils. The outputs of this program are the given parameters of van Genuchten model (1980) of soil moisture retention curve (SMRC) (i.e. residual soil moisture content (θ_r), saturation point (θ_s), α parameter (the inverse of air entry suction) and n & m constants for fitting curve. Also, saturation hydraulic conductivity was predicted. The given data to this program clear that the studied soils is clayey texture for the three soil layers. The statistical analysis showed that there are significance differences between the three soil layers in pairs (0-25 &25-50, 0-25-&50-75, and 25-50 &50-75) at probability 0.05. The three charts are belonging to the three layers, which had been predicted with their soil hydraulic properties.

Data in the three charts and in Table (3) pointed to the field capacity values at 330 mbar was 0.4580, 0.5220, and 0.4686 for the first, second and third layer, respectively. So this definition is an invalid for this case because the air entry suctions were 435, 769, and 588 mbar for the same layers, respectively. The meaning of that air will be entering into soil at 435, 769, and 588 mbar for the same layers, respectively. Hence, before these suctions no finding air for plant respiration and field capacity at 330 mbar is an invalid method to determine it under this case. Availability of soil moisture starts from 435, 769, and 588 mbar for the same layers, respectively, however, field capacity values will be after these suctions not before them. El Gendy and Bedaiwy (2002) suggested that the starting of concavity on SMRC is the beginning effect of soil matrix suction (starting of field capacity) and the end of the convexity on SMRC is the end of macro pores effect and starting of field capacity. From the above discussion an inflexion point on SMRC is the field capacity. So, the inflexion points were calculated and F.C values were found 0.3133, 0.3318 and 0.3065 at 1205.379, 1738.69 and 1518.371 mbar, for the three layers, respectively. Values of the inflexion points are increased as soil texture became heavier, the direct effect in values of inflexion points is related to total porosity and pore size distribution while the indirect one is related to clay content (Talha et al., 1986). Field capacity by El Gendy and Bedaiway (2002) method may be correct because value of F.C equals double of wilting points, approximately, which are 0.1431, 0.1544 and 0.1446 for the three soil layers, respectively (Table 3). The height values of wilting points for the three soil layers might be due to the high concentration of sodium and potassium (Table 2) lead to increase the swelling of clay mineral so the ability of soil to store soil moisture become high. This fact about studied soils make sure what the workers found in the field. The cultivated crops need less frequent irrigation than those cultivated in different areas. The wilting phenomenon for plants and lack in the crops yield will be occurred at extra irrigation due to reducing the permeability, consequently, late of air interference to roots for respiration.

The second layer (25-50 cm) is more dense due to high clay percentage (59.17), micropores is dominate, so, hydraulic conductivity reduced to 50% of that of first layer so it is considered a hard pan and an impediment to air and water diffusion into the soil profile from the upper layer.

SMRC models are shown in the chart (1) for predicting the soil moisture content (first model) and soil matric suction (second model). These models depend on the first five initial values, which are cleared in the same charts. Fig. (1) illustrate SMRC of the three layers together.

Saturated hydraulic conductivity of the three soil layers is very low (0.72, 0.36, and 0.36 cm/h, respectively) this indicates that the soil water movement is very low, too.

Chart (1): Input and output data of RETC program for the first layer (0 –25 cm layer) of the studied soil.

The given data to RTEC program for (0-25 cm layer) of the studied soil
Sand = 22.29%, Silt = 29.38%, Clay = 48.33%, BD = 1.2 g/cm^3
$\theta_{0.33\ bar}$ =0.4651 cm^3/ cm^3, θ_{15bar} = 0.2287 cm^3 cm^3

Predicted Initial values of the hydrophysical properties coefficients

No	Name	Initial value	
1	θr	0.0931	cm^3 cm^{-3}
2	θs	0.5336	cm^3 cm^{-3}
3	α	0.0023	mbar^{-1}
4	n	1.6140	
5	m	0.3804	
6	l	0.5000	
7	Ks	0.0002	cm/sec (0.72 cm/hr,)

Soil moisture retention equations

$$\theta = \theta_r + (\theta_s - \theta_r)\left[1 + (\alpha h)^n\right]^{-m}$$

$$\theta = 0.0931 + (0.5336 - 0.0931)\left[1 + (0.0023h)^{1.6144}\right]^{-0.3804}$$

$$h_{mbar} = \left[\frac{1}{0.0023}\right]\left[\left(\frac{(\theta - 0.0931)}{(0.5336 - 0.0931)}\right)^{-\frac{1}{0.3804}} - 1\right]^{\frac{1}{1.6140}}$$

Unsaturated hydraulic conductivity equation

$$K(\theta) = K_S\left(\frac{\theta - \theta_r}{\theta_S - \theta_r}\right)^L\left[1 - (1 - \left(\frac{\theta - \theta_r}{\theta_S - \theta_r}\right)^{\frac{1}{m}})^m\right]^2$$

Hydraulic diffusivity equation

Where:

θ is the volumetric soil moisture content at soil matric suction, h, mbar,
θ_r is the residual volumetric soil moisture content,
θ_s is the saturation point, cm^3/cm^3
n & m are constant of fitting for the soil moisture retention curve,
α is the inverse of air entry suction, $mbar^{-1}$,
L is a constant's Mualem for predicting unsaturated hydraulic conductivity ($K\theta$), cm/sec
Ks is the saturated hydraulic conductivity, cm/ sec.,
D (θ) is hydraulic diffusivity, cm^2 /sec, and
($dh/d\theta$) is the inverse of the hydraulic capacity, cm

Chart (2) Input and output data of RETC program for the second layer (25-50 cm layer) of the studied soil

The given data to RTEC program for (25-50 cm layer) of the studied soil
Sand = 18.54% , Silt = 22.29% , Clay = 59.17% , BD = 1.18g/cm3
θ 0.33 bar =0.5225, θ15bar = 0.2573

Predicted Initial values of the hydrophysical properties coefficients

No	Name	Initial value
1	θr	0 .1033 $cm^3 cm^{-3}$
2	θs	0.5604 $cm^3 cm^{-3}$
3	α	0 .0013 $mbar^{-1}$
4	n	1.7369
5	m	0.4243
6	l	0.5000
7	Ks	0 .0001 cm/sec (0.36 cm/hr,)

Soil moisture retention equations

$$\theta = 0.1033 + (0.5604 - 0.1033)\left[1 + (0.0013\ h)^{1.7369}\right]^{-0.4243}$$

$$h_{mbar} = \left[\frac{1}{0.0013}\right]\left[\left(\frac{(\theta - 0.1033)}{(0.5604 - 0.1033)}\right)^{-\frac{1}{0.4243}} - 1\right]^{\frac{1}{1.7369}}$$

Chart (3) Input and output data of RETC program for the third layer (50 -75 cm layer) of the studied soil

The given data to RTEC program for (50 - 75 cm layer) of the studied soil
Sand = 23.54%, Silt = 24.25%, Clay = 52.21%, BD = 1.25 g/cm3
θ 0.33 bar =0.4850, θ15bar = 0.2430

Predicted Initial values of the hydrophysical properties coefficients

No	Name	Initial Value
1	θ_r	0.0930
2	θ_S	0.5304
3	α	0.0017
4	n	1.6520
5	m	0.3947
6	l	0.5000
7	Ks	0.0001

Soil moisture retention equations

$$h_{mbar} = \left[\frac{1}{0.0017}\right]\left[\left(\frac{(\theta - 0.0930)}{(0.5304 - 0.0930)}\right)^{-\frac{1}{0.3947}} - 1\right]^{\frac{1}{1.6520}}$$

$$\theta = 0.0930 + (0.5304 - 0.0930)\left[1 + (0.0017\ h)^{1.6520}\right]^{-0.3947}$$

Table (3) SMRC data of the three layers of the studied soils

h,mbar	θ v (0-25)	θ v (25 - 50)	θ v (25 - 75)
1	0.5336	0.5604	0.5201
10	0.5332	0.5603	0.5199
50	0.5286	0.5587	0.5173
100	0.5189	0.5549	0.5114
200	0.4935	0.5429	0.4947
300	0.466	0.5271	0.4748
330	0.458	0.522	0.4686
400	0.44	0.5095	0.4542
435	0.4315	0.5031	0.4471
500	0.4165	0.4911	0.4343
588	0.3981	0.4751	0.4179
600	0.3958	0.4729	0.4158
700	0.3776	0.4555	0.3987
769	0.3663	0.444	0.3879
800	0.3616	0.439	0.3832
900	0.3474	0.4235	0.3691
1000	0.3349	0.4092	0.3564
1205	0.3133	0.383	0.3338
1738	0.274	0.3318	0.2912
1518	0.288	0.3505	0.3065
2000	0.2604	0.3132	0.2761
3000	0.2254	0.2647	0.2369
4000	0.2047	0.2358	0.2134
5000	0.1907	0.2165	0.1976
6000	0.1805	0.2027	0.1862
7000	0.1727	0.1923	0.1774
8000	0.1665	0.1841	0.1705
9000	0.1614	0.1775	0.1648
10000	0.1572	0.172	0.1601
11000	0.1535	0.1674	0.1561
12000	0.1504	0.1634	0.1526
13000	0.1477	0.16	0.1496
14000	0.1453	0.157	0.147
15000	0.1431	0.1544	0.1446

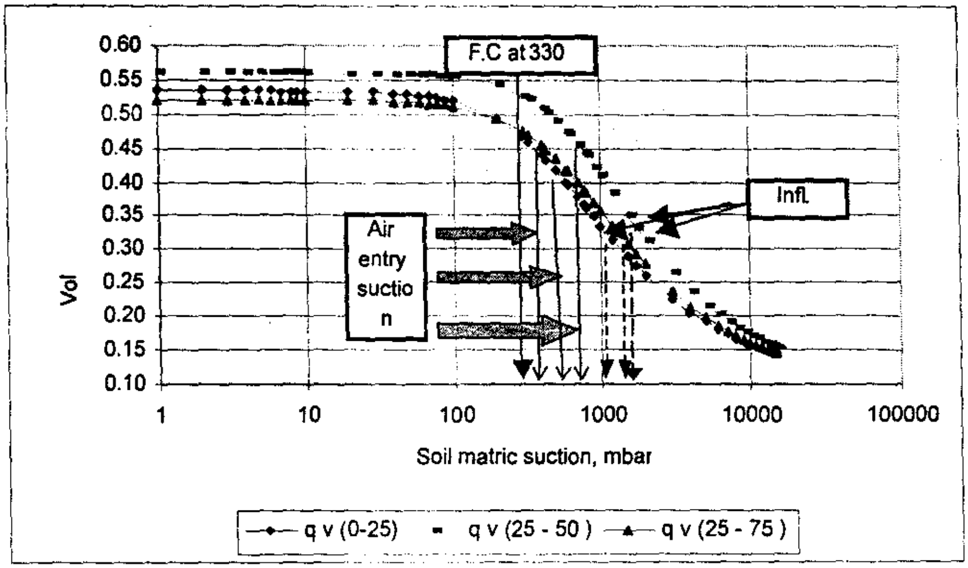

Fig. (1) SMRC of the three soil layers of the studied soils.

K (θ) vs θ_v relationship

Figs (2, 3 and 4) illustrate that the relationship between soil moisture content and unsaturated hydraulic conductivity of 0 – 25, 25 –50, and 50 - 75 cm layers of soils. As a result of high soil matric potentials of clay the values of K (θ) were very low and their values were clear up level 0.30 soil moisture.

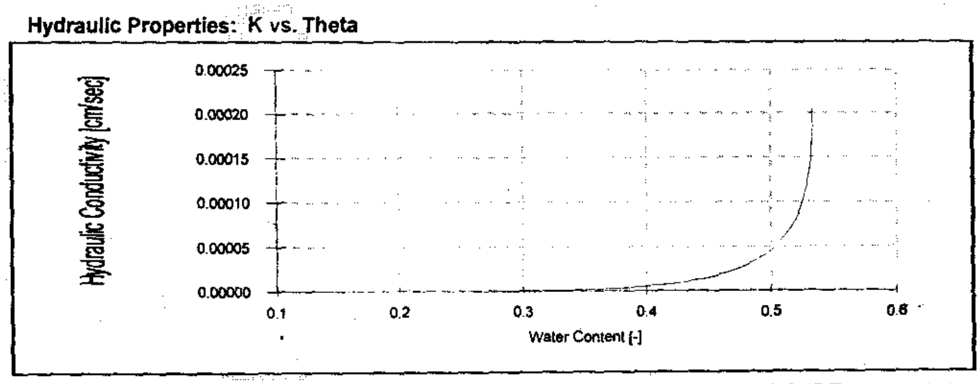

Fig. (2) Unsaturated hydraulic conductivity K (θ) vs θ_v of 0-25 cm

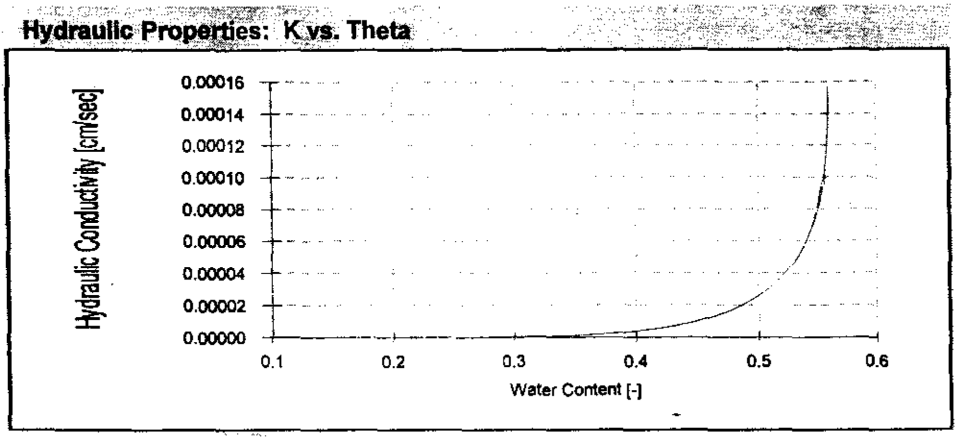

Fig. (3) K (θ) vs soil moisture content (θ_v) of 25-50 cm, depth

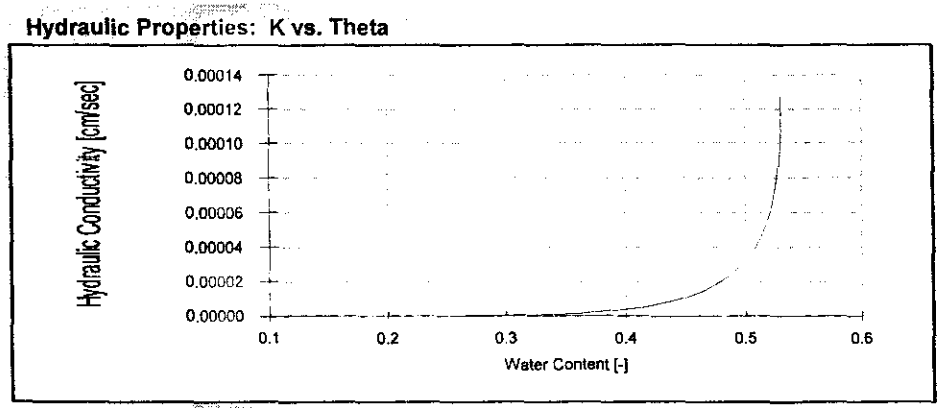

Fig. (4): K (θ) vs soil moisture content (θ_v) of 50-75 cm, depth

Hydraulic capacity vs θ_v relationship

The hydraulic capacity (dθ/ dh) reaches to maximum point 0.000275, 0.00018 and 0.00021 cm^{-1} at soil moisture contents 0.49, 0.5 and 0.49 for arrange the three soil layers, respectively. Hydraulic capacity is the slope of the SMRC approximately and controlled the water flow in the soil as in Richard equation. So, in the first layer its value was the highest one and in the second layer was the lowest one. The decreasing hydraulic capacity in this soil reflects the high potential spent from the soil on soil water changing resulting from the holding water on the surface of soil particles leads to slow motion of the soil water (Figs. 5, 6 and 7).

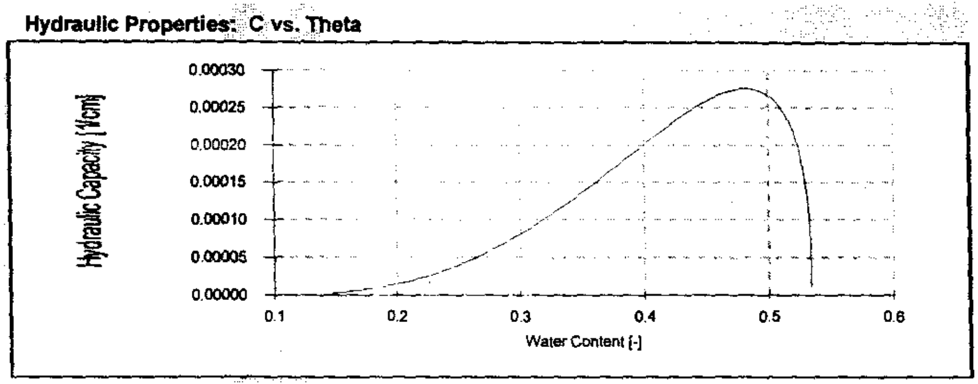

Fig. (5): Hydraulic capacity vs θ_v of 0-25 cm, depth

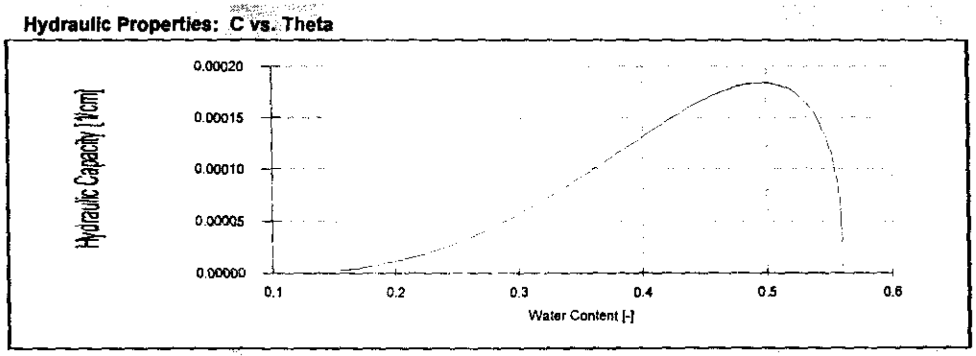

Fig. (6) Hydraulic capacity vs θ_v of 25-50 cm, depth

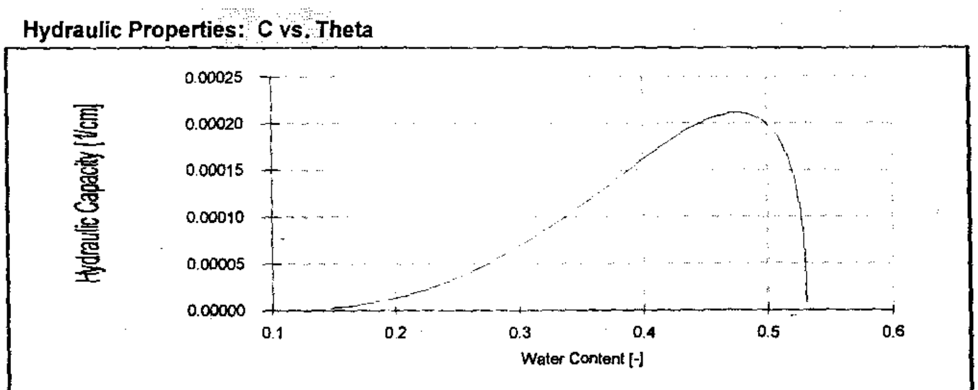

Fig. (7) Hydraulic capacity vs θ_v of 50 -75 cm, depth

Diffusivity vs θ_v relationship

That the hydraulic diffusivity is the product K(θ) X I dh/dθ I where, I dh/dθ I is the inverse of hydraulic capacity, so the water diffusion in this soil is very high although its difference between the layers (Fig 8, 9 and 10). The higher values of water diffusivity gave this soil the character of water finding along soil profile, especially in the second layer, which looks, like a hard pan, prevent water drainage.

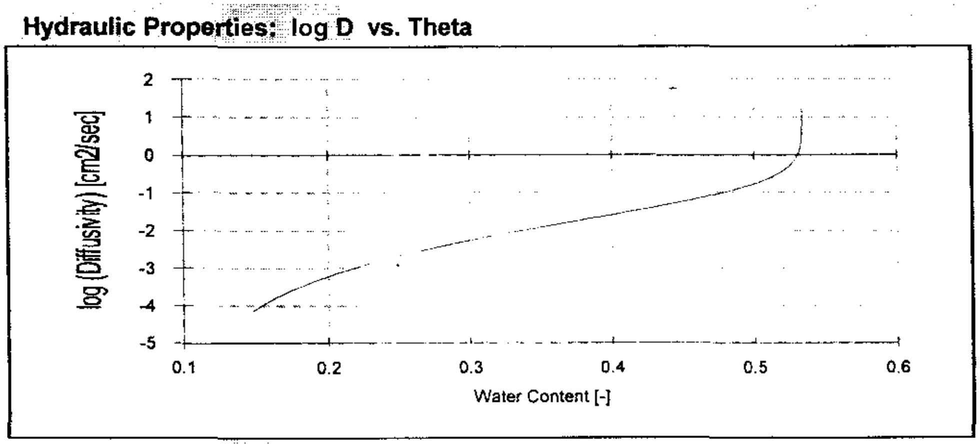

Fig. (8): Hydraulic diffusivity vs θ_v of 0-25 cm, depth

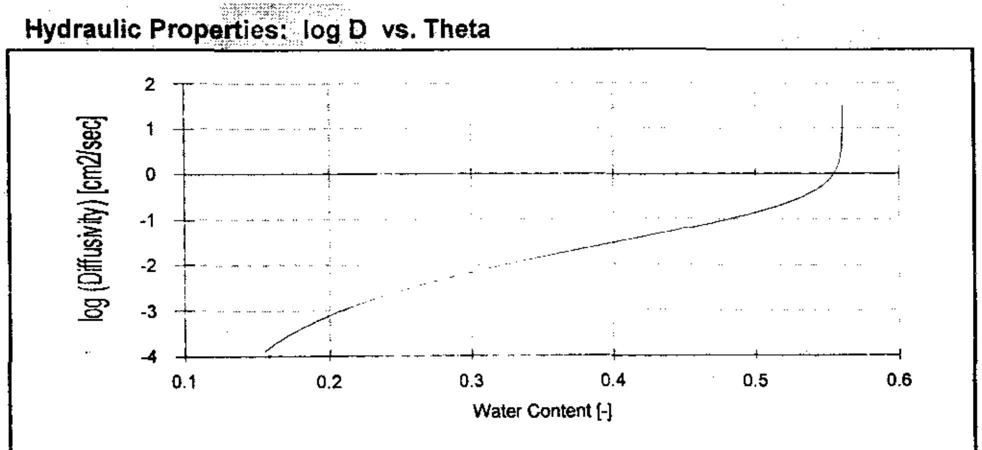

Fig. (9): Hydraulic diffusivity vs θ_v of 25-50 cm, depth

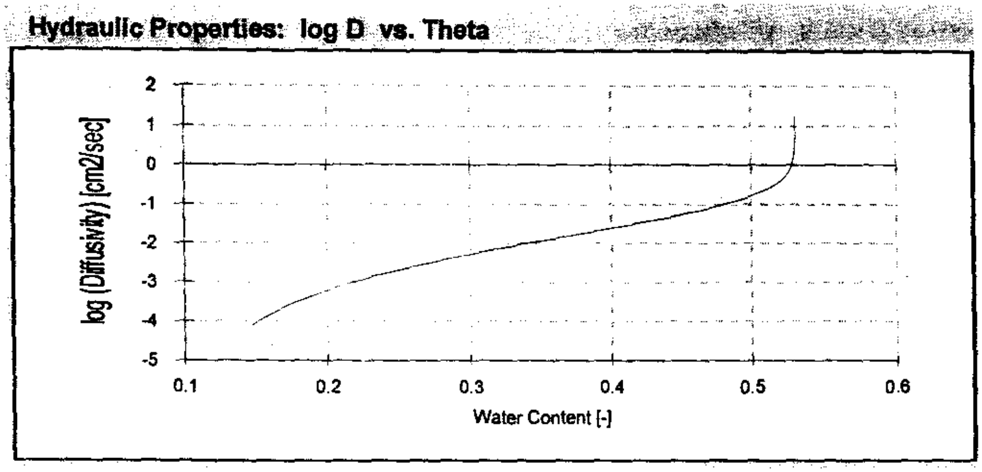

Fig. (10): Hydraulic diffusivity vs θ_v of 50 -75 cm, depth

From the above mentioned discussion, it clears that the problem of this soil is due to the second soil layer, which poor in hydraulic properties impacted on all properties of the first layer especially air and water movement. The second layer needs management such as apply sand in order to improve its grain size distribution and pore size distribution to diffuse air and water root zone of plant.

Conclusion

The studied soil (eastern of Idko lake) has a heavy texture (clayey soil texture) and air entry suction was after 330-mbar (F.C) as we know to determine soil field capacity. So, field capacity is obtained at 435, 769, and 588 mbars for three layers, respectively). As a result of lower saturated hydraulic conductivity and finding the second layer, which is considered a hard pan obviously showed a considerable decrease the air and moisture motions are lower, however the soil moisture depletion takes more time, so the irrigation process prevent respiration for plant.

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الملخص العربي

استخدام الشبكة العصبية لتفسيرالظواهر الهيدروليكية فى بَعْض الأراضي الواقعة

شرقِ بحيرةِ ادكو–مصر

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تهدف هذه الدراسة لإيجاد تفسيرَ لبعض الظواهر الهيدروليكيةِ في بعض الأراضـــي الواقعـــة شرق بحيرة ادكو حيث لوحظ أن هذه الأراضي تَحتفظُ بماءِ الرَيِّ لوقت طويل مع الحركةِ البطيئةِ للمياه خلال القطاع الأرضي، بالرغم من كفاءة اداء شبكةِ المصارف جيده و بالتالي فإن المحاصيل المنزرعـــة تحتاج لفترة طويلة بين الريات مقارنة بتلك النامية في مناطق أخرى حيث تذبل النباتات مع زيادة مياه الري .

تم اختيار 6 قطاعات أرضية ممثلة لمنطقة الدراسة, 18 عينة أرضية تـم تجميعهــا لتمثـل القطاعات المدروسة بواقع 3 عينات من كل قطاع لتمثل الثلاث طبقات الأولى (0–25, 25–50 و50–75سم). تم إجراء تحليل لبعض الخصائص الفيزيائية والهيدروفيزيائية وكذلك التحليلات الكيمائية على العينات الأرضية المدروسة. تم استخدام برنامج RETC للتنبؤ بالخواص الهيدروليكية.

تشير النتائج أن الاراضى المدروسة ذات قوام طينـي وتراوحـت قيمـة معامـل التوصـيل الهيدروليكي المتنبأ بها من البرنامج فى الحالة المشبع بين 0.36–0.72 سم/ الساعة وأن جهد دخـول الهواء كان اكبر من 330 ملي بار وهى القيمة المتعارف عليها لتقدير السعة الحقلية الا أن جهد دخـول الهواء للطبقات الثلاثة كان 435 ، 769 ، 588 ملي بار على التوالي. وهـذا غيرمـألوف والـسعة الهيدروليكية (hydraulic capacity) كانت منخفضة جدا (0.00028, 0.00018و 0.00021 سم$^{-1}$ للثلاث طبقات على التوالى) بينما كانت قـيم الانتـشارية الهيدروليكيـة (hydraulic diffusivity) مرتفعة جدا. أما نقط الانقلاب على منحنـى الـشد الرطـوبى كانـت عنـد 1205.38, 1738.69, 1518.37 ملي بار للثلاث طبقات على التوالي. لذلك فان سبب المشكلة فى هذه الأراضى هـو سـوء الخصائص الهيدروفيزيائية للطبقة الثانية (25–50سم) والتي يمكن اعتبارها طبقة طينية صماء (hard pan) تؤثر على جميع خصائص الطبقة الأولى (0–25سم) وتمنع حركة الماء وانتشار الهواء داخـل قطاع التربة و ارتفاع منسوب الماء الأرضي الذي يتذبذب بين 90 و 105 سم

مما سبق ولتجنب المشاكل التى تواجه النباتات فى الحصول على المـاء والهـواء فـى هـذه الأراضى توصى الدراسة بتحسين قوام الأرض بصفة عامة و الطبقة الثانية بصفة خاصة وذلك بالحرث العميق (تحت التربة) مع إضافة الرمل لتخفيف القوام لكي يساعد على انتشار الماء والهواء داخل قطـاع الأرض لمنع ذبول النباتات ونقص المحصول.