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تأثير مدة الاستخدام الزراعي وجودة مياه الري على التغيرات في جودة التربة في بعض الأراضي البحيرية- مصر

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الملخص العربي

أجريت هذه الدراسة بهدف تتبع التغيرات التي تطرأ على جودة التربة **(Soil Quality)** ومدى تأثرها بمدة الاستخدام الزراعي (١، ٢، ٣، ٤، ٥، ١٠، ١٥ عاما) بالإضافة إلى الأراضي البكر وكذلك مصادر وجودة مياه الري (مياه النيل ومياه مخلوطة) فى بعض الأراضى البحيرية فى قرية دويونو جنوب بحيرة ادكو، مع اقتراح دليل مناسب يعبر عن جودة التربة وحساب دليل نسبى لجودة الأراضى **(RSQI)** طبقا للطريقة المقترحة بواسطة كل من **Wang and Gong** عام ١٩٩٨.

تميزت منطقة الدراسة بأن معظم الأراضى ذات جودة منخفضة الى متوسطة حيث تراوحت قيمة الدليل النسبى لجودة الأراضى **(RSQI)** ما بين ٣٥.٢٥- ٧٧.٠ وقد أدى استزراع الأرض الى ارتفاع قيم **RSQI** مقارنة بالأراضى البكر. قيم **RSQI** كانت أعلى فى الأرض المنزرعة مقارنة بالأرض البكر. قيم التغير فى الدليل النسبى لجودة الأراضى **(ΔRSQI)** نتيجة الزراعة تغيرت فى مدى واسع وتراوحت بين ٠.٢٥ و٤١.٧٥. قيم **RSQI** قد ارتفعت مع تقدم مدة الاستخدام الزراعي حتى ١٠ سنوات ثم حدث انخفاض فى قيمة الدليل **(RSQI)** في الأراضي المنزرعة لمدة ١٥ عام والتى تميزت بزيادة قيم كلا من التوصيل الكهربي **(EC)** والقلوية **(SAR)** نظرا لارتفاع مستوى الماء الأرضي مع انخفاض قيم الماء المتاح للنبات. نفس الاتجاه السابق لوحظ فى قيم التغير فى الدليل النسبى لجودة الأراضى **(ΔRSQI)** وكذلك التغير السنوى **ΔRSQI per year (ΔRSQI/ year)** نتيجة اختلاف مدة استخدام الأرض. أقسام جودة التربة بدأت تتحسن بعد سنتين من الزراعة حيث تحسنت من القسم الخامس **(class V)** التى تميزت به الأرض البكروالمنزرعة لمدة عام الى القسم والثالث **(classe III)** بعد ٣، ٤ سنوات

وتميزت الأراضى المنزرعة لمدة ٥ و١٠ سنوات بالقسم الثانى (classe II) من أقسام جودة التربة والذى انخفض مرة أخرى للقسم الثالث (classes III) بعد ١٥ عام من الاستخدام (تحت نفس جودة مياه الرى).

تميزت الأراضي التي تستخدم مياه النيل فى الرى بقيم أعلى فى الدليل النسبى لجودة الأراضى (RSQI) والتغير فى الدليل النسبى لجودة الأراضى (ΔRSQI) وكذلك التغير السنوى فى الدليل النسبى لجودة الأراضى (ΔRSQI/ year) من تلك التى تستخدم المياه المخلوطة. أيضا أستخدام مياه النيل فى الرى أدى الى تحسين مستويات جودة التربه بالمقارنه باستخدام المياه المخلوطة. يوجد ارتباط معنوى عالى بين الدليل المقترح لجودة التربة والمحصول الفعلى للقمح والذره حيث كان معامل الارتباط ٠.٨٩٢ و ٠.٩٠٤ على التوالى.

مما سبق يمكن استنتاج أن دليل جودة الأراضى المقترح فى هذه الدراسة RSQI يمكن استخدامه بنجاح فى المناطق المحدودة التى بها اختلافات صغيرة حيث يحتاج الى كمية أقل من المدخلات بالإضافة لذلك أنه يعطى ارتباط معنوي عالي مع المحصول.

يمكن تحسين الخواص الكيميائية والطبيعية والخصوبة وبالتالى دليل جودة التربة فى منطقة الدراسة من خلال تجنب استخدام نوعيه منخفضة الجودة من مياه الري فضلا عن إنشاء نظام صرف جيد وكذلك بإضافة المخصبات العضوية والمخلفات الزراعية وبالتسميد الكاف والمتوازن.

SOIL QUALITY CHANGES AS INFLUENCED BY LAND USE PERIODS AND IRRIGATION WATER QUALITY IN EGYPTIAN LACUSTRINE SOILS

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ABSTRACT: ***The current study was carried out to compare and analyze changes in soil quality, under different land use periods (1,2,3,4,5,10 and 15 years) and two irrigation water sources of different qualities (Nile and mixed water) in some lacustrine soils at Debono village south of Idko Lake. Soil quality index of the investigated soil was proposed and relative soil quality index (RSQI) was calculated according to the method proposed by Wang and Gong (1998).***

The studied soils are characterized by low to intermediate soil quality, as values of relative soil quality index (RSQI) ranged from 35.25 to 77.00. The cultivated soils have higher RSQI values than those representing virgin soils (35.25). This means that cultivation tends to improve the soil quality. Also, changes in relative soil quality index (ΔRSQI) values due to cultivation were relatively wide and ranged between 0.25 and 41.75. RSQI increased with increasing land use period. Soils cultivated for 15 years showed relatively low RSQI due to imperfect drainage, rising of water table and low available water content. This trend was also observed in ΔRSQI, it was 38.50 and 41.75 in soils cultivated for 5 and 10 years respectively, while it was 25.25 in soils cultivated for 15 years. ΔRSQI per year (ΔRSQI/year) increase as land use period increases up to 5 years. Soil quality classes improved from class V in soils represent virgin soils to class II in soils cultivated for 5 and 10 years (under the same irrigation water quality). The soils which use Nile water for irrigation hade relatively higher RSQI values (49-77) than those using mixed water (49.0-63.5). Highest ΔRSQI or ΔRSQI/year values were found in soils using Nile water for irrigation, while lower values were observed in soils using mixed water. Better improvement was found in soils cultivated for 5

and 10 years and irrigated by Nile water. High significant correlation was observed between RSQI and actual wheat or corn yields with the correlation coefficients 0.892 and 0.904 for wheat and corn respectively. RSQI can be used successfully since it needs minimum data set and can show minor variation at the microscale and has a significant correlation with yield.

Key words: ***Soil quality, Relative soil quality index, Water quality, Land use period, Lacustrine soils***

INTRODUCTION

Agriculture sustainability in saline soils at northern lakes of Egypt is required to meet the urgent demand of food for the increasing population. Land management is useful for improving soil quality, and achieving the agriculture sustainability. Therefore, better soil management and conservation are essential to improve soil production and reduce soil degradation.

Several investigators in Egypt studied the effect of land use periods and land management practices on different soil characteristics and subsequently on soil quality. Noaman and Sheta (1988) found in their study on the irrigated dried parts of El-Manzala Lake that the surface soil salinity decreased after two years of cultivation with no clear changes in texture. According to Abou-Hussien (1999), the contents of both total and available N, P, K, Fe, Mn, Zn and Cu were increased with increasing cultivation period in some Kalioubiya soils. The use of saline waters for irrigation leads to a marked accumulation of total soluble salts in soils (El-Sawaby and Abu-EL-Anine, 1977 and Abd-Allah, 1988).

The importance of soil quality in agricultural sustainability and environmental impact has been recognized in recent years. Soil quality is an intricate interaction of chemical, biological, physical and environmental components of soil systems. Land use and management practices affect the direction and degree of soil quality changes. Therefore, such relation is the major concern in the present study.

Larson and Pierce (1991) defined soil quality as “the capacity of a soil to function within the ecosystem boundaries and interact positively with the environment external to that ecosystem.” Three soil functions are considered essential: provide a medium for plant growth, regulate and partition water flow through the environment, and serve as an effective environmental filter. According to Karlen *et al.* (1997), soil quality is the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation.

Wang and gong (1998), defined soil quality as "The function of soil to supply nutrients and other physico-chemical conditions to plant growth, promote and sustain crop production, provide habitat to soil organisms, ameliorate environmental pollution, resist degradation, and maintain or improve animal health.

Agriculture practices coupled with poor management have been responsible for considerable land degradation. With the databases and soil quality assessments, scientists should be able to predict soil behavior under various cropping systems and land uses. Moreover, it is also important to predict the vulnerability of soils to degradation or to determine when soil quality will be impaired in the long term (Miller and Wali, 1995). Thus, there is an urgent need to develop early-warning indicators to predict potential land degradation and identify the early stages of actual degradation. The sustainable agriculture based on maintenance, and enhancement of the inherent soil quality. So, efficiency soil quality indicators must be introduced, characterized and quantified.

To measure soil quality, a minimum data set (MDS) of soil characteristics that represents soil quality must be selected and quantified (Gregorich et.al, 1994; Wander and Bollero, 1999). The MDS may include biological, chemical and physical soil characteristics. The MDS, recommended by Kennedy and Papendick (1995), includes organic matter, bulk density, depth to hardpan, electrical conductivity, fertility, pH, yield, infiltration, mineralizable nitrogen potential and water holding capacity.

A single soil characteristic is of limited use in evaluating differences in soil quality (Reganold and palmer, 1995). Using more than one quantitative variable requires a system for combining the measurements into a useful index.

Soil quality (Q) can be defined as the sum of individual soil qualities q_i (soil characteristics) and is expressed as follow

$$Q = f\,(q_1 \ldots\ldots\ldots\ldots\ldots\ldots q_n)$$

A minimum data set of soil characteristics should be selected from those soil characteristics in which changes are measurable and relatively rapid (Gregorich *et al.,* 1994). According to Singer and Ewing (2000), it is important to know about changes in soil quality (dQ) than the magnitude of Q. Changes in soil quality are a function of changes in soil characteristics (q_i) over time (t):

$$dQ = f\,[(q_{1,t} - q_{1,to})\ldots\ldots\ldots(q_{n,t} - q_{n,to})]$$

Karlen *et al.* (1994) developed a soil quality index (QI) based on four soil functions: accommodating water entry (we), retaining and supplying water to plants (wt), resisting degradation (rd), and supporting plant growth (spg).

After normalizing, each value is then multiplied by its weighting factor (wt) and the products (QI) are summed as follow:

$$QI = q_{\underline{we}}\ (wt) + q_{wt}\ (wt) + q_{rd}\ (wt) + q_{spg}\ (wt)$$

The values of the index ranged between zero and one.

Wang and Gong (1998) assessed and analyzed soil quality changes after eleven years of reclamation in some subtropical soils in China. They used a similar method of Karlen *et al.* (1994) and introduced a new concept namely Relative Soil Quality index (RSQI).The equation for calculating RSQI value is:

$$RSQI = (SQI / SQI_m)*100$$

Where SQI is soil quality index and SQI_m is the maximum value of SQI (at the most optimum conditions). Their selection of the soil quality indicators as well as the weight of each indicator was based on the previous studies and the natural conditions of the studied area. SQI used in the above mentioned method was calculated according to Karlen et al., (1994) using the following equation:

$$SQI = \Sigma\ W_i\ I_i$$

Where (W_i) are the weight of each indicator and (I_i) are the marks of the indicator classes.

The current study is carried out to shed the light on the changes in the soil quality that are expected to take place when virgin lacustrine deposits are cultivated for different periods using different irrigation water quality, at Debono region south of Idko Lake, Egypt.

MATERIALS AND METHODES

The studied area is selected to represent soils developed from lacustrine deposits at Debono village south of Idko Lake. It is bounded to the north and west by Idko Lake, to the south by El-Bosaily drain and to the east by Debono village.

Fifteen profiles were selected to represent variations in different land use periods (non-cultivated, 1, 2, 3, 4, 5, 10 and15 years) and two irrigation water sources (Nile water and mixed water).

Soil samples were collected for laboratory analysis. These samples were air-dried, ground and passed through 2-mm sieve. The main chemical (in saturation-paste extract), fertility and physical properties of soils were determined according to the methods outlined by Jackson (1958), FAO (1970) and Page *et al* (1982).

Two water samples from irrigation canal (Nile water), and mixed water canal were collected every month for chemical characterization.

Evaluation of soil quality changes

1) Selection of soil quality indicators.

Based on soil quality concept and according to the previous studies in the investigated area and the adjacent areas, ten soil qualities were selected as soil quality indicators for this study. They include organic matter content %, clay %, salt content, ESP, water table level, available N, available P, available K, hydraulic conductivity (K_s) and available water. These properties reflect the suitability of soil physical and chemical conditions as well as the nutrient status of the soil for plant growth.

2) Rating of soil quality indicators

Soil quality indicators were rated into four classes (I, II, III and IV). Class I is the most suitable for plant growth and class IV represents the least suitable with severe limitations for plant growth. The range for each class is shown in Table (1). Because soil quality assessment is purpose and site specific, the rating for each class is based on the experience of the lacustrine soils under similar conditions. Also considering to what extent would the lacustrine soils improve under the optimum conditions (Labib and Sys, 1970; Fathi *et al.* (1971), El-Zahaby, 1976; El-Husseiny *et. al.,* 1985; El Gendy *et al* (2005) and Ragab (2007). Marks of 4, 3, 2 and 1 were given to class I, II, III and IV, respectively.

3) Weights of the indicators.

The contribution or importance of each indicator to soil quality is usually different, and can be indicated by a weighting coefficient. There are many ways to assign the weight for each indicator. This includes experience, mathematical statistics or models (Wang and Gong, 1998). In this study, the weight for each indicator (Table 1) has been assigned on the basis of previous research (El-Husseiny *et. al.,* 1988; Noaman and Sheta, 1988 and El-Zahaby *et. al.,* 1999) and experience under Egyptian conditions. The sum of all weights was normalized to 100 %.

Table (1): Soil quality indicators and their weights and classes for the evaluation of soil quality in Idko area

Indicators	Weights	Class I	Class II	Class III	Class IV
Organic matter %	9	> 1.5	1.0-1.5	0.5-1.0	<0.5
Clay %	12	<40	40-45	45-50	>50
Salinity (EC dS/m)	14	<4	4-8	8-16	>16
ESP	14	<5	5-10	10-15	>15
Water table level (cm)	13	>150	125-150	100-125	<100
Available water %	10	>30	25-30	20-25	<20
Hydraulic conductivity(cm/day	10	>30	20-30	10-20	<10
Available N (ppm)	6	>60	40-60	20-40	<20
Available P (ppm)	6	>10	6-10	3-6	<3
Available K (ppm)	6	>2000	1500-2000	1000-1500	<1000
Mark of indicator class		4	3	2	1

4) Quantitative evaluation of changes in soil quality.

The selected soil qualities in the studied soil profiles were integrated in a single value namely relative soil quality index (RSQI), according to the method proposed by Wang and Gong (1998) as mentioned before. The SQI value for a soil can be produced by summing up its 10 indicators- SQI values. Naturally the maximum value of SQI for the soil is 400 and the minimum value 100.

An optimal soil will have a normalized RSQI of 100, but real soils will have lower values, which indicate directly their distance from the optimal soil. By computing RSQI values, soil quality in different profiles representing different land use periods and irrigation water quality can be compared. Similarly, the change in RSQI (∆RSQI) could quantify changes in soil quality under different conditions.

Changes in RSQI (∆RSQI) values were calculated as follows:

$$\Delta RSQI = RSQI\ (cultivated) - RSQI\ (virgin)$$

Also changes in RSQI per year (∆RSQI/ year) values were calculated.

Data concerning the yield (wheat and corn) of the cultivated soils were collected from the owners.

RESULTS AND DISCUSSION

Table (2) contains data pertaining to mean values of some chemical, fertility and physical properties of the studied soils.

Table (3) contains data pertaining to mean values of some chemical properties of irrigation waters in the study region (averages of 12 water samples).

Scores of soil indicators {the weight of each indicator (w_i) * the mark of the indicator class (I_i)} which take values 1, 2, 3 or 4 according the class as well as the soil quality index (SQI), which is produced by summing up these scores ($SQI = \sum w_i * I_i$) are presented in Table (4).

Values of relative soil quality index (RSQI) are presented in Table (5). They were calculated using the equation:

$$RSQI = (SQI / SQI_m) * 100$$

where SQI is soil quality index, SQI_m is the maximum value of SQI. The maximum value of SQI is 400 and the minimum value is 100, as mentioned before in the material and methods.

Five classes are suggested to describe the soil quality, as shown in the following:

Classes	RSQI value	
I	> 85	(best soils)
II	70-85	
III	55-70	
IV	40-55	
V	<40	(worst soils)

However, different weights and ranges were introduced by Wang and Gong (1998) for some subtropical soils. Actually, the weights of indicators and the range of the quality classes differ from one study to another due to the variations in the soil types (sandy, alluvial, calcareous or lacustrine soils) as well as the environmental conditions.

Table (2): Some chemical and physical properties were selected as soil quality indicators.

P No	Source of Irrigation w.	EC dS/m	SAR	Available (ppm) N	Available (ppm) P	Available (ppm) K	O.M %	Ks cm/day	Clay %	W.t.depth cm	avalable water %
Virgin soils											
1		30.00	60.49	35.00	2.30	1287	0.57	8.0	52.50	65	26.50
Soils cultivated for 1 year											
2	Nile	16.43	45.54	37.50	2.46	1482	0.55	14.5	52.00	85	27.50

3	mixed	21.80	49.52	22.50	2.70	1287	0.43	13.0	51.20	86	25.2
Soils cultivated for 2 years											
4	Nile	10.98	26.88	37.50	3.1	1053	0.62	18.4	50.00	112	25.50
5	mixed	15.64	38.25	35.00	3.40	1209	0.52	16.2	48.75	102	26.00
Soils cultivated for 3 years											
6	Nile	7.90	11.28	42.50	3.20	1055	0.75	19.6	49.50	112	27.00
7	mixed	11.00	26.88	45.00	3.25	1650	0.58	17.0	42.50	117	28.50
Soils cultivated for 4 years											
8	Nile	5.20	11.55	45.00	4.20	780	0.96	22.3	48.50	122	28.50
9	mixed	9.10	19.28	45.00	3.60	1287	0.82	19.8	42.50	125	29.60
Soils cultivated for 5 years											
10	Nile	3.92	9.57	52.5	4.400	1780	1.28	18.5	42.50	100	31.50
11	mixed	6.25	12.90	64.00	4.30	1975	0.96	14.0	44.00	125	26.50
Soils cultivated for 10 years											
12	Nile	2.20	6.53	62.5	7.15	1955	1.12	20.2	45.75	130	29.00
13	mixed	8.20	14.17	69.00	6.22	2365	0.85	16.2	42.50	105	23.00
Soils cultivated for 15 years											
14	Nile	4.29	9.85	52.5	6.12	1450	0.89	11.3	48.00	65	19.50
15	mixed	10.14	17.22	58.5	6.200	1985	0.82	10.2	47.50	63	17.50

Table (3): Mean values of chemical properties of irrigation water in the studied area.

Irrigation W. source	pH	EC_w dS/m	SAR	Cations meq/L				Anions meq/L		
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}
Nile	7.06	0.52	1.43	1.600	1.800	1.86	0.22	2.00	2.00	1.20
Mixed	6.94	1.03	4.58	1.800	1.900	6.23	0.34	3.00	4.70	2.60

Table (4): Scores of soil indicators and soil quality index in the studied profiles.

Profile No.	Source of irrigi. w.	The weights of the indicators * the marks of the indicators classes(Wi * Ii)										
		EC	SAR	Ks	AV.W	W.t. depth	Clay	O.M	Av. N	Av.P	Av.K	SQI
Virgin soils												
1	Non	14	14	10	30	13	12	18	12	6	12	141
Soils cultivated for 1 years												
2	Nile	14	14	20	30	13	12	18	12	6	12	151
3	Mixed	14	14	20	30	13	12	9	12	6	12	142

Soils cultivated for 2 years												
4	Nile	28	14	20	30	26	24	18	12	12	12	196
5	Mixed	28	14	20	30	26	24	18	12	12	12	196
Soils cultivated for 3 years												
6	Nile	42	28	20	30	26	24	18	18	18	12	236
7	Mixed	28	14	20	30	26	36	18	18	12	18	220
Soils cultivated for 4 years												
12	Nile	42	28	30	30	26	24	18	18	12	12	240
9	Mixed	28	14	20	30	26	36	18	18	12	12	214
Soils cultivated for 5 years												
10	Nile	56	42	20	40	26	36	27	18	12	18	295
11	Mixed	42	28	20	30	26	36	18	24	12	18	254
Soils cultivated for 10 years												
12	Nile	56	42	30	30	39	24	27	24	18	18	308
13	Mixed	28	28	20	20	26	36	18	24	18	24	242
Soils cultivated for 15 years												
14	Nile	42	42	20	20	13	24	27	24	18	12	242
15	Mixed	28	14	20	20	13	24	27	24	18	18	206

Table (5): Relative soil quality index (RSQI) and changes in relative soil quality index (∆RSQI) and their classes in the studied profiles.

Prof.No.	Source of irr. Water	SQI	RSQI	RSQI classes	∆ RSQI	∆RSQI/year
virgin soils						
1	Non	141	35.25	V		
Soils cultivated for 1 years						
2	Nile	151	37.75	V	2.50	2.50
3	mixed	142	35.50	V	0.25	0.25
Soils cultivated for 2 years						
4	Nile	196	49.00	IV	13.75	6.88
5	mixed	196	49.00	IV	13.75	6.88
Soils cultivated for 3 years						
6	Nile	236	59.00	III	23.75	7.92
7	mixed	220	55.00	IV	19.75	6.58
Soils cultivated for 4 years						

8	Nile	240	60.00	III	24.75	6.19
9	mixed	214	53.50	IV	18.25	4.56
Soils cultivated for 5 years						
10	Nile	295	73.75	II	38.50	7.70
11	mixed	254	63.5	III	28.25	5.65
Soils cultivated for 10 years						
12	Nile	308	77.00	II	41.75	4.18
13	mixed	242	60.50	III	25.25	2.53
Soils cultivated for 15 years						
14	Nile	242	60.50	III	25.25	1.68
15	mixed	206	51.50	IV	16.25	1.08

Effect of cultivation on soil quality

The data recorded in Table (4 and 5) indicate that most of the studied soils are characterized by low to intermediate soil quality, as values of relative soil quality index (RSQI) ranged from 35.25 to 77.00. Soil profiles representing cultivated soils have higher RSQI values (35.5 – 77.0) than those representing virgin soils (35.25). This means that cultivation tends to improve soil quality, through increasing the organic matter content, available water and most of available nutrients in addition to lowering EC and SAR values as shown in Table (2). However, changes in relative soil quality index (ΔRSQI) values due to cultivation were wide and ranged between 0.25 and 41.75, as shown in Table (5). It was found also that the rate of ΔRSQI per year (ΔRSQI/year) in the cultivated soils ranged widely from 0.75 to 7.92 / year. This could be assigned to the variation in the management practices (different irrigation water quality and land use periods).

Concerning the effect of cultivation on soil quality classes in the studied area, it was noticed that soil quality classes were improved in the cultivated soils comparing with virgin soils. Soil quality classes improved from class V in profile 1 which represents virgin soils to class IV, III and II in most profiles that represent cultivated soils (Table 5).

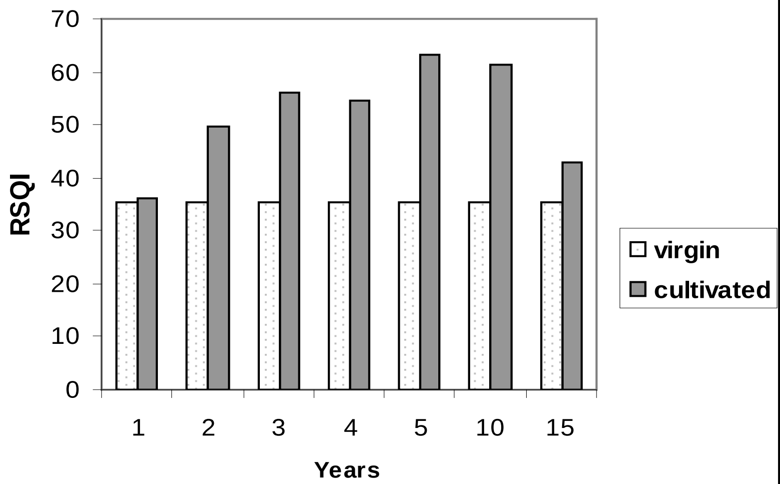
Effect of land use period on soil quality

Regarding, the effect of land use periods on the relative soil quality index (RSQI), data illustrated in Table (5) and Figure (1) indicate that RSQI increased with increasing land use period until about 10 years, and then tended to slightly decrease. Comparing relative soil quality index for profiles 8, 10 and12 which represent soils cultivated for 4, 5 and 10 years and have RSQI 60.00, 73.75, and 77.00 respectively, differ only in the land use period

(under the same other management practices) show this trend. This could be attributed to installation of drainage system, decreasing of soil salinity and alkalinity which improved physical and chemical soil properties as well as the relative increase of OM, N, P and K contents in the studied soils and consequently increase of soil quality index (SQI) as shown in Tables (2 and 4). This reflects the relative higher application of fertilizers and continuous addition of manures and/or accumulation of plant residues in the soils. These results are in harmony with those obtained by El-Reweiny and Rushdi (1975), Abou Hussien (1999) and Beshay and Sallam (2001) where they found a significant increase in the organic matter content in the cultivated soils by various crops for the long periods.

However, the soils which were cultivated for 15 years have relatively lower values of RSQI than those cultivated for 10 years. It was 60.5 and 51.5 in profiles 14 and 15 which represent soils cultivated for 15 years, while it was 77.0 and 60.5 in profiles 12 and 13, which represent soils cultivated for 10 years respectively (under the same irrigation water quality), as shown in Table (5) and Fig. (1). This may be due to imperfect drainage, rising of water table, which increased soil salinity (EC) and soil alkalinity (ESP) and to the relative decrease of OM and available N, P and K and available water content as well as low values of hydraulic conductivity (K_s) in these soils as shown in Table (4). These results are in agreement with those of El Gendy *et al*. (2005) they indicated that 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.

The above trend was also observed in the change in RSQI (ΔRSQI) values; it was 24.75, 38.50, 41.75 and 25.25 in profiles 8, 10, 12 and 14 which represent soils cultivated for 4, 5, 10 and15 years respectively as shown in Table 5.



Fig(1):Effect of land use period on RSQI

Concerning the effect of land use period on the rate of ΔRSQI per year (ΔRSQI / year), Data in Table (5) indicate that ΔRSQI/year increased with increasing the cultivation period up to 5 years. It increased from 2.25 (in soils cultivated for 1 year only) to 7.70 (in soils cultivated for 5 years) as shown in Table (5). This means that the rate of development of this soil is relatively lower at the beginning of reclamation and cultivation. However, ΔRSQI/year decreased again in the soils which were cultivated for 10 and 15 years as shown in Table (5). Comparing between profiles 10, 12 and 14 which have ΔRSQI/year 7.70, 4.18 and 1.68 and represent soils cultivated for 5, 10 and 15 years respectively (under the same irrigation water quality) show this trend.

Concerning, the effect of land use periods on soil quality classes in the study area, it can be stated that after 2 year of cultivation the soil quality classes improved as land use periods increased. It was improved from class V in virgin soils and soils cultivated for one year to classes III and II in soils were cultivated for 5 and 10 years (Table 5). Soils cultivated for 15 years have the worst soil classes (class III and IV) comparing with 5 and 10 years of land use period.

Effect of irrigation water quality on soil quality

For evaluating the effect of irrigation water quality on RSQI values, data illustrated in Table (5) and Figure (2) indicate that the soils used Nile water for irrigation have relatively higher values of RSQI than those used mixed water. It was 60.00, 76.25, 77.00 and 60.5 in profiles 8, 10, 12 and 14, which represent soils irrigated with Nile water, while it was 53.50, 63.50, 60.50 and

51.50 in profiles 9, 11, 13 and 15, which represent soils irrigated with mixed water, respectively (under the same land use period). This may be caused by the relatively higher EC and SAR values in the mixed water compared with Nile water (Table 3) which will decrease soil quality index and lead to lower RSQI value.

The above results are in accordance with the data of the ΔRSQI and the annual changes of RSQI per year (ΔRSQI / year). Values of ΔRSQI were 41.75 and 25.25, while the ΔRSQI / year were 4.18 and 2.53 in profiles 12 and 13, which represent soils irrigated for 10 years by Nile and mixed water respectively (under the same land use period). The same trend was observed also in profiles 2, 4, 6, 8, 10 and 14 compared with profiles 3, 5, 7, 9, 11 and 15, respectively, as shown in Table 5.

Regarding the effect of irrigation water quality on soil quality classes, data in Table (5) show that generally, the soils which used Nile water had improve soil quality classes than those irrigated with mixed water. However, in the first 3 years of cultivation the same soil classes were found in soils irrigated by Nile water or mixed water (classes IV or V). While soils cultivated for 4, 5, 10, and 15 years and using Nile water had the best soil classes comparing with those which irrigated by mixed water (under the same land use period) as shown in Table (5). Class II characterized soils that was irrigated with Nile water, as shown in profiles 10 and 12, while class III was found in profiles 11 and 13, which represent soils irrigated with mixed water (under the same land use period). The same trend was also noticed in profiles 8, 9 and 14, 15.

It can be concluded from the above discussion that the relatively wide variations in the SQI, RSQI, ΔRSQI and ΔRSQI/year values as well as soil quality classes reflect the different land use periods and sources of irrigation water (under the same management practices). Also, it can be stated that the land use period and irrigation water quality play an important role in the soluble salts content and sodium adsorption ratio (SAR) values in the investigated soils.

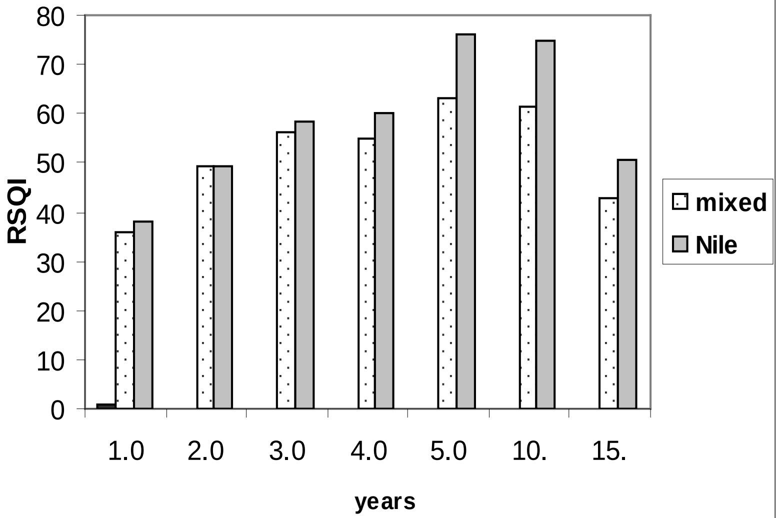


Fig (2): Effect of irrigation water quality on RSQI

Actual yield

Yield data were collected from the sampled area's owners about actual yield of the main field crops (wheat and corn).

Data of the actual yield in the study area are presented in Table (6). The data show high variations, this may be due to the effect of land use periods and irrigation water quality in the investigated soils. High significant correlation was observed between RSQI and actual wheat or corn yields, since the correlation coefficients were 0.892 and 0.904 for wheat and corn respectively.

Concerning, the effect of land use period on yield, data in Table (6) show that there is an increase in actual yield of soils cultivated for 5 and 10 years compared with soils cultivated for 1,2,3,4 and15 years (under the same irrigation water quality). Soils using Nile water as a source of irrigation had a higher actual yield than those using mixed water under the same land use period. Comparison between yield of pairs of profiles (10 and 11), (12 and 13) and (14 and 15) in Table (6) reveals such trend. These results are in harmony with those obtained from soil quality (RSQI) studies.

Finally, the above discussions indicated that the RSQI may be used successfully, since it needs minimum data set, able to show minor variation at the microscale and has a significant correlation with actual yield.

Table (6): actual wheat and corn yield (ardab / fed) for the studied area.

Profile No.	Land use period	Irrigation w. source	Actual yield (ardab / fed.)	
	years		Wheat	Corn
1	Virgin			
2	1	Nile		
3	1	mixed		
4	2	Nile	4.0	-
5	2	mixed	-	-
6	3	Nile	6.5	5.5
7	3	mixed	4.0	2..5
8	4	Nile	7.5	9.5
9	4	mixed	6.5	3.0
10	5	Nile	11.5	15.0
11	5	mixed	7.5	7.0
12	10	Nile	12.5	18.5
13	10	mixed	7.0	7.0
14	15	Nile	6.5	7.5
15	15	mixed	4.5	3.5

Conclusion

The best soil quality class in the studied area is class II, it characterized soils that are cultivated for 5 and 10 years, irrigated with Nile water. It was found also that the soils in the studied area have moderate soil quality class (class III) which characterized soils that were cultivated for 5 and 10 years, irrigated with mixed water. Class V was found in virgin soils as well as soils cultivated for 1 year and using Nile or mixed water for irrigation. Soils that cultivated for 15 years are characterized by quality classes III and IV in soils using Nile or mixed water respectively. However, the studied soils could be improved through better management practices and avoiding irrigation with low quality water and construction of an efficient drainage system as well as careful addition of organic manures, better balanced fertilization, rotation with green manure and legumes.

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تأثير مدة الاستخدام الزراعي وجودة مياه الري على التغيرات في جودة التربة في بعض الأراضي البحيرية– مصر

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الملخص العربي

أجريت هذه الدراسة بهدف تتبع التغيرات التي تطرأ على جودة التربة **(Soil Quality)** ومدى تأثرها بمدة الاستخدام الزراعي (١، ٢، ٣، ٤، ٥، ١٠، ١٥ عاما) بالإضافة إلى الأراضي البكر وكذلك مصادر وجودة مياه الري (مياه النيل ومياه مخلوطة) فى بعض الأراضى البحيرية فى قرية دويونو جنوب بحيرة ادكو، مع اقتراح دليل مناسب يعبر عن جودة التربة وحساب دليل نسبى لجودة الأراضى **(RSQI)** طبقا للطريقة المقترحة بواسطة كل من **Wang and Gong** عام ١٩٩٨.

تميزت منطقة الدراسة بأن معظم الأراضى ذات جودة منخفضة الى متوسطة حيث تراوحت قيمة الدليل النسبى لجودة الأراضى **(RSQI)** ما بين ٣٥.٢٥– ٧٧.٠ وقد أدى استزراع الأرض الى ارتفاع قيم **RSQI** مقارنة بالأراضى البكر. قيم **RSQI** كانت أعلى فى الأرض المنزرعة مقارنة بالأرض البكر. قيم التغير فى الدليل النسبى لجودة الأراضى **(ΔRSQI)** نتيجة الزراعة تغيرت فى مدى واسع وتراوحت بين ٠.٢٥ و٤١.٧٥. قيم **RSQI** قد ارتفعت مع تقدم مدة الاستخدام الزراعي حتى ١٠ سنوات ثم حدث انخفاض فى قيمة الدليل **(RSQI)** في الأراضي المنزرعة لمدة ١٥ عام والتى تميزت بزيادة قيم كلا من التوصيل الكهربي **(EC)** والقلوية **(SAR)** نظرا لارتفاع مستوى الماء الأرضي مع انخفاض قيم الماء المتاح للنبات. نفس الاتجاه السابق لوحظ فى قيم التغير فى الدليل النسبى لجودة الأراضى **(ΔRSQI)** وكذلك التغير السنوى **ΔRSQI per year (ΔRSQI/ year)** نتيجة اختلاف مدة استخدام الأرض. أقسام جودة التربة بدأت تتحسن بعد سنتين من الزراعة حيث تحسنت من القسم الخامس **(class V)** التى تميزت به الأرض البكروالمنزرعة لمدة عام الى القسم والثالث **(classe III)** بعد ٣، ٤ سنوات

وتميزت الأراضى المنزرعة لمدة ٥ و١٠ سنوات بالقسم الثانى (classe II) من أقسام جودة التربة والذى انخفض مرة أخرى للقسم الثالث (classes III) بعد ١٥ عام من الاستخدام (تحت نفس جودة مياه الرى).

تميزت الأراضي التي تستخدم مياه النيل فى الرى بقيم أعلى فى الدليل النسبى لجودة الأراضى (RSQI) والتغير فى الدليل النسبى لجودة الأراضى (ΔRSQI) وكذلك التغير السنوى فى الدليل النسبى لجودة الأراضى (ΔRSQI/ year) من تلك التى تستخدم المياه المخلوطة. أيضا أستخدام مياه النيل فى الرى أدى الى تحسين مستويات جودة التربه بالمقارنه باستخدام المياه المخلوطة. يوجد ارتباط معنوى عالى بين الدليل المقترح لجودة التربة والمحصول الفعلى للقمح والذره حيث كان معامل الارتباط ٠.٨٩٢ و ٠.٩٠٤ على التوالى.

مما سبق يمكن استنتاج أن دليل جودة الأراضى المقترح فى هذه الدراسة RSQI يمكن استخدامه بنجاح فى المناطق المحدودة التى بها اختلافات صغيرة حيث يحتاج الى كمية أقل من المدخلات بالإضافة لذلك أنه يعطى ارتباط معنوي عالي مع المحصول.

يمكن تحسين الخواص الكيميائية والطبيعية والخصوبة وبالتالى دليل جودة التربة فى منطقة الدراسة من خلال تجنب استخدام نوعيه منخفضة الجودة من مياه الري فضلا عن إنشاء نظام صرف جيد وكذلك بإضافة المخصبات العضوية والمخلفات الزراعية وبالتسميد الكاف والمتوازن.