Evaluation of Calcareous Soil Health Indicators in Borg El Arab Area, West Alexandria City, Egypt

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Abstract: The aim of this study was to predict statistical model correlation between soil health and data set of various soil and water properties. Four sites at Borg El Arab area were selected, Bahig area which is irrigated with Nile water (Control), and ; municipal waste water Mary Mina; industrial area along to Emtedad El Rabaa ; the region adjacent to the reins of the village Elsaied Darwish, and the area irrigated by artesian wells Alroystadt, to achieve these goals, surface sampling and subsurface soil at different distances from the sources of irrigation (5000,1500,1000,500,250,50 meters). Estimation of chemical, physical and biological characteristics for soil based on the obtained data. It is clear that it is possible to calculate soil health, irrigation water quality, soil fertility and crop yield, by monitoring the pollution in the different irrigation water sources.

Keywords: Soil Health, Borg El Arab, Salinity, Water quality.

INTRODUCTION

1. Soil Health

Soil Science Society of America Annual Meeting, Minneapolis (Karlen and Stott, 1994); the OECD Soil Biota Meeting, Adelaide, OECD (1998) and Doran and Safley (1997) have defined soil health as the continued capacity of soil to function as a vital living system, within ecosystem and land use boundaries, to sustain biological productivity promote the quality of air and water environment and maintain plant, animal and human health. All authors considered that the term soil health encompasses the living and dynamic nature of soil, and that this differentiates it from soil quality. Doran *et al.* (1994) and Haris and Bezdicek (1994) indicated that soil quality focuses more on the soil's capacity to meet defined human needs such as the growth of a particular crop, while soil health focuses more on the soil's continued capacity to sustain plant growth and maintain its functions.

2. Chemical properties

A soil chemical composition standard soil test analysis package measures levels of pH and plant nutrients. Measured levels are interpreted in the framework of sufficiency and excess but are not crop specific (Andrews *et al.,* 2003).

3. Physical properties

Aggregate stability is a measure of the extent to which soil aggregates resist falling apart when wetted and hit by rain drops. Available water capacity reflects the quantity of water that a disturbed sample of soil can store for plant use. It is the difference between water stored at field capacity and the wilting point, and is measured using pressure chambers (Andrews *et al.,* 2004).

4. Biological properties

Total soil organic matter consists of both living and dead material, including well decomposed humus. Active carbon is a "leading indicator" of soil health (Chen and He, 2003) response to changes in crop and soil management, usually responding much sooner than total organic matter content (Andrews *et al.,* 2003). Root Health Rating is a measure of the quality and function of the roots as indicated by size, color, texture and absence of symptoms and damage by root pathogens such as *Fusarium*, *Pythium*, *Rhizoctonia*, and *Thielaviopsis*.

5. Evaluation

A successful transition to reduced tillage and planting operations often requires significant green or animal manuring and/or focused tillage a calcareous soil from a long-term tillage experiment (Abdelrazek, 2014). The moldboard plow treatment on the left has 34% water stable aggregates while the soil under zero-till management on the right has 56% water stable aggregates, 0.25 mm sieve (Roling, 1995; Fayed *et al.,* 2005).

Scoring function to the right is the scoring functions graph for aggregate stability for silt, sand and clay textured soils. The red, yellow and green shading reflects the color coding used for the ratings on the soil health report. Scoring curve of soil health indicators, cumulative normal distribution for scoring nutrients in a calcareous soils, Mathematical model to be used in soil health evaluation (Roming *et al.,* 1996; Sarrantonio *et al.,* 1996).

A. more is better

More is better our scoring curve for soil health assessment generally following three types of functions which are: a. more is better: In this situation, the higher the value of the indicator, the higher the score until a maximum level is attained. Indicators falling in this class include aggregate stability, available water capacity, organic matter content, active carbon content, potentially mineralizable nitrogen, and extractable potassium (Fig. 1)

B. less is better

Less is better, the scoring curve in this case gives higher scores to lower values of the indicator. Soil measurements in this group include surface hardness, subsurface hardness and root health assessment (Fig. 1).

C. optimum curve

Optimum curve: In this case, the curve rises to the highest level with increasing indicator values and remains stationary at the maximum score. As the indicator value increases, the scores start decreasing (Liebig and Doran 1999 and Lobry de Bryun and Abbey, 2003). Indicators that were scored this way are pH and extractable phosphorus (Fig. 1).

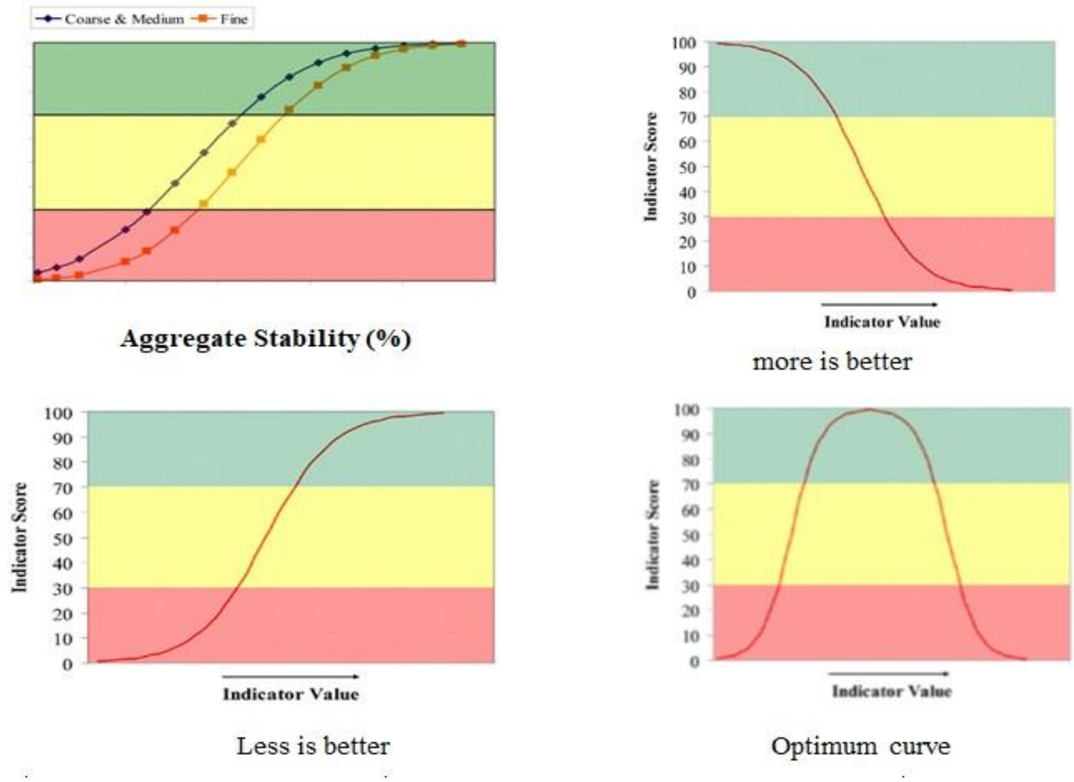


Fig (1). Scoring function in soils
(Source: Wander and Drinkwater (2000)

Scoring functions were developed for the individual indicators, following work by Andrews *et al.* (2004) The scoring functions enable a value for a specific indicator to be converted to a rating and assigned color (red, yellow, green) on the soil health report (Table1). In the context of our soil health assessment, a scoring function is a curve that assigns specific scores between 0 and 100 to the values measured for individual indicators. A score of 100 is the best (highest) while a score of 0 is the worst (poorest). For most of the indicators, scoring functions were developed separately for the major soil textural groups (sand, silt, and clay) based on data distributions. We used the data collected across the Northeastern United States to establish these scoring curves. The scoring functions for many indicators consist of the cumulative normal distribution (CND) curves normalized to a scale of 0-100 for scoring soil health indicators (Fig 1) (Wander and Drinkwater, 2000).We used the following values to set the threshold for rating soil health indicators: i.) 0 – 30 corresponds to deficiency of an indicator implying that it will constrain soil use; ii) >30 - <70 correspond to the intermediate region of the indicator and iii) 70 – 100 indicates that the indicator value is at an optimal level (Green *et al*., 1993 and Karlen *et al.,* 2003).

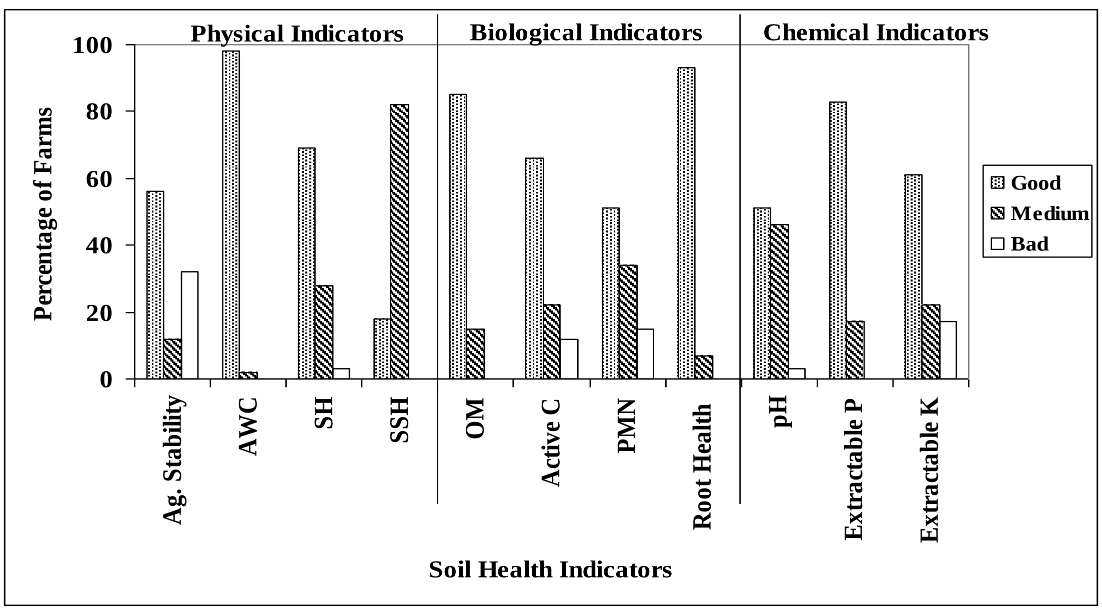
The soil measurements that were scored in this way include aggregate stability, available water capacity, surface hardness, subsurface hardness (Fig. 2). Soil minor element and micronutrient values were scored based on the number of elements that are either deficient or excessive (Doran and Safley, 1997).

A deficiency or excess of one element brings the indicator score down to 6, while a deficiency or excess of two elements brings the score down to 1. Specific scoring functions for individual indicators used in our soil health assessment are shown in each section where they are discussed. An overall soil quality score is computed from the sum of all the individual indicator scores and is expressed on a percentage scale. The overall classification of the soil based on the percentage score is given as (Abdelrazek, 2014).

Table (1). Soil Classes

Soil Classes			
i.	> 85%	Very High	Class I
ii.	70 -85%	High	Class II
iii.	55 - 70%	Medium	Class III
iv.	40 - 55%	Low	Class IV
v.	< 40%	Very Low	Class V

Source: Karlen *et al.* (2003).



SH: surface Hardness SSH: Subsurface Hardness

Fig (2). Soil health indicators

Source: Wander and Drinkwater (2000)

MATERIALS AND METHODS

1. Study area description and location of the studied samples

This study was carried out in the region of Borg El Arab on the northwest coast of Egypt and west Alexandria city by about 48 km. The studied area is close to the new cities that have been constructed and located at latitude 30 ▫ 45 and 30 ▫ 55 north and at longitude 29 $^{\circ}$ 30$'$ and 29° 50$'$ east and covers an area of 4000 feden which is rising from the sea by 23 meters (Fig. 3).

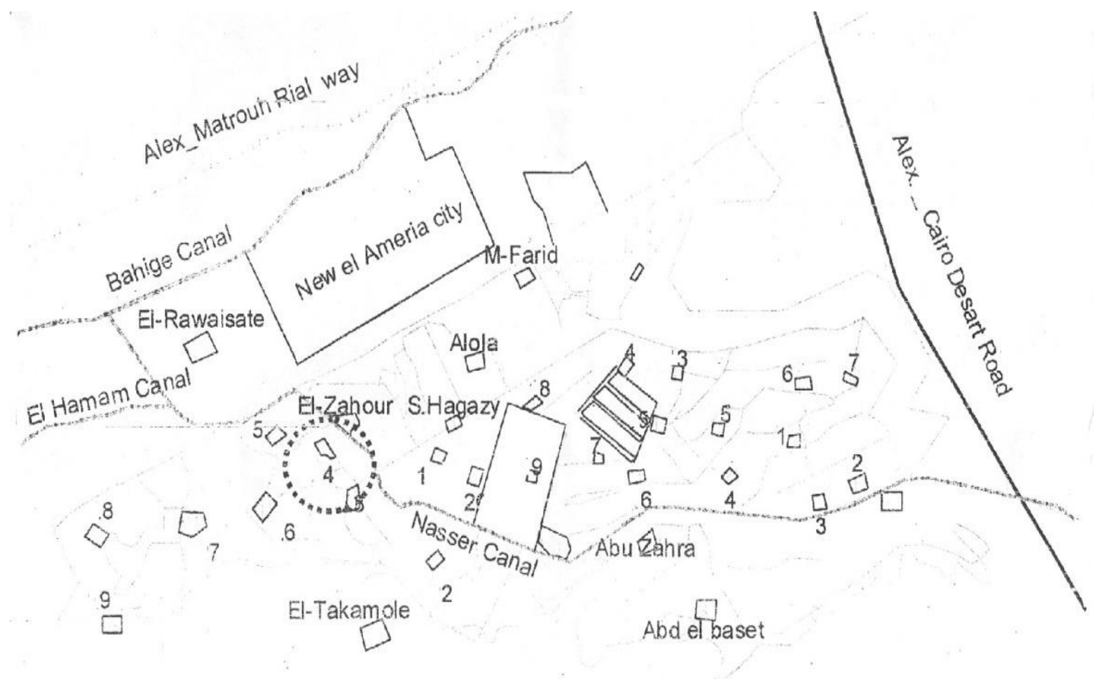


Fig (3). Key map of the study area showing the locations of the studied samples

2. Soil sampling

Forty eight soil samples (0 -20 and 20-40 cm) were collected, as shown in Fig (3).These samples represent variations in cropping patterns, and different irrigation water sources.

3. Soil analysis

1. Chemical characteristics

1) Soil reaction (pH) of the saturated soil paste was determined using Beckman's pH meter, (Jackson, 1958).
2) Electrical conductivity (EC,dS/m) of the saturated soil extracts using a conductometer (Reynolds and Topp, 2008).
3) Organic matter was determined following Walkley and Black method, (Moebius *et al.,* 2007).

4) Available phosphorus by sodium bicarbonate method, as an extracting agent, according to (Olson and Watanabe, 1965).

2. Physical characteristics

The soil samples were air-dried, ground and passed through a 2 mm plastic sieve and stored for analysis.
Mechanical analysis using the pipette method, as cited by (FAO, 1970)
Sodium hexametaphosphate and sodium carbonate were used as dispersing agent. Soil texture was determined using the texture triangle diagram (Soil Survey Staff, 1962).
Soil bulk density (D_b) using core sampler, as described by (Richards, 1954).
Soil hydraulic conductivity (K cm/ hr $^{-1}$) using the constant head test (for disturbed coarse textured soils), as described by (Baruah and Barthakur, 1997).

3. Soil Enzymes Activity determination

1) Soil dehydrogenase (DHA) activity was estimated following the methods of Casida *et al.*(1964).Dehydrogenase enzymes convert 2, 3, 5-triphenyl tetrazolium chloride (TTC) to 2, 3, 5-triphenylformazan(TPF) The absorbance of TPF was measured spectrophotometrically at 485 nm, Following the method of (Tabatabai and Bremmer,1969;Eivazi and Tabatabai, 1990;Tabatabai, 1994; Ekenler and Tabatabai, 2002). All enzymatic activities were expressed on dry weight basis (drying the soil for 24 h at 105 °C).

2) Soil Urease (urea amidhydrolase) is the enzyme that catalyses the hydrolysis of urea to carbon dioxide and ammonia. It occurs in a large number of higher plants and microorganisms, particularly bacteria; Urease is unique, among soil enzymes, where it affects the performance of fertilizer. 5 g soil was mied with 20 ml borate pH 10.0 and 2.5 ml urea solution 20mM and was incubated at 37^{o} for 2 h. After incubation, 30 ml 1M KCl solution were added and the suspension mixed for 30 min. After filtration, 9 ml distilled water and 5 ml of 17 g of sodium salicylate 120 mg of nitroprussate 100 ml NaOH (0.3 M) 1 distilled water v/v/v and 2 ml of Na dichloroisocyanide (0.1 % w/v in distilled water) were mixed with filtrate solution and incubated for 30 min. NH_4 concentrations were measured with a spectrophotometer at 690 nm. The method used to measure urease activity was that of (Alef and Nannipieri, 1995).

3) Soil Phosphatase (Disodium p-nitrophenyl phosphate) is added to soil, and a buffer is used to maintain the pH value (pH 11 for alkaline phosphatase). The concentration of a hydrolysis product (p-nitrophenyl) is proportional to phosphatase activity (Tabatabai and Bremmer, 1969; Eivazi and Tabatabai, 1990; Tabatabai, 1994; Ekenler and Tabatabai, 2002).

4. Water sampling

Sampling process based on scientific methodology that will preserve as much as possible on the characteristics chemical properties of water and by following these steps. After cleaning the glass bottles of the type of acid solution using chlorine (HCl) were washed with plain water. Then several times with distilled water, And finally dried in an oven temperature of 60 m and the aim of this process is to remove the effects of Pollution Wash bottles, Several times with water to be calibrated In the last bottles are tightly closed with conservative not to leave bubbles Air to stay inside (WPCF, 1998).

5. Water analysis

- (PH) of the saturated soil paste was determined using Beckman's pH meter, (Jackson, 1958).
-Electrical conductivity (EC dS/m) of the saturated soil extracts using a conductometer (Jackson, 1958).
- SAR (Sodium Adsobtion Ratio) was calculated as:

$$SAR = Na^{+}/\sqrt{(Ca^{++} + Mg^{++})/2}$$

Where Na^{+}, Ca^{++} and Mg^{++} refer to their concentrations in eq/l (Donahue *et al*., 1990)

-Heavy metals sub sample of 500 ml were preserved with 2 ml nitric acid to prevent precipitation and adhesion of metals on the bottle walls (APHA and AWWA, 1998)

Table (2). Concentration of some elements in irrigation water sources

W.I.S*	pH	EC	SAR	Fe	Mn	Zn	Cu	Pb	Cd	Co	Ni
		dS/m					mg/l				
Bahig Canal (Nilewater)	7.9	0.81	0.76	2.2	1.1	0.06	0.04	0.01	-	-	-
artesian well	8.8	2.53	3.80	6.1	3.1	0.21	0.15	002	-	-	-
Mary Mina (Sludge)	7.3	3.80	4.76	52.4	3.86	1.27	1.04	0.35	0.03	0.001	0.26
Industry Brick	6.2	3.6	6.99	52.9	18.2	6.8	5.2	6.6	2.7	3.7	4.8
Oils	6.0	3.21	6.76	49.2	9.5	7.5	5.8	6.4	3.7	4.2	3.8
Stainless steel	6.4	3.92	6.21	91.2	9.8	8.3	2.9	102	4.8	6.5	4.3

*W.I.S: irrigation water source

Irrigation sources: El Nubaria canal provides the irrigation water. It receives its water directly from the Nile. El Nasr canal is a concrete lined branch from the Nubaria canal which provides water to El Nubaria, Sugar Beet, El-Bostan and Borg El Arab areas. Surface irrigation is applied in most of Borg El Arab area and water delivery to the farm is by gravity Fig. (3). Pressurized systems of irrigation is also used where, water from tertiary canals is pumped using either collective pump stations in the case of investors and small settlers, or separate pumps for units of 20 feddans for small groups of two to four graduates. Heavy metals content in effluents of these factories, sewage drainage, and artesian well and Nile water Table (8).

6. Soil Health Assessment

Soil health indicators and their weights and classes for the evaluation of soil health in the study area were carried out as following: Mechanical analysis, soil bulk density (D_b) and soil hydraulic conductivity (K cm/hr). Chemical composition: a standard soil test analysis package measures the levels of pH, plant nutrients and toxic elements. organic matter; any material that is derived from living organisms, including plants, soil fauna and soil enzymes as indicators of soil health (Fayed, 2003), Table (3).

Potentially mineralizable nitrogen is the amount of nitrogen that is converted (mineralized) from an organic form to a plant-available inorganic form by the soil microbial community over seven days in an incubator. It is a measure of soil biological activity and an indicator of the soil health assessment (Andrews *et al.,* 2003 and Karlen *et al.,* 2003) .

7. Soil health indicators

Table (3). The Soil health indicators used in the present study

More is better	Less is better	Optimum
Organic matter, O.M %	Bulk density, kg/m^3	pH
Biomass, mg/g	Electric Conductivity dS/m	Phosphorous mg/kg
Enzymes	Sodium Adsorption Ratio, (SAR)	
Urease		
Phosphatase		
Dehydrogenase		
K, mg/kg		
N, mg/kg		

8. Statistical analysis

All obtained data of soil, plant and water were statistically analyzed.
The data were analyzed using statistical software SYSTAT- 12. One-way analysis of variance was carried out to compare the means of different treatments and least significant differences at $P < 0.05$ were obtained using Duncan's multiple range test (DMRT) (Duncan, 1955). The data were also subjected to Pearson correlations analysis, and cluster analysis, to identify the relationship between the variables and to find out the key soil parameters that are sensitive to heavy metals exposure.

Table (4).Soil health test report

Cornell Soil Health Assessment

[redacted]

Agricultural Service Provider:
None
Cedar Basin Crop Consulting
cbcc@earthlink.net

Sample ID: L_555
Field/Treatment: Tenge E
Tillage: 1-7 inches
Crops Crown: COG, COG, SOY
Date Sampled: 12:00:00 AM
Given Soil Type: Muscatine
Given Soil Texture: Silty Clay Loam
Coordinates: [redacted]

Measured Soil Textural Class: Silt Loam **Sand: 28% Silt: 56% Clay: 16%**

Test Report

	Indicator	Value	Rating	Constraint
Physical	Available Water Capacity	0.31	100	
Physical	Surface Hardness			Not Rated: No Field Penetrometer Readings Submitted
Physical	Subsurface Hardness			Not Rated: No Field Penetrometer Readings Submitted
Physical	Aggregate Stability	49.5	78	
Biological	Organic Matter	4.6	79	
Biological	ACE Soil Protein Index	5.8	29	Organic Matter Quality, Organic N Storage, N Mineralization
Biological	Root Pathogen Pressure	4.7	54	
Biological	Respiration	0.58	4	Soil Microbial Abundance and Activity
Biological	Active Carbon	744	76	
Chemical	pH	6.0	66	
Chemical	Phosphorus	10.9	100	
Chemical	Potassium	164.5	100	
Chemical	Minor Elements Mg: 456 Fe: 0.8 Mn: 9.2 Zn: 0.4		100	
Overall Quality Score			71	High

Comprehensive Assessment of Soil Health - The Cornell Framework Manual (Abawi, 2014 and Cornell Framework Manual, 2012)

RESULTS AND DISCUSSION

1. Effect of wastewater irrigation on soil health

1. Set of various soil properties

Indicators of soil heath are measurements of soil properties that have the greatest sensitivity to change and, can be related to the functioning of the soil. Soil health indicators should be capable of detecting changes in physical, chemical and biological soil properties and how they interact with one another (Table 5).

Table (6) shows that statistical model correlation between soil health and set of various soils. Numbers of tests were carried out to specify the physical, chemical and microbiological properties of the soil which decides the soil health index.

Table (5). Key soil health indicators for plant in Borg El Arab area that match productivity with sustainability and are responsive to management changes as a result of growing plant

Test	Description	Physical, chemical and biological	Sensitivity	What is best?
Bulk density	Bulk density is a measure of how compacted a soil is, and if the soil has enough air space for plant roots and organisms to function	Physical	Slow to Change	Less is best
Clay	Clay very important for fertility and soil enzymes as a humus	Physical	Slow to Change	More is best
Hydraulic conductivity	Hydraulic conductivity is a measure of how fast water enters the soil. Water entering too slowly may lead to pending, water logging	Physical	Slow to Change	More is best
Electrical conductivity (EC)	Electrical conductivity (EC) is a measure of the dissolved salts in the soil. A high soil EC reading can indicate high levels of nutrients from fertilizers	Chemical	Changes Rapidly	Less is best
Soil pH	Farm practices affect the level of acidity in the soil. Soil pH measures the level of acidity and can influence nutrient availability and soil biology.	Chemical	Medium	Optimize
Soil Phosphorus available	A measure of how much phosphorus is in the soil. Not enough phosphorus can slow plant growth	Chemical	Medium	Optimize
Organic matter	Energy/C storage water and nutrient retention	Biological	Medium	More is best
Urease	Belong to group of enzymes acting on C –N bonds of urea, a fertilizer sources and a major constituent in urine of grazing animals	Biological	Medium	More is best
Phosphatase	Release plant available PO_4 from organic matter	Biological	Medium	More is best
Dehydrogenase	Exist as integral part of intact cell and reflects total oxidative activities of soil microflora / important in oxidizing soil organic matter	Biological	Medium	More is best

(O'Neil *et al.*, 1977; Smith and Paul, 1990; Gupta *et al.,* 1977; Dick, 1997: Carter and While 1986 ; Doran and Safley (2002)

2. Evaluation of the soil health

Many indicators of soil health have been suggested, including biomass potentially mineralizable N and soil enzymes and plant nutrients. Thus, in our study we examined the effect of water quality on soil health indicators in Borg El Arab area and determine the relationships between these indicators. Since fertilizers, pesticides and wastewater irrigation are being widely used by farmers in Borg El Arab area and it is important to consider their possible impact on soil health.

Table (7) indicates that the soils irrigated with Nile water are generally characterized by intermediate to low relative soil health index (RSHI) values ranging between (12.98 - 16.48) Data also showed that soil samples representing soil irrigated with Nile water have higher (RSHI) values then those representing soil irrigated with Industrial Waste Water (6.70 – 7.40 %) while means that Nile water tends to improve the soil health (Table 7).

This may be due to the higher water relative quality, organic matter content, fine fractions and most of the available nutrients and absented Pb, Cd, Co, Ni from the Nile water as well as the relative higher application of fertilizers and manures, which resulted in higher RSHI values and subsequently their (∆RSHI) values.

Concerning the effect of the source of irrigation water on the values of (∆RSHI) data presented in Table (7) and illustrated in Fig (4) indicate that using Nile water caused a relative higher (∆RSHI) value (16.48) than using artesian water (9.38%) Fig (5) in the soil irrigated with Nile water at different distances respectively; and also it could be due to the relative lower EC and SAR values in Nile water than artesian water, while the similar RSHI value (12.75%), which was obtained in soils irrigated with sewage water in the same area and distance having relative low salinity than other source of artesian water. Moreover, the organic matter content enhances water movement and salt leaching to relatively deeper horizons. As for the effect of biological activity; Table (7) and Fig (6) indicate a variation in RSHI values (11.23- 12.25) in the case of soils irrigated with sewage water at different distances. Investigation of the data indicators showed that the obtained lower values of RSHI were due to the increase in values of E.C as well as the presence of available micronutrients in high amounts, Table (7) compared with soil irrigated with Nile water, where the frequent use resulted in carbonates which depress the availability of micronutrients.

On the other hand, an opposite trend is observed in soils using with Industrial Waste Water irrigation (Fig 7), where RSHI value increased as distance increased (6.70-7.48%). Investigation of the relation ∆RSHI values and soil irrigated with Industrial Waste Water indicates that there is a wide variation in such values within the different distances (50 m -5000 m) from water source, this in this context, values of ∆RSHI ranges from 5 to 30 % respectively, as shown in Table (7)

Table (6). Scores of soil indicators and soil health in the studied area irrigated with different water quality

I.W.S.	Distance (m)	Physical Indicators			Biological Indicators			Chemical Indicators				SHI*
		Db	Clay	Kh	Urease	Phosph-atase	Dehyd-rogenase	EC	pH	P	OM	
Nile Water	50	9.1	7.4	5.0	3.9	4.9	6.5	5.3	5.5	4	5.8	57.4
	250	7.2	6.5	5.3	2.9	6.9	6.8	5.9	5.6	1	6.2	54.3
	500	6.3	6.2	6.2	3.9	6.4	5.3	4.9	6.6	3	4.5	53.3
	1000	6.2	6.5	5.4	1.3	5.6	9.8	2.9	6.7	2	5.5	51.9
	1500	4.2	6.2	9.2	9.2	5.7	6.8	2.8	6.4	2	6.2	58.7
	5000	3.8	9.2	8.2	9.2	9.8	8.3	2.8	5.2	2	7.4	65.9
Artesian Water	50	2.1	6.2	5.3	2.8	2.8	3.8	1.2	4.1	1	2.2	31.5
	250	2.5	2.1	3.2	1.8	5.5	2.6	1.2	6.7	8	3.1	36.7
	500	3.1	5.1	5.2	1.6	5.3	5.6	1.1	6.8	1	2.4	37.2
	1000	4.5	3.2	4.8	1.4	4.6	2.9	1.0	6.7	5	3.4	37.5
	1500	4.1	4.9	3.5	1.3	4.2	2.5	2.1	5.4	1	1.2	30.2
	5000	4.3	7.8	4.7	1.2	1.3	1.3	1.1	5.1	1	6.8	34.6
Sewage Water	50	6.9	4.1	3.9	5.2	4.5	2.8	2.1	4.3	4	7.1	44.9
	250	4.9	5.6	1.5	6.1	5.5	3.4	1.0	4.5	7	6.7	46.2
	500	7.9	4.1	6.2	7.5	4.2	3.4	2.5	4.2	1	5.9	46.9
	1000	6.9	7.5	6.6	7.8	4.7	5.5	1.9	4.6	1	1.1	47.6
	1500	6.9	1.3	9.9	3.1	5.4	4.5	2.6	4.5	4	6.1	48.2
	5000	7.9	3.2	9.9	4.2	1.6	4.3	2.9	4.2	3	7.7	48.9
Industrial Waste Water**	50	2.5	1.8	1.8	2.1	3.8	3.3	1.2	5.1	4	1.2	26..8
	250	1.9	1.5	1.4	1.8	2.1	1.5	1.2	2.8	8	5.1	27.3
	500	3.5	2.5	1.6	2.6	2.8	3.9	1.9	5.8	1	2.3	27..9
	1000	2.1	2.6	1.4	1.2	2.1	5.1	1.0	5.6	5	2.4	28..5
	1500	4.1	2.8	1.6	1.2	6.4	3.5	1.2	5.6	1	1.2	28.7
	5000	3.1	5.1	4.6	5.1	1.8	1.2	1.0	5.4	1	1.6	29.9

***SHI calculate by **scoring function in** soils
** Industrial Waste water from Borg El Arab industry area

Table (7). Relative soil health index (RSHI) and changes in relative soil health (∆RSHI) and their classes in Borg El Arab area irrigated with different water quality

I.W.S	Distance(m)	SHI	RSHI*	∆RSHI	∆ RSHI/m	RSHI classes
Nile water	50	57.4	14.35	-	-	IV
	250	54.3	13.58	0.77	15×10^{-3}	IV
	500	53.3	13.33	0.25	5×10^{-5}	IV
	1000	51.9	12.98	0.35	35×10^{-5}	IV
	1500	58.7	14.68	1.7	1×10^{-1}	IV
	5000	65.9	16.48	1.8	36×10^{-5}	III
Artesian water	50	31.5	7.88	-	-	V
	250	36.7	9.18	1.3	4×10^{-3}	V
	500	37.2	9.30	0.12	24×10^{-5}	V
	1000	37.5	9.38	0.08	8×10^{-5}	V
	1500	30.2	7.55	1.83	122×10^{-5}	V
	5000	34.6	8.65	1.1	22×10^{-5}	V
Sewage water	50	44.9	11.23	-	-	V
	250	46.2	11.55	0.32	128×10^{-5}	V
	500	46.9	11.73	0.18	36×10^{-5}	V
	1000	47.6	11.90	0.17	17×10^{-5}	V
	1500	48.2	12.23	0.33	22×10^{-5}	V
	5000	48.9	12.25	0.02	4×10^{-6}	V
Industrial Waste Water**	50	26..8	6.70	-	-	V
	250	27.3	6.83	0.13	52×10^{-5}	V
	500	27..9	6.98	0.15	3×10^{-4}	V
	1000	28..5	7.13	0.15	15×10^{-5}	V
	1500	28.7	7.18	0.05	3×10^{-5}	V
	5000	29.9	7.48	0.3	6×10^{-5}	V

* RSHI= (SHI / SHIm) X 100).
∆RSHI = $RSHI_{50m}$ – $RSHI_{250m}$...etc
∆RSHI/m=∆RSHI / Distance (m)
SHI: Soil Health Indicators SHI_m: maximum value of SHI. RSHI: Relative Soil Health Indicators
∆RSHI: Change Relative Soil Health Indicators
** Industrial Waste Water**from Borg El Arab industry area

Table (8). Guidelines for interpretations of water quality for irrigation (FAO, 1985)

Potential irrigation problems	Units	None	Slight- Moderate	Sever
		Salinity		
ECw[1]	dSm^{-1}	<0.7	0.7 -3.0	>3.0
TDS	mgL^{-1}	<450	450-2000	>2000
		Infiltration		
SAR2 =0-3 ECw[1]	>0.7		0.7 -2.0	>0.2
3 -6	>1.2		1.2-0.3	>0.3
6-12	>1.9		1.9-0.5	>0.5
12-20	>2.9		2.9-1.3	>1.3
20-40	>5.0		5.0-2.9	>2.9
		Specific Ion Toxicity		
Sodium (Na)	SAR	<3	3-9	>9
Chloride (Cl)	mgL^{-1}	<4	4-10	>10
Boron (B)	mgL^{-1}	<0.7	0.7-3.0	>3.0
		Miscellaneous		
Nitrogen (NO_3-N)	mgL^{-1}	<5	5-30	>30
Bicarbonate (HCO_3)	mgL^{-1}	<1.5	1.5-8.5	>8.5
pH			Normal Range 6.5- 8.4	

1: ECw means Electrical conductivity of irrigation water at 25°C. 2: SAR means sodium adsorption ratio. 3: NO_3-N means nitrate nitrogen reported in terms of elemental nitrogen from Borg El Arab industry area).

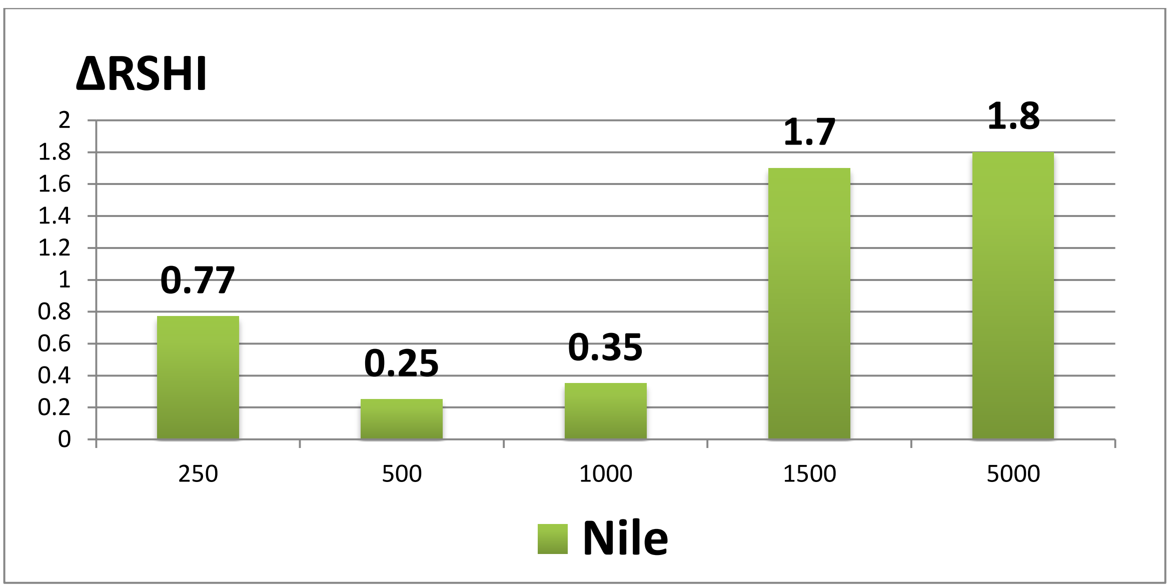


Fig (4). Changes in relative soil health index (ΔRSHI) in Borg El Arab area irrigated with Nile water

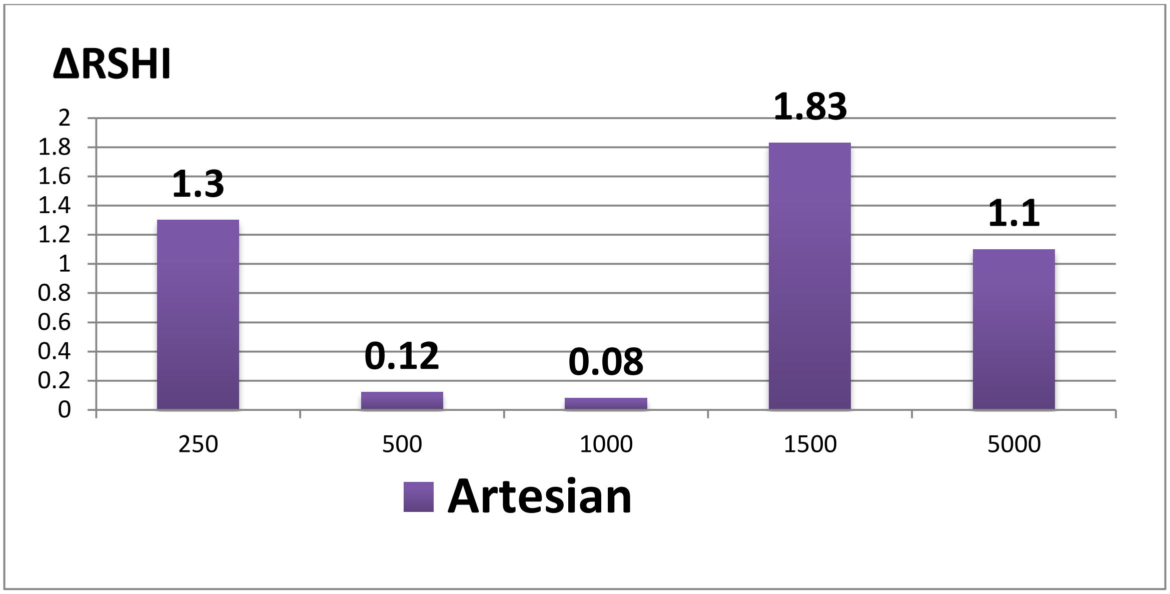


Fig (5). Changes in relative soil health index (ΔRSHI) in Borg El Arab area irrigated with artesian water

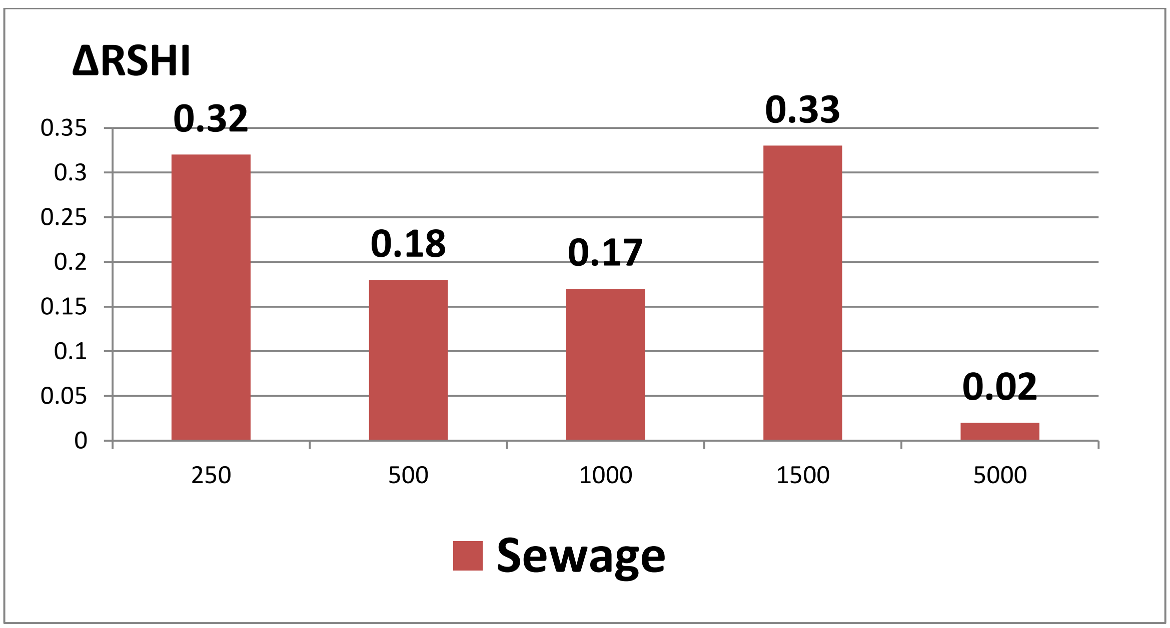


Fig (6). Changes in relative soil health index (ΔRSHI) in Borg El Arab area irrigated with Sewage water

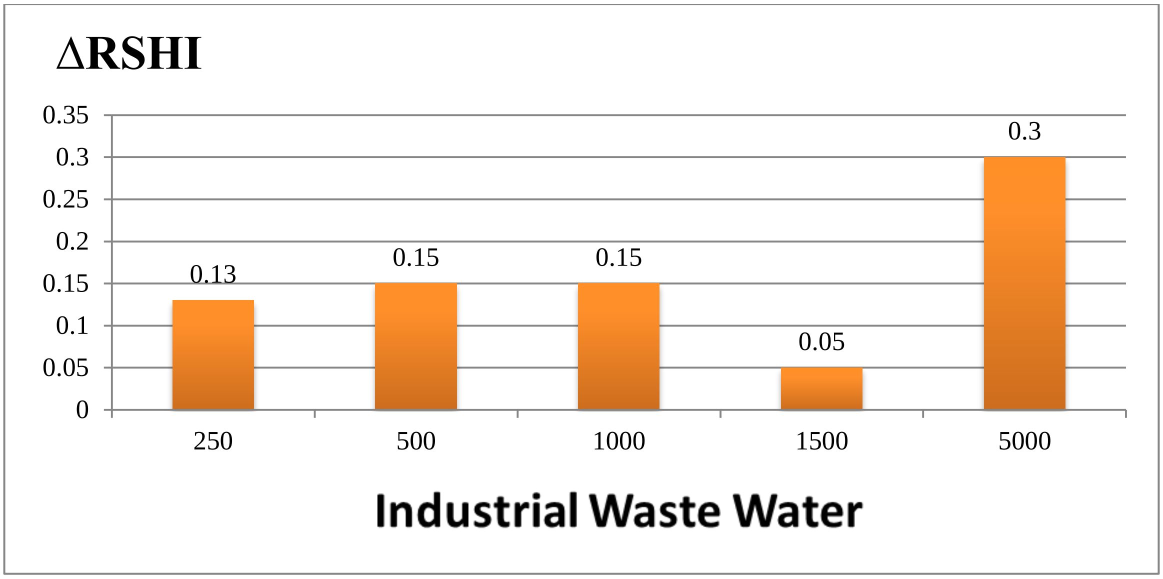


Fig (7). Changes in relative soil health index (ΔRSHI) in Borg El Arab area irrigated with Industrial Waste Water

This indicates that ΔRSHI values are mainly governed by variation in heavy metals and toxic metals content and management practices rather than distance from polluted sources However, it was also found that rate of ΔRSHI per meter decreases with increasing pollution (Sewage water and Industrial Waste Water from Borg El Arab industry area). It ranged from (52×10^{-5} – 6×10^{-5}) in Industrial Waste Water, respectively this means that the rate of development of these soils is relatively higher at the beginning of pollution and irrigation. Similar values were obtained by (Monkied *et al.,* 2006) Concerning the effect of wastewater irrigation of soil health classes in the study area, data indicate that it improved most of the soils using Nile water as source of irrigation as shown in Table (7).

The best soil health (class III) and it Characterized only soil irrigated with Nile water at distance of (5000 m); It was also found that most of the soil irrigated with wastewater have soil health class V, while those using artesian water as a source of irrigation have the worst soil health class V, Such low soil health classes are mainly due to their low fertility status as well as unfavorable chemical, physical characteristics as stated before, and polluted with heavy metals.
The mentioned soil having a relative higher class III, (control) is characterized by a higher biological, nutrient and enzymaticactinty in soil surface (Brookes *et al.,* 1985; Nayak *et al.,* 2007). On the light of the above results, it can be concluded that the studied soils could be improved by better management practices through careful irrigation quality, addition of organic matter, better balanced fertilization, rotation with green manures and legumes and avoiding irrigation with low quality water as well as construction of an efficient drainage system (Brookes and McGrath, 1984)

CONCLUSION AND RECOMMENDATIONS

• The concept of soil health can be calculated easily and applied to the farmers
• The importance of the quality of irrigation water for soil and plant health and therefore the health of the human being and the environment.
• Soil must be improved by removing excess salt, improving the drainage system and disposing the contaminated water.
• Attention has to be given to fertile through soil analysis.
• An interest in organic agriculture which offer replacement of mineral fertilizer to get rid of the chemical pollution of the soil, and increase the humic substances to increase soil health.
• Use water requirements for each crop under modern irrigation systems.
• There are differences in some signs of the soil health at different distances from the irrigation source (industrial - sewage - Artesian - Nile), which means the need remove of contaminated irrigation sources of water and using an easy measurement to monitor the soil health during one growing season.
• Using arithmetic is an easy way to monitor environmental pollution to soil and resource that marks agricultural soil conservation and access to agricultural products environmentally safe and healthy.

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الملخص العربي

تقييم مؤشرات صحة التربة الجيرية بمنطقة برج العرب – غرب مدينة الاسكندرية ، مصر

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تهدف هذه الدراسة الى التنبؤ من خلال نموذج احصائى ، يربط بين بعض خصائص التربة التى يمكن استخدامها فى تقدير صحة التربة. وتم اختيار اربع مناطق من منطقة الدراسة المختارة سلفا وهى منطقة بهيج تروى بمياه النيل (كونترول)، ومنطقة مارى مينا تروى بمياه الصرف الصحى لمجمع مارى مينا والمنطقة الصناعية امتداد الرابعة تروى بمياه الصرف الصناعى وهى المنطقة المتاخمة لزمام قرية السيد درويش، ومنطقة تروى بمياه ابار ارتوازى بالرويستات، كمواقع للدراسة ولتحقيق هذه الاهداف، تم اخذ عينات سطحية وتحت سطحية من التربة على مسافات مختلفة خلال العروة الصيفية على مسافات (٥٠،٢٥٠،٥٠٠،١٠٠٠،١٥٠٠،٥٠٠٠ متر).

تم تقدير الخصائص الكيميائية والفيزيائية والبيولوجية للتربة والعناصر الثقيلة وخصوبة التربة NPK(النيتروجين والفوسفور والبوتاسيوم) والنشاط الانزيمى للتربة (اليوريز Urease والفوسفاتيز Phosphatase والدهيدروجينيز Dehydrogenase).

وبناءا على هذه النتائج يتضح انه بالامكان تحديد مفهوم صحة التربة وجودة مياه، الرى وتحديد خصوبة الارض عن طريق حساب دليل صحة التربة ، برصد التلوث الناتج عن استخدام مياه الرى الاقل جودة ثم عمل Soil Health Card (SHC) للتربة لرصد التغيرات على فترات متقاربة أى خلال موسم زراعى واحد.

الكلمات المفتاحية: صحة التربة، برج العرب، الملوحة، جودة مياه الرى.