Zagazig J. Agric. Res., Vol. 44 No. (4) 2017 1303-1314

Soil and Water Science

http:/www.journals.zu.edu.eg/journalDisplay.aspx?Journalld=1&queryType=Master

CAPABILITY OF FIELD SPECTROSCOPY FOR THE ASSESSMENT OF SOIL CONTAMINATION IN SOUTHERN PORT-SAID GOVERNORATE

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Received: 30/03/2017 ; Accepted: 21/05/2017

ABSTRACT: Soil contamination by heavy metals considers as main environmental problem in the world, most of them have toxic effects on plant and microorganisms in soil when permissible concentration levels are exceeded. The objective of the current work is detection of soil contamination in southern Port-said Governorate using spectroscopy Vis-NIR (350-2500 nm). To predict contaminated soil through Vis-NIR 58 different sites were selected in southern Port-said Governorate. Spectroradiometer ASD was used to measure the spectral reflectance of soil site. Three heavy metals Pb, Mn and Cd have been selected to achieve this purpose. Stepwise multiple linear regression (SMLR) was used to construct calibration models. The concentrations of heavy metals were estimated with high accuracy where, the models were validated based on the independent validation. The results illustrated that, R^2 was recorded 0.94, 0.70 and 0.66 for Cd, Mn and Pb respectively. The concentration of soil contamination by Cd, Mn, and Pb are under the threshold. except area contaminated with Cd is (10791.08) faddans. However, Remote Sensing and Geographic Information System (GIS) are provide detailed spatial information on soil contamination , it's rapidly and inexpensive.

Key words: Soil contamination, spectroscopy, heavy metals.

INTRODUCTION

The contamination of natural environment components such as soil, sediment, water and biota by heavy metals is a major, worldwide concern because of their toxicity. Heavy metals concentration is considered as one of the keys which, affects directly on soil quality and crop quality which, effected on human health. The use of wastewater for irrigation fulfills certain socioeconomic and environmental goals such as increasing production or profits and diminishing of wastewater discharge to the environment. On the other hand, wastewater is considered a source of harmful pathogenic diseases and the contamination of surface and ground water (Hamilton *et al.,* 2007).

Wastewater contains a variety of pollutants including pathogens and heavy metals which can potentially harm the environment as well as human and animal health (Qadir *et al.,* 2007). Approximately one million acre in the Nile delta depends on drainage water for irrigation (Abu Zeid, 2011). Reusing this drainage water may cause adverse effects on soil, crop, animal, and human health. One of the most polluted drains in Egypt is Bahr El-Baqar (Omran and Abd El-Razek, 2012). Bahr El-Baqar drain receives untreated waste water starting from east of Cairo, at the discharge point of El-Gebel El-Asfar and then joined by Belbeis drain, down to the confluence with Qalubiya drain. The length of the main drain is 170 km discharges in El-Manzala Lake and has two main branches, Qalubyia drain and Bilbies drain. It receives and carries the greatest part of wastewater (about 3 BCM/year) into Lake Manzala through a very densely populated area of the Eastern Delta

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passing through Qalubyia, Sharkia, Ismailia and Port Said Governorates. Four main sources of pollutants which cause deterioration in Bahr El-Baqar are: The industrial activities in Shoubra El-Khema including metal production, food processing, detergents and soaps manufacturing, textile finishing and paper production; Industrial activities in Zagazig area; Waste water discharged from Belbeis drain to Bahr El-Baqar; and Domestic discharge received from rural areas around Bahr El-Baqar drain. Assia *et al.* (2004) showed that Bahr El-Baqar drain transports water to the Lake Manzala north-eastern edge of the Nile Delta .The discharge of industrial, agricultural and municipal wastewaters in Bahr El-Bakar drain led to contamination of these soils. These soils receive many kinds of pollutants especially heavy metals such as lead, cadmium, nickel, and mercury which are considered the most hazardous. Saad (1997) concluded that 58% of the total drainage water of Bahr El-Baqar drain comes from agricultural drainage, 2% from industrial drainage and 40% from domestic and commercial drainage.

Ramadan (2003) studied the concentration of (Zn, Pb, Cd and Hg) in the soils of the eastern sector of Lake Manzala and reported that the concentrations of Zn were within the standard critical range of 70 to 400 mg/kg. Lead concentration was also within the standard critical range in soils of 30 to 300 mg/kg. The same applies on Cd concentrations in soils showing a range of values (5 to 9 mg/kg) with the standard critical range (3-8 mg/kg). Mean Hg concentration in soils showed that it is the most epidemic pollutant with a range of 40 to 245 mg/kg much higher than the standard critical range (0.3-5 mg/kg).The Manzala Lake is influenced by fresh water runoff from the land *via* drains and canals. This water enriched the lagoons with nutrients including phosphate, nitrate and silicate. In addition, some drains discharge considerable amount of sewage and industrial wastes directly into the lagoons (Loranger and Zayed, 1994).

Geochemical remote sensing technologies provide a fast, macro way to access to the Earth's surface chemical information, thereby has been widely used in many fields such as environmental geochemistry and soil sciences. As powerful tool for monitoring vegetation stress, hyper spectral remote sensing technique is increasingly being used, directly or indirectly to monitor the status of heavy metal pollution (Kooistra *et al.*, 2001). Researchers have shown that can accurately determine soil properties and heavy metals in visible-near-infrared (VNIR) spectroscopy in the spectral range 400-2500 nm under laboratory conditions. It can be almost continuously, and relatively less expensive and faster than traditional wet chemical measurements, and save time compared to standard laboratory tests (Yun, 2003).

Multiple linear regression (MLR) is one of several methods to band selection for derivative heavy metals and soil properties using reflectance field spectrometer. MLR is a classical method that creates a linear combination of the spectral values at every single wavelength to correlate as closely as possible to the dependent reference values. The regression coefficients are estimated by minimizing the error between predicted and observed response values in a least squares sense (Schwartz *et al.*, 2011).

Objectives of these search detection from capahbility of spectrometer reflectance data to detection soil contamination and soil properties in Southern Port-said Governorate. Development Multi Linear regression for relationships between reflectance data and soil contamination and soil properties in the studied area. Validate Multi Linear regression of spectral reflectance data which detect heavy metal concentration and soil properties through the results of soil contamination from traditional method (atomic absorption) and wavelet-fractal analysis spectrometer (VNIR SWIR) and soil contamination. Production spatial distribution maps for soil contamination and soil properties to deleting contamination areas in Southern soil Port-said Governorate. Create Hazard map for heavy metals contamination in southern soil port- said-Governorate.

MATERIALS AND METHODS

Study Area and Methodology

The study area is located between longitude 32°17' 39.56" and 32°17' 39.16"E and latitude 30°58'45.64"N 30°58' 34.56"N. It is situated north-east of Cairo, east of the Nile Delta, south of Manzala lake and west of Suez Canal as shown in Fig. 1. The study area has several environmental problems related to increasing soil pollution. The area attributed as an arid region where the minimum annualized temperature is 11.2°C and is recorded during January while the maximum annualized temperature is 31°C and is recorded during August. The relative humidity varies throughout the year, ranging from 67.2 to 82.87%. Visibility differs from ranged between 8.5 and 10.3 km. Where the lowest values are observed in December, whereas the highest values are recorded in July. The minimum annual wind speed is 12.3 km/hr., and is recorded during November while the maximum annual wind speed is 18.3 km/hr., and is recorded during March. The investigation area is described by (Mohamed *et al.*, 2011).

The total surface area of the study area is approximately (51527.58 faddans). A reconnaissance visit was performed for the study area to get different landscape features; land-use and land-cover patterns. The extensive field surveys were guided with a Global Positioning System (GPS) receiver. Fifty eight different sites were selected randomly in southern Port-said Governorate where is found homogeneity in physiographic unites, and give each sample chance to represent population sample.

Laboratory Analyses

Soil Electric conductivity (EC), organic matter (OM), pH, soluble cations and anions, $CaCO_3$, cation exchange capacity (CEC), and Particle size distribution was determined according to (Bandyopadhyay, 2007). The concentration selected heavy metals were determined using an atomic absorption spectrophotometer (Shimadzu, AA-6800). Fig. 2 shows the overall methodology used in this study.

Spectroscopy Analysis

The ASD FieldSpec FR spectroradiometer samples spectral radiance across the wavelength range 0.35–2.5 mm with spectral resolution of 0.003 mm at ffi 0.7 mm and 0.01 mm at ffi 1.4 and 2.1 mm. Its nominal noise equivalent changes in radiance (neL) are 1.4 10–9 W cm–2 nm–1 sr–1 at 0.7 mm, 2.4 10–9W cm–2 nm–1 sr–1 at 1.4 mm and 8.8 10–9W cm–2 nm–1 sr–1 at 2.1 mm. The contact probe (Fig. 7) has a stable light source integrated with the mount for the spectrormeter optic cable five spectra of each sample were obtained. All of the measurements were made with the sensor located directly over the center of the sample. The mean of the five spectra was determined to provide a single spectral value. ViewSpec software used to convert spectral data from DN data to reflectance data and export it to ASCII text files, which used easily in Microsoft Excel.

Geostatistical Analysis

Geostatistical methodology uses the semi-variogram to quantify the spatial variation of a regionalized variable. The semi-variogram, γ (h), measures the variability mean between two points X and X+h, as a function of their distance h. The experimental variogram is calculated for several lag distances. It is then generally fitted with a theoretical model, such as a spherical or exponential model. These models provide information about the structure of the spatial variation as well as the input parameters for spatial prediction by kriging. soil contamination (Lead, Cadmium, Manganese) were entered into a field-scale GIS and interlayer data analytical tools were utilized to quantify spatially dependent relationships. Ordinary Kriging (O.K) is one of the most basic kriging methods (Meul and Van Meirvenne, 2003). At an unsampled Location X0, Z is estimated by:

$$Z\times(X0)= \sum \lambda i Z(X\ i\ ) \qquad (1)$$

i =1

Where:

Z×(X0) is the estimated value of the random Variables (RV) Z at the unsampled location X0 and λi are the n weights assigned to the observation points Z(xi). The weights λi sum to one to assure unbiased conditions and they are found by minimizing the estimation variance. The RV Z(x) can be decomposed into a trend component m(x) and a residual Component R (x):

$$Z(X\ )= m(X)+ R(X) \qquad (2)$$

OK assumes stationarity of the mean and considers m(x) to be a constant, but of unknown

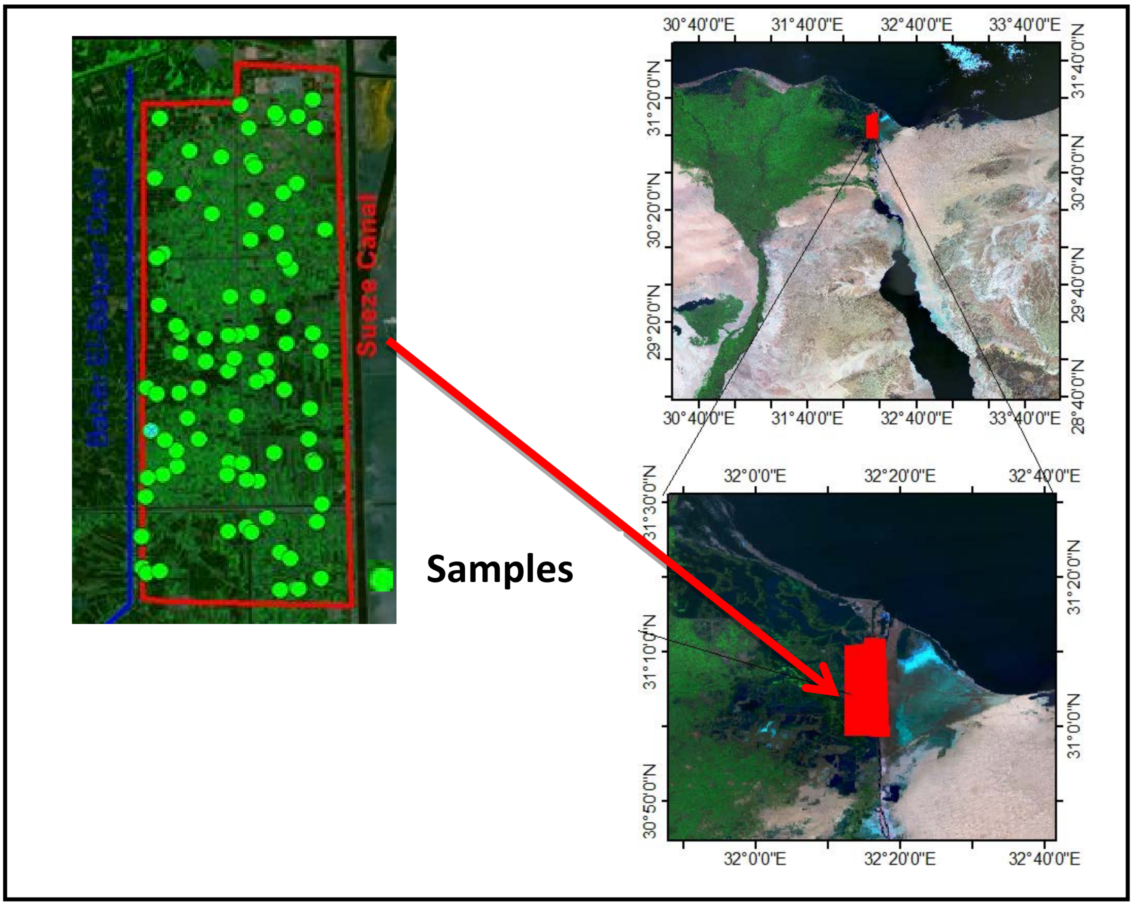

Fig. 1. Location map of the study area

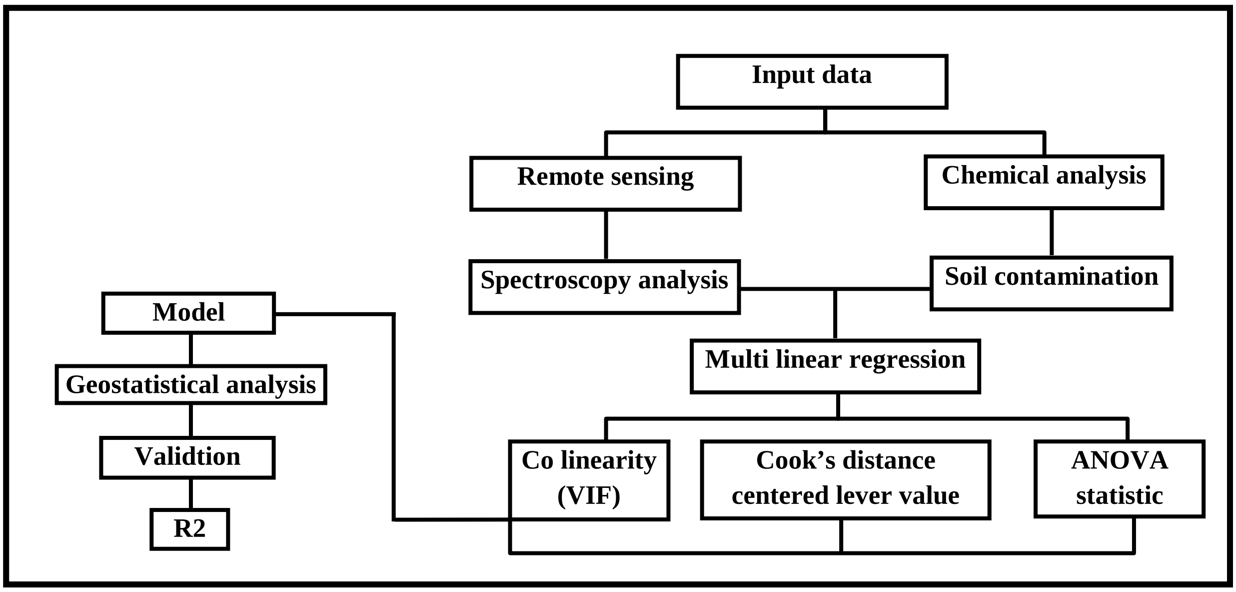

Fig. 2. Flowchart for the research methodology steps

value. Nonstationary conditions are taken into account by restricting the domain of stationarity to a local neighbourhood and moving it across the study area. The residual component R(x) is modeled as a stationary RV with zero mean and under the assumption of intrinsic stationarity, its spatial dependence is given by the semivariance γR (h):

$$\gamma R(h) = \frac{1}{2N(h)\ i=1} N\sum(h)[\{R(x+h)-R(x)\}2] \quad (3)$$

Assuming a constant mean m(x), Eq. (3) is equivalent to:

$$\gamma(h) = \frac{1}{2N(h)\ i=1} N\sum(h)[Z(x+h)-Z(x)\}2]$$

Multi Linear Regression (MLR)

The simplest way to express a relationship between variables is a linear relationship. The linear expression is as follows :

$Y = a + b_1X_1 + b_2X_2 + \ldots\ldots. + b_2X_n$

Where:

Y is the heavy metals concentration explained by wave lengthes and soil properties X_1, X_2 and X_n, a is intercept and b_1, b_2 and b_n are the regression coefficients (Cohen *et al.,* 2003).

This can be tested first for linear regression analysis. This means if the independent variable (soil contamination, soil properties) decreases or increases then the depended variable (spectra) will either decreases or increase. The relationship should be tested for the following: ANOVA statistic, Collinearity Cook's distance and Centred Lever Value.

RESULTS AND DISCUSSION

Soil Physico-Chemical Characteristics and Spatial Distribution of Selected Heavy Metals

Table 1 show some physicochemical characteristics and heavy metal levels in soil. The concentration of each heavy metal is always controlled by different soil parameters *e.g.* (soil pH, organic matter, calcium carbonates and cation exchange capacity), However the current ECe values ranged between 0.561 and 2.91 dSm^{-1} which consider non saline soil of the study area. These results indicate the good management of these soils with leaching many times as it used as fish ponds. The organic matter varied from 0.51 to 2.9%. These soils are used as fishponds and have some residual of organic feeding on soil surface which is the reason why the OM content is high. Soil organic matter plays an important role not only in iron oxidation and reduction but also it forms complexes with any soluble iron that is released. The organic matter extract, doubtless, chelates with iron and holds it for a time in a soluble condition and thus it can be transported within the plant tissues. The cation exchange capacity varied from 17.2 to 25.3 mol/kg. pH varied from 7.2 to 7.6 this indicate that the heavy metals in this soil is complex compound and pHC_aCl_2 was greater than the unit of pHw. This indicate that the soil has positive charges on their surfaces which have amorphous iron oxides and organic matter. The $CaCO_3$ (%) ranged from 5.7 to 40.2%, and the highest values related to their content the samples from shells in the field. As shown in Table 1 the texture of soils in the studied area were sandy loam or sandy. This indicates that the rate of increase dispose of heavy metals in the soil.

According the geostatistical analysis approach as shown in Fig. 3, contamination soils are characterized by slightly pollution as lead values around 0.2-13.4 ppm. Manganese values ranged from 194.4 to 402.4 ppm, while cadmium exceed threshold which ranged between 1.6-4.2 ppm, all heavy metals have been recorded rise in values lied in southern section. The discharge of industrial, agricultural and municipal wastewaters in Bahr Elbakar drain led to contamination of these soils. These soils receive many kinds of pollutants especially heavy metals such as lead, cadmium, nickel, and mercury which are considered the most hazardous (Park and Shin, 2006).

Spectral Reflectance Of Selected Heavy Metals

Spectroradiometer (ASD Field Spec) is used to evaluate quantitative analysis of heavy metals where, using stepwise multi-linear regression procedure between the concentration of a given constituent for soil contamination and the spectral response which measured by

Table 1. Soil characteristics of the study area

Sample No.	pH_w	pH $CaCl_2$	EC dSm^{-1}	CEC $mol_c\ Kg^{-1}$	$CaCO_3$ (%)	OM (%)	Menanical composition (%)			Texture
							silt	Clay	Sand	
1	7.45	8.08	1.66	22.1	18.0	1.69	30	15.4	54.6	loam_sandy
2	7.35	8.23	0.659	19.5	21.3	0.51	6.7	13.3	80	sandy_loam
3	7.53	8.17	1.2	19.6	33.6	1.92	10	15	75	sandy_loam
3b	7.52	8.18	1.01	24.5	31.0	2.05	11.9	16.7	71.4	sandy_clay_loam
4	7.6	7.96	1.55	22.1	34.4	2.02	6	29.7	64.3	sandy_clay_loam
5	7.31	8.19	2.91	20.2	18.6	2.50	13	32	55	Loam
6	7.32	7.92	1.85	20.4	17.9	1.84	46.3	15.7	38	sandy_clay_loam
7	7.45	7.91	2.2	21.5	26.0	2.70	8.8	29.4	61.8	Loam
8	7.32	8.12	1.12	21.3	21.3	1.52	41.1	11.8	47.1	sandy_loam
9	7.4	8.05	1.5	22.5	25.2	2.05	33.8	6.8	59.4	sandy_loam
10	7.51	8.16	1.12	21.1	24.5	1.92	27.5	11	61.5	sandy_loam
10b	7.33	8.2	0.822	22.9	12.2	1.77	27.1	16.7	56.2	Loam
11	7.26	8.21	1.11	21.3	18.6	2.02	40.8	10.2	49	sandy_loam
12	7.53	8.02	1.02	19.5	37.1	2.02	25.3	6.3	68.4	sandy_clay_loam
13	7.32	7.93	1.709	19.6	12.8	2.07	6.6	32.9	60.5	Loam
14	7.45	8.09	2.22	19.6	22.9	2.40	12.2	36.6	51.2	sandy_clay_loam
15	7.56	8.1	0.565	18.7	39.1	2.30	29.7	24.7	45.6	sandy_clay_loam
16	7.45	8	1.65	19.3	32.3	2.35	22.2	22.2	55.6	sandy_loam
17	7.55	8.11	1.5	20.1	35.3	1.59	17.4	29.1	53.5	sandy_loam
18	7.43	8.1	2.3	21	13.3	1.95	36.7	7.6	55.7	sandy_clay_loam
19	7.44	7.76	1.981	21.3	12.6	2.53	38.9	5.6	55.5	Loam
20	7.63	8.01	1.65	21.5	40.2	2.27	13.7	20.5	65.8	Loam
21	7.51	7.84	1.709	21	18.0	2.38	40.6	16	43.4	clay_loam
22	7.43	7.95	2.6	19.5	16.1	1.64	33	17	50	clay_loam
23	7.33	8.08	2.5	19.6	10.2	2.40	19.6	39.2	41.2	clay_loam
24	7.28	7.97	2.7	18.7	6.5	2.21	19.2	38.5	42.3	Loam
25	7.3	7.82	2.18	19.4	9.6	2.90	45.5	10.1	44.4	Loam
26	7.34	7.93	2.3	18.7	22.6	2.10	47.1	9.4	43.5	sandy_loam
27	7.37	7.91	2.3	18.9	11.2	1.84	26.7	6.7	66.6	sandy_loam
28	7.43	8.19	1.71	18.5	17.7	0.91	25.8	12.4	61.8	sandy_loam
29	7.33	8.16	2.7	18.4	9.6	2.27	22.5	19.1	58.4	sandy_loam
30	7.29	7.92	1.452	17.6	6.2	1.09	26.5	11.8	61.7	sandy_loam
31	7.34	8.19	1.028	17.2	9.6	1.47	23.3	7.8	68.9	sandy_loam
32	7.23	8.05	2.5	17.6	5.7	1.95	45	7.5	47.5	sandy_loam
33	7.24	7.92	2.28	18	6.2	1.29	41.8	5.3	52.9	Loam
34	7.22	8.21	2.4	18.2	5.7	1.49	36.8	17	46.2	Loam
35	7.35	7.92	2.7	19.7	7.0	1.59	39.4	9.9	50.7	sandy_loam
36	7.33	8	2.8	19.6	9.6	2.05	42.1	6.9	51	sandy_loam
37	7.33	7.69	2.09	19.8	7.6	1.19	48.1	3	48.9	Loam
38	7.36	7.8	2.5	20.1	9.0	2.30	39.4	12	48.6	Loam
39	7.29	7.84	2.2	23.1	13.3	1.57	29.9	25.4	44.7	sandy_loam
40	7.45	8.08	2.4	19.8	15.6	2.55	38.5	4.5	57	sandy_loam
41	7.39	7.84	1.9	20.3	18.5	1.54	30.2	4.4	65.4	sandy_loam
42	7.43	8.18	2.18	20	6.2	1.06	13.1	17.9	69	sandy_loam
43	7.34	8.21	1.8	21	8.6	0.86	12.9	14	73.1	sandy_loam
44	7.36	7.93	2.4	20.1	12.8	2.20	39.9	6.8	53.3	sandy_loam
45	7.26	8	1.3	20.6	9.4	2.00	43.8	5.6	50.6	sandy_loam
46	7.41	8.2	1.06	23.5	10.4	1.52	18.3	20.6	61.1	sandy_loam
47	7.38	7.95	2.64	24.1	6.8	2.27	41.3	6.8	51.9	sandy_loam
48	7.4	8.1	2.73	23.6	8.8	1.59	30.1	16.1	53.8	sandy_loam
49	7.51	8.09	1.32	24.3	23.7	1.47	19.2	13.5	67.3	Loam
50	7.34	8.15	2.6	20.87	17.7	1.90	39.9	13.1	47	Loam
51	7.21	8.07	1.792	25.3	9.4	2.35	43.6	8.7	47.7	silty_loam
52	7.31	8.14	2.1	24.7	11.2	1.09	54.4	9.1	36.5	Loam
53	7.34	7.96	2.1	25.1	7.6	2.55	42.9	11	46.1	Loam
54	7.41	7.95	2.8	24.6	14.8	1.97	43.2	16.1	40.7	Loam
55	7.42	7.83	2.7	24.6	11.7	2.02	36	13.8	50.2	Loam
56	7.34	7.7	2.4	23.5	11.5	2.4	38	14.5	47.5	Loam

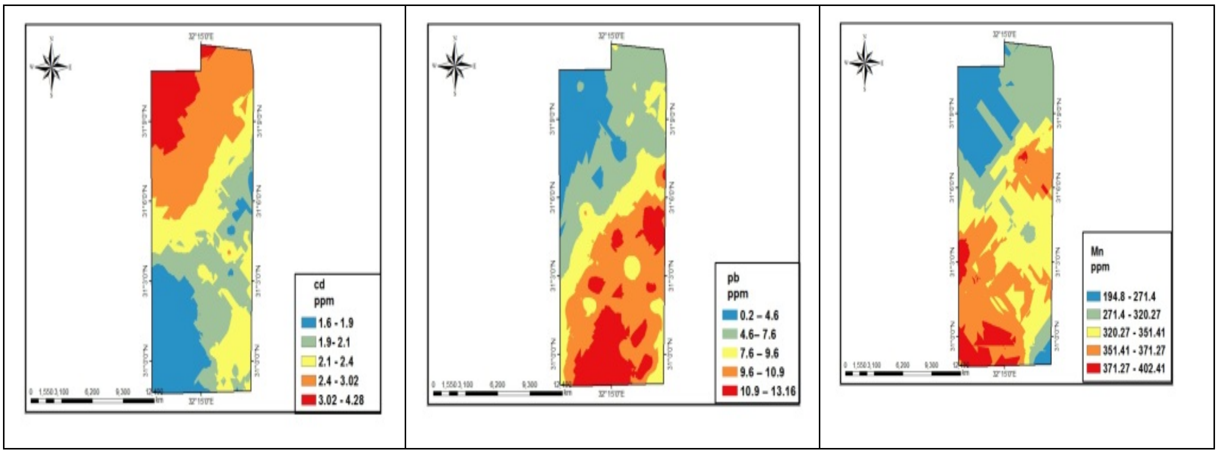

Fig. 3. Spatial distribution of selected heavy metals

Spectroradiometer (reflectance, R; absorption, A; first order derivative of absorption, A; and standardized reflectance). In the multiple regression setting, the response variable y (soil contamination) depends on not one but several explanatory variables: matrix x (spectral data) to estimate the concentration of heavy metals. The results showed the overall form of the ASD spectra is quite similar among the studied soil samples. Therefore stepwise multiple linear regression (MLR) is used to describe the correlation between concentration of heavy metals and their effects on spectral reflectance.

For calibration based on multivariate statistics, a stepwise regression procedure was used in order to limit the number of input variables. Variables were entered or removed from the model depending on the testes for hypothesis. As illustrated in Table 2 the ANOVA Test appear that the sum of squares of regression for all parameters are higher than residuals. In addition, the F statistics at confidence level of 95%, for (Cd) are higher than the number of samples selected and confidence level of 50%, for (Mn, Pb) are smaller than the number of samples selected that means the relationship is not coincident and that there is genuine relationship between the reflectance and (Cd), and not genuine relationship between the reflectance and (Mn and Pb).

The values of Beta in all parameters are negative, which indicates that the relationship is an inverse one, meaning the spectral reflectance increase as the parameters content decreases.

Tolerance (T the percentage of variance in a given predictor that cannot be explain by the other predictor) for (Mn, Cd and Pb) are (0.77, 0.86 and 0.83) which if close to (1) indicate that 100% of the relationship cannot be explained by other variables. (VIF Variance Inflation Factors) for (Mn, Pb and Cd) are (21.4, 22.1 and 26.5) big than (2) that indicate this variables are not collinearity which meaning two or more predictor variables in a multiple regression model aren't highly correlated.

The statistical parameters from the calibration processes of the optimal combinations are given the best predictive equations were chosen as the equation by MLR with the highest R^2 as shown Table 3.

The changes occurred in reflectance values in different regions along with spectral curve, especially in near infrared (NIR) and visible region are associated with increasing heavy metals concentrations. As illustrated Table 3 spectral reflectance was 505, 490,1679, 1913 and 494 nm for Lead also1679, 506 and 1958 nm for manganese and 1705, 1917, 1161nm for cadmium. R^2 was 0.51 and 0.73 and 0.91 for Pb, Mn and Cd respectively.

The accuracy of quantitative analysis was evaluated by calculating the R^2 value of a linear regression relating the measured soil heavy metals (forty samples) with the predicted from the models. The relationship between measured

Table 2. Test the hypothesis to select the best model

Parameter	ANOVA Test			Standardized Coefficients	Collinearity Statistics	
	Sum of Squares		F	Beta	Tolerance (T)	VIF
	Regression	Residual				
Mn $_{ppm}$	135895.315	36230.624	30.944	-2.585	0.77	21.4
Cd $_{ppm}$	8.553	.821	118.019	-2.795	0.86	22.1
Pb $_{ppm}$	478.304	443.898	14.277	-2.099	0.83	26.5

Table 3. Models have been extracted by MLR with R^2

Parameter	Equation	Wavelengths	R^2	spectral range
Pb ppm	$13.39-33.8*x_1+35.8*x_2-96.0*x_3+101.3*x_4$	Where x_1, x_2,x_3,x_4 represent separately reflectance at wavelengths: 505nm, 490 nm ,1679nm,1913nm 494nm	0.51	Blue-Green - Near Infrared
Mn	$466.28-1937.4*x_1+1002.53*x_2+1389*x_3-410.24*x_4$	Where x_1, x_2,x_3,x_4 represent separately reflectance at wavelengths: 1679nm, 506 nm ,1958nm,500nm	0.73	Green- Near Infrared
Cd	$1.45+32.6*x_1-17.1*x_2-17.09*x_3$	Where x_1, x_2,x_3 represent separately reflectance at wavelengths: 1705nm, 1917 nm ,1161nm	0.91	Near Infrared

and predicted values was plotted in Fig. 4. The result revealed a good relationship between the measured heavy metals and the predicted ones where, Cd, Mn and Cd have high accuracy with R^2 0.94, 0.70 and 0.66, respectively. The accuracy estimation illustrates the quantity of soil heavy metals content has been measured by traditional method (Atomic).

Hazard Mapping of Heavy Metals

Bahr El-Baqar drain receives untreated waste water starting from east of Cairo, at the discharge point of El-Gebel El-Asfar and then joined by Belbeis drain, down to the confluence with Qalubiya drain. The length of the main drain is 170 km discharges in El-Manzala Lake and has two main branches, Qalubyia drain and Bilbies drain. It receives and carries the greatest part of wastewater (about 3 BCM/year) into Lake Manzala through a very densely populated area of the Eastern Delta passing through Qalubyia, Sharkia, Ismailia and Port-said Governorates. Four main sources of pollutants which cause deterioration in Bahr El-Baqar are: The industrial activities in Shoubra El-Khema including metal production, food processing, detergents and soaps manufacturing, textile finishing and paper production; Industrial activities in Zagazig area; Waste water discharged from Belbeis drain to Bahr El-Baqar; and Domestic discharge received from rural areas around Bahr El-Baqar drain. Soil represents a major sink for heavy metals ions, which can then enter the food chain *via* plants or leaching into ground water. GIS can be used to assess the soil pollution potential. In order to prevent soil pollution before it occurs and avoid the future need for costly remediation efforts. The Geostatistical Analyst can be used to map the probability that any heavy metals values exceed the threshold. The heavy metals vulnerability maps for agricultural purposes are shown in

Fig. 5. The whole area is divided into two classes on the basis of hazard, low and high

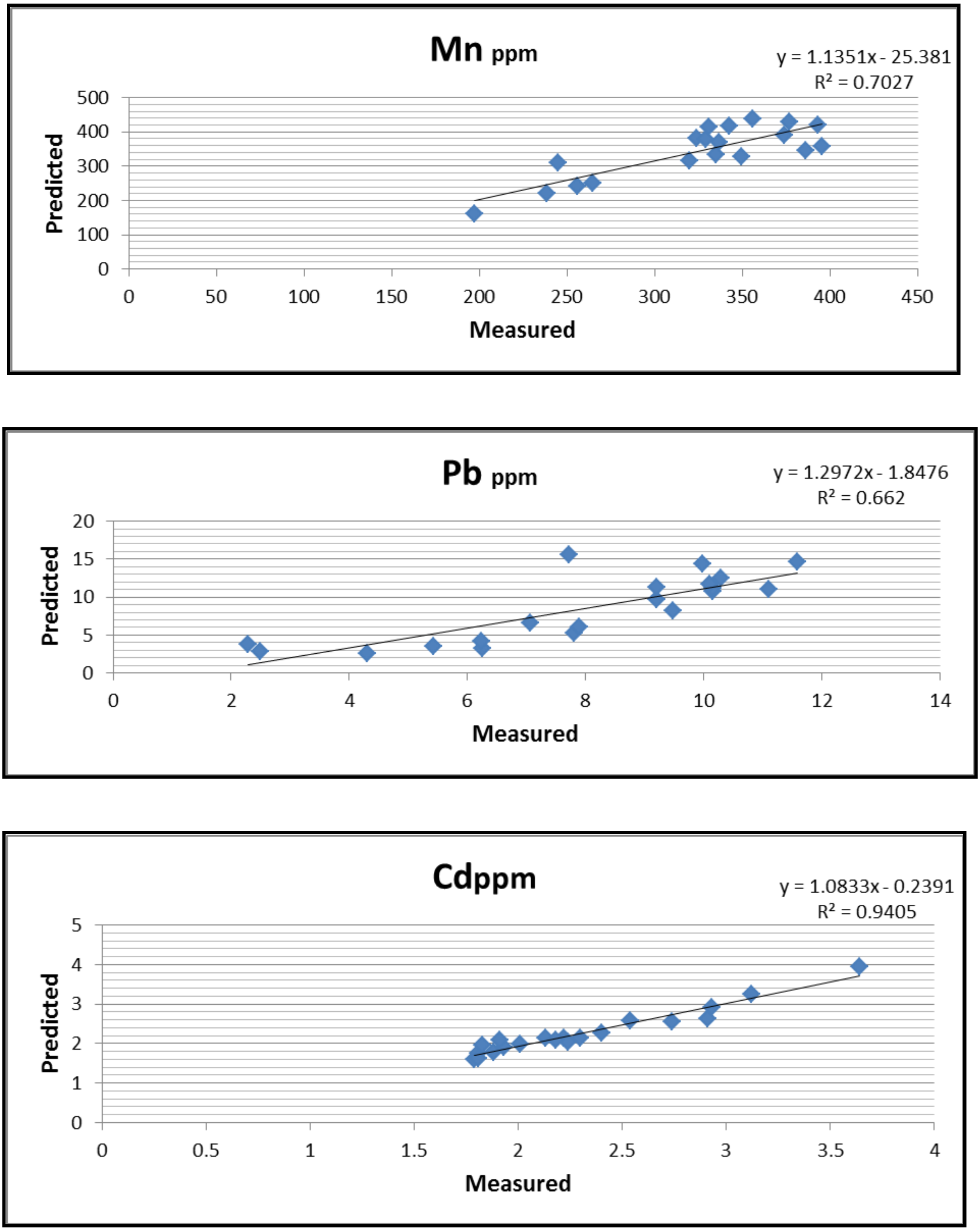

Fig. 4. Correlation between measured and predicted the selected heavy metals

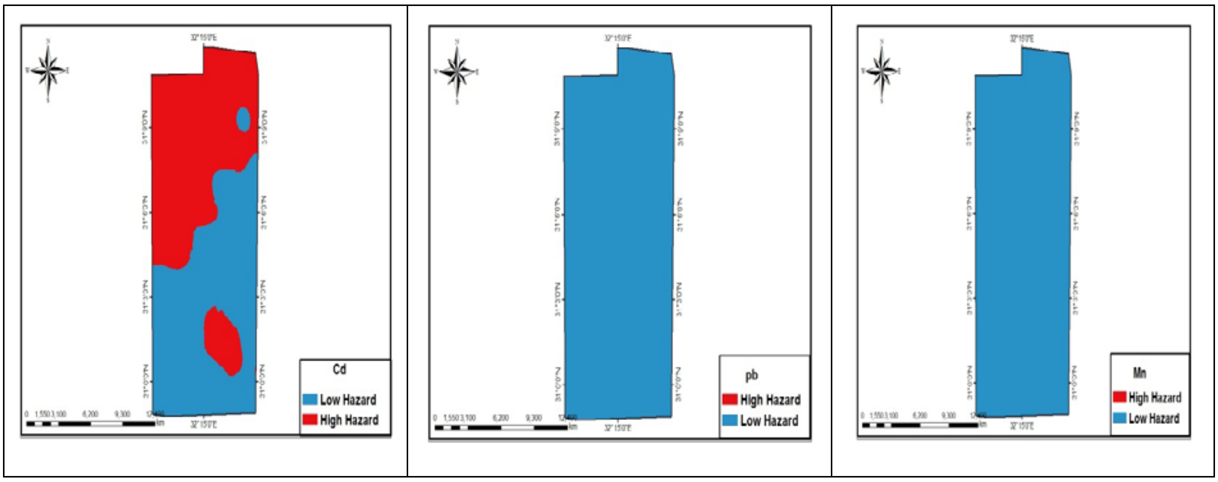

Fig. 5. Hazards of Cd, Pb and Mn

according to WHO (2009). Most of the soil samples fall in the low hazard classes. Pb, Mn, and Cd metals concentrations are under the threshold value in soils which falls in the low hazard category. However, only Cd falls in the high hazard category. The total study area (10791.08) faddans is contaminated with Cd.

Conclusion

This search using spectral reflectance to detect soil contamination in southern distreic of Port-Said Governorate. Heavy metals have been predicted from spectral reflectance by using MLR. The result show Spectrum data which taken in Vis-NIR range (350-2500 nm) and could be used to estimate the soil contamination with high accuracy the same in abstract. Therefore, Visible Near-infrared (Vis-NIR) reflection spectroscopy is cost and time-effective that could be alternatives to the traditional methods of heavy metals analysis. In addition, this paper highlights the environmental hazards occurred southern Port-said Governorate, the results showed concentration of soil contamination by Cd, Mn, and Pb are under the threshold. Except for an area contaminated with Cd covering 10791.08 faddans. Due to insecticides, fungicides, sludge, and commercial fertilizers us aye.

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قدرة الاسبكتروسكوبي في تقييم تلوث التربة في جنوب محافظة بورسعيد

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يشكل تلوث التربة بالعناصر الثقيلة مشكلة بيئة علي مستوي العالم وذلك لما لها من اثار علي النبات والكائنات الحية ذلك مع زيادة مستوي ونسبة التركيزات لهذه العناصر، وتهدف هذه الدراسة الي قياس مدي فاعلية وقدرة الاستشعار من البعد من خلال الانعكاسات الطيفية في الكشف عن تلك الملوثات وعناصر وخصائص التربة، بالاضافة الي تعميم نتائج هذه القدرة علي صور الاقمار الصناعية للحصول علي اسطح مستمرة تعبر عن قيمة الملوث او العنصر محل الدراسة، يتضمن النطاق الطيفي للانعكاسات الطيفية مدى واسع من البيانات التي يمكننا الكشف من خلالها علي خصائص وملوثات التربة في النطاق مابين المرئي – تحت الحمراء القريبة من ٣٥٠ إلى ٢٥٠٠ نانوميتر حيث تعتبر هذه التقنية هي واحدة من أحدث التقنيات علي مستوي العالم التي يمكنها الكشف عن التفاصيل داخل النسيج الواحد ، ولكي يتثني لنا الوصول لتحقيق هذا الهدف تم الاعتماد علي ثمانية وخمسون عينة سطحية بجوار مصرف بحر البقر بجنوب بورسعيد حيث منطقة الدراسة، كما تم تحليل ثلاث ملوثات وهي الرصاص، الكادميوم والمنجنيز، تم استخدام الانحدار الخطي المتعدد بطريقة Stepwise وذلك لاستخراج نموذج رياضي يمكن من خلاله الحصول علي قيمة الانعكاس الطيفي التي تحدد القيمة الكمية لتلك الخصائص والملوثات داخل عينة التربة، وذلك بإستخدام خصائص وملوثات التربة المقاسة معمليا والانعكاسات الطيفية لنفس العينات محل الدراسة لتحديد وادخالهما معا في علاقة خطية متعدده واستنتاج تلك القيم، وأظهرت النتائج قدرة الاستشعار من البعد عن طريق الانعكاسات الطيفية للاسبكتروسكوبي (جهازالهيبرسبكترل) القدرة في الكشف عن الملوثات داخل عينات التربة بمنطقة الدراسة بدقة وصلت اعلاها في الكادميوم والمنجنيز حيث سجلا نسبة R^2 ٠.٩٤، ٠.٧٤ على التوالي، وتقل في الرصاص لتبلغ ٠.٦٦، كما أوضحت نتائج الدراسة ان ملوثات التربة للعناصر الثقيلة (كادميوم - منجنيز ورصاص) هي ضمن الحدود المسموح بها طبقا لمنظمة الصحة العالمية، على الرغم من وجود مساحة بلغت١٠٧٩١ فدان تعاني من ارتفاع عنصر الكادميوم بالتربة داخل منطقة الدراسة.يمكننا من خلال الاستشعار من البعد ونظم المعلومات الجغرافية الكشف عن التلوث بالمعادن الثقيلة وخصائص التربة بسهولة وييسر وتكلفة أقل.

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