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ESTIMATION OF SOIL SALINITY IN SOME PHYSIOGRAPHIC MAPPING UNITS OF WADI GARAWLA , MATROUH, EGYPT, USING ELECTROMAGNETIC INDUCTION (EMI)

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ABSTRACT: The rapid increment of soil salinity in dry lands led to more maintenances for lots of practices to improve and conserve the degraded fields. The process of soil survey is time consuming and expensive, therefore, the new remote sensing techniques become important to monitoring, estimate soil salinity in quick, easy, cheap, and could be replicate any time. The electromagnetic induction (EMI) instruments used to estimate soil salinity in easy and rapid technique. But the collected EMI instrument readings measured the soil salinity as relative value depend on the instrument calibration point and the readings need to change in EC values (dS/m). The aims of this study are mapping the physiographic units of Wadi Garawla area, Matrouh, Egypt; test the spatial distribution of the calibrated Profiler EMP-400 instrument readings; and estimated EC values from calibrated instrument readings.

The results of EMI readings of VDM orientation correlated with EC values assessed in the laboratory were the most suitable for estimating EC values to study the multi and simple regressions using the EMI readings. The correlation results showed that, there was an increase in the significance of the relationship between the measured soil salinity in the laboratory with the estimated EC values using calibrated instrument readings of VDM EMI measurements at 13, 14, and 15 KHz. The descriptive statistical of the produced maps showed that, using the calibrated 15 KHz readings values gave the lowest standard deviation. This confirms that, it is the most appropriate readings to estimate the soil salinity values maps.

Key words: Electromagnetic induction (EMI), soil salinity, physiographic mapping units, Wadi Garawla, Matrouh.

INTRODUCTION

The North West Coastal region depends on rain fed argic-pastoral systems development in semi-arid environments, which need many of challenges to management and sustainable its natural resource. More than 120 thousand Bedouin whose livelihood depends on rain fed agriculture in the North West Coastal zone of Egypt. It extends over 350 km from west of Alexandria to the Libyan border content 218 Wadis (Ellis, 1994). Human settlements and land use are entirely dependent on rainfall and on various forms on water harvesting. Annual rainfall, restricted to the winter months and to a narrow 20 km strip along the coast, with an average between 140 mm in the West to 75 mm in the East. Rainfall patterns are extremely erratic, with high fluctuations spatially as well as within and between years.

Ismail et. al. (2013) identified the land quality and crops suitability of east Qattara Depression area using geostatistical analyses, GIS and RS. They combined the geomorphic mapping units with the geological map and the Hill shaded map using the capability of GIS software to create the physiographic mapping units. Shoman et. al. (2013) identified the land quality, land evaluation, and crops suitability of some areas in Egypt using geostatistical analyses, GIS and RS. They combined the geomorphic mapping units with the geological map using the capability of GIS software to create the physiographic mapping units. Wahab and El Semary (2012) study the landforms which were delineated by using the digital elevation model, Landsat ETM+ and ground truth data. Also, Ismail and Yacoub (2012) created the geomorphic mapping units based on the histogram of digital elevation model values map, then the physiographic mapping units were

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created by combining the geomorphic mapping units with the geologic map.

Active remote sensing sensors are becoming widely used in precision agriculture, due to the quick, easy and non-invasive identification of soil spatial variability. The soil electrical conductivity (EC) is the main parameter measured by sensors, which is correlated to many factors, like soil water content, salinity, clay content and mineralogy, bulk density, and porosity. Ismail and Yacoub (2014) illustrated that, the used of EMI instrument in assessing soil salinity is powerful and successful for each entire land use types and for individual points. The calibration equation developed at one date is suitable to predict the salinity for the soil samples from EMI measurements taken at another date based on land use types. Doolittle et. al. (2014) illustrated that, Electromagnetic induction (EMI) were used to characterize the spatial variability of soil properties since the late 1970s. Brevik and Hartemink (2010) concluded that, it is important to note that, EC readings are a composite of soil properties. They cannot replace the detail provided by sampling and describing soils in the field. For this reason, ground trothing of EMI data will remain important. Brevik et al. (2006) and Priori et al. (2010) illustrated that, the results of using the three instruments single-frequency Electro-Magnetic Induction sensor (EMI, Geonics, EM38-DD), multi-frequency EMI sensor (GSSI Profiler EMP- 400) and geo-electric system (ARP Automatic Resistivity Profiling) produced similar spatial patterns, obtained with soil electric conductivity (EC) of the three sensors were similar. On the other hand, the correlation with EC and clay correlation was strong for all sensors, except for EM38_HDP. WoLr-eNneupr et al. (1986) presented a method for calibrating electromagnetic induction instrument readings with saturated paste electrical conductivity (ECe) for field mapping purposes. They illustrated that, the resulting regression equation yields a quick reliable equation that avoids complex mathematics and converts the instrument readings into weighted forms of commonly used saturated paste electrical conductivity values.

The objectives of this study are: 1) mapping the physiographic units in Wadi Garawla area; 2) collected the EMI instrument readings; 3) calibrate the EMI instrument readings using the measured EC value of the instrument calibration point; 4) calculate multi and simple regression equations using the correlation between the EMI instrument readings and measuring EC values of soil samples in the laboratory; 5) estimate the EC values using the calibrated EMI instrument readings; 6) study the relation between the estimated EC values within the three physiographic mapping units (Inner, Near Outer, and Far Outer) of Wadi Garawla basin; and 7) test the spatial distribution of the EMI instrument readings, measured EC values of soil samples, and estimated EC values from instrument readings.

Location of the study area

Wadi Garawla area is located at about 25 Km east south of Mersa Matrouh city, Egypt, covering about 25965 feddans (Map 1). It is suited between latitude 31° 12^{-} $32.07^{=}$ and 31° 16^{-} $15.99^{=}$ N and between longitude 27° 16^{-} $02.19^{=}$ and 27° 22^{-} $39.73^{=}$ E. Wadi Garawla basin cover an area of 5403 feddan which is started from the north west coast road and extent inside wadi Garawla for about 10 Km long in the west south direction and with 5.5 Km wide from east to west direction.

MATERIALS AND METHODS

MATERIALS

1. Images and Maps used

- Recent satellite images of Planet Scope with 3-meter resolution, dated in September 2018.
- Three topographic maps with scale 1:25,000 named Wadi El-Garawla, Wadi El-Qasaba, and Gabal Shqoqa were used to cover the study area (GDMS, 2009).
- Geological maps of Alexandria with scale 1: 500,000 (EGPC, 1986).

2. Instruments used

- Digital electromagnetic induction instrument Profiler EMP-400 (GSSI, 2017).
- Dynamic GPS, SWERI Data Collector system (SDC) to define and determine the location of the soil samples in the field.

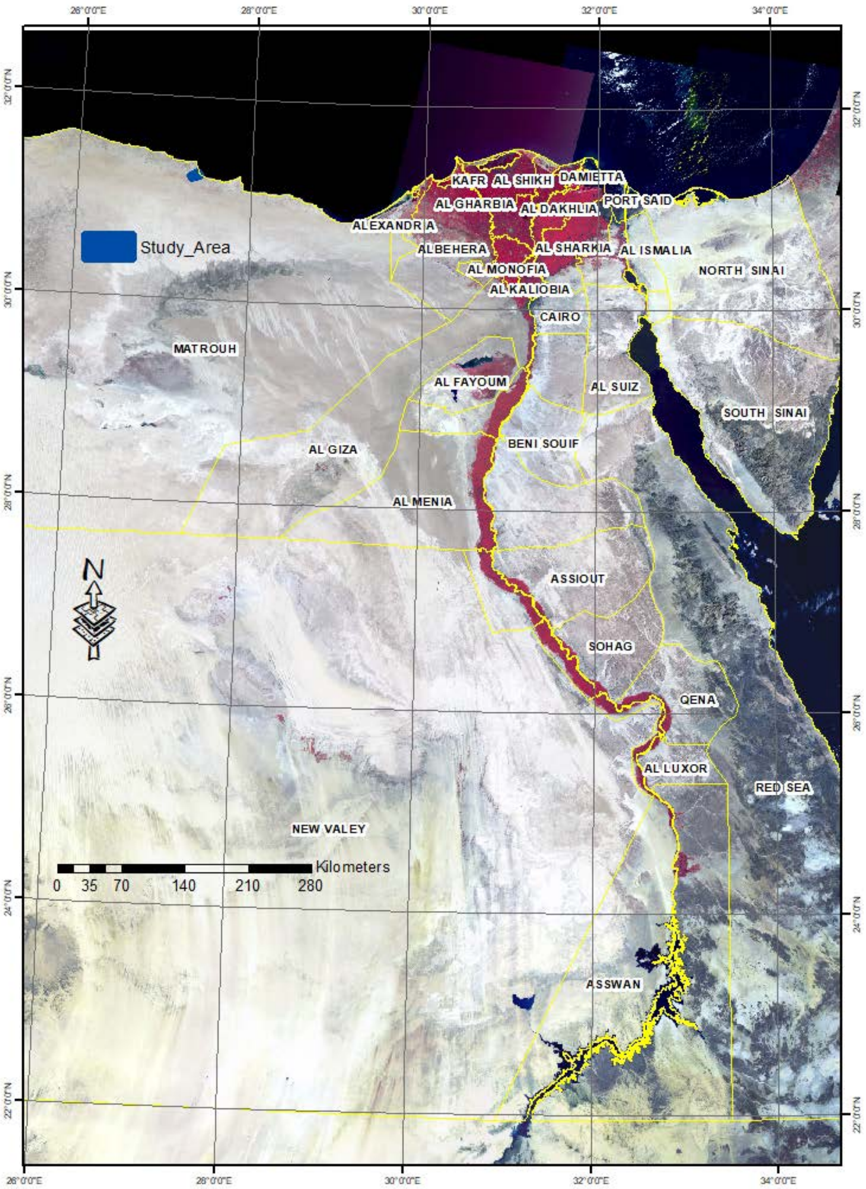
3. Software

- Geographic Information System (ArcGIS, 2016),
- The integrated land and watershed management system (ILWIS, 2009)
- The Statistical Production and Service Solutions Software (SPSS, 2008).

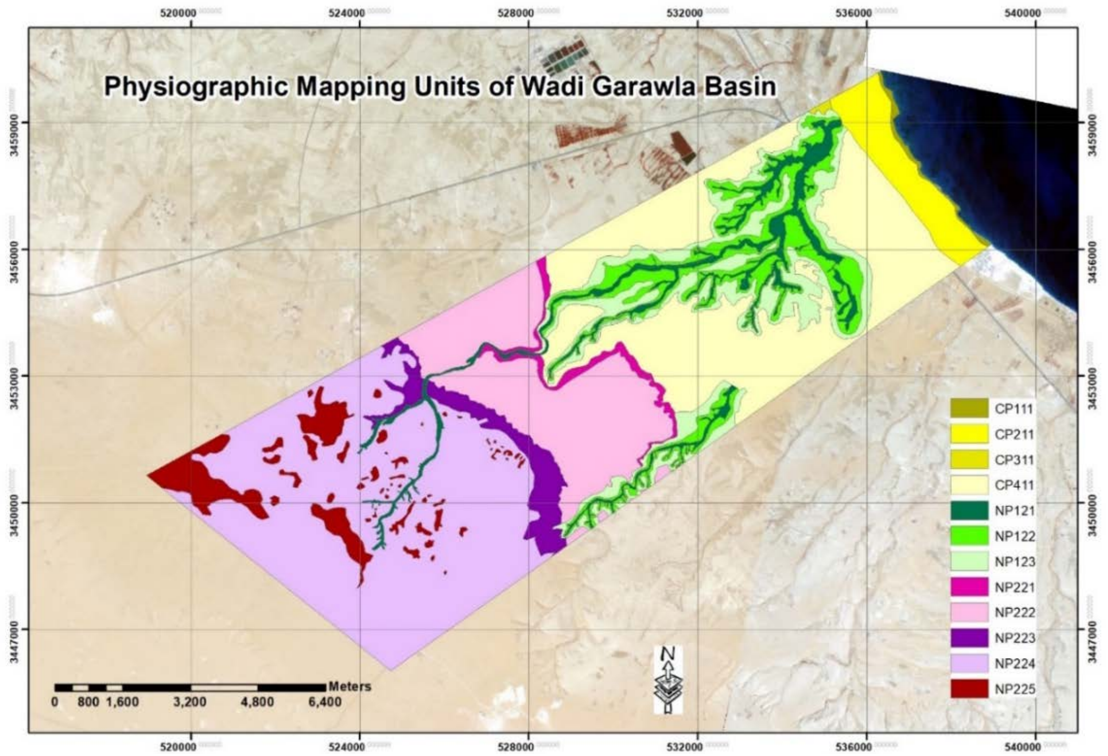
METHODS

1. Interpretation and mapping the physiographic units of Wadi Garawla area:

The physiographic units map of Wadi Garawla area (Map, 2) was created based on the photo interpretation of the Planet Scope satellite images (3-meter resolution) dated in September 2018, analyze the digital elevation model (DEM) of the topographic maps (scale: 1:25000), geological map and the field work according to Zinck (2016). The UTM WGS1984 Zone 35 north is used as maps projection system.



Map (1): The general Location of the study area



Map (2): Geographical distribution of the physiographic mapping units of Wadi Garawla area.

2. Fieldwork experimental design and EMI (Profiler EMP-400) configuration:

Three plots were determined in a dry rainfed calcareous soils (Map, 2), which are named Inner, NP121 (Fig trees), Near Outer, NP122 (dry plough soil), and Far Outer, NP123 (dry bare soil). Each plot areas were measured using EMI instrument (profile EMP-400). Only surface soil samples (0-30 cm) were collected in both irregular system (64 points) and regular system (24 points). The locations of measuring points were design in orthogonal grid of an area 54 meters X 20 meters with total number of 100 points in 4 lines and 25 rows for the selected physiographic mapping units. The measurements were collected in two modes for selected physiographic mapping unit after instrument calibration operation done. The first was in the direction of Vertical Dipole Mode (VDM) and the second was the direction of Horizontal Dipole Mode (HDM). Therefore, 200 readings were collected for each plot with 600 readings using 2 seconds of the maximum data acquisition rate. The EMI instrument (profile EMP-400) was carried using pallet on shoulder with one meter height. Three wave lengths frequencies of 13 KHz, 14 KHz, and 15 KHz were selected to collect the EMI instrument (profile EMP-400) readings. The measurement orientation of the Inner unit was started at the top left (yTLZ), the measurement orientation of the Near Outer unit was started at the left bottom (yLBZ), and the measurement orientation of the Far Outer unit was started at the top right (yRTZ).

3. Laboratory work

The surface soil samples were air dried, gently crushed, and then sieved through a 2-mm sieve. Fractions below 2 mm were subjected to chemical and physical analyses as following:

- Particle size distribution was analyzed by Hydrometer method (Richards, 1954).
- Total calcium carbonate percent was determined using Collin's Calcimeter (Nelson, 1982).
- The electrical conductivity of the saturated soil paste extract was carried out according to Rhoades (1982).

4. Study the relation between profiler readings and soil samples analyses

The correlation operation in SPSS software V.17 was used to test the relation between Profiler EMP-400 readings of each plot with its soil properties analyses (EC, SP%, $CaCO_3$%, Sand%, Silt%, and Clay%) of irregular and regular samples design. Also, the correlation operations were used to select suitable orientation VDM or HDM and irregular or regular distance of the Profiler EMP-400 readings.

5. Calibrate the Profiler EMI readings

The target of calibrated instrument readings was used to change the instrument readings from relative values to instrument readings in dS/m units. The EMI readings were calibrated using EC value measurement of the instrument calibration point in the field and the readings average of the wavelength 13KHz, 14KHz, and 15 KHz of the calibrated instrument point.

6. Correlation of original and calibrated EMI readings, with the EC values from Laboratory analyses

The correlation operation in SPSS software was used to test the relation between EMI readings of each plot with calibrated EMI readings and EC values from Laboratory analyses.

7. Calculate the sample and multi regressions formulas

The multi and sample regression operations were used to determine the suitable formula parameters for each plot used the calibrated EMI readings (13KHz, 14KHz, and 15KHz) as multi regression and calibrate EMI reading (15KHz) as sample regression. The multi linear regression model applied on this study assumes that, the surface soil salinity of the response variable $Y_{salinity}$ depends on the independent variables X_{1-n} (EMI readings of each plot).

8. Correlation comparison between lap EC values and estimated EC values

The correlation operation of SPSS software was used to calculate the correlation significant between EC values obtained from laboratory analysis and EC values estimated using calibrate EMI readings to study the goodness of using the existing simple and multi regressions formulas.

9. Study the spatial distribution of calibrate EMI readings, lab EC values and estimated EC values

The integrated land and watershed management system ILWIS 3.7 developed in ITC, (produced 2009), was used as the main software for these activities. The interpolation operation of ILWIS 3.7 software was used to create EC values obtained from laboratory analysis and estimated EC values using calibrate Profiler EMP-400 readings of each plot.

RESULTS AND DISCUSSION

Physiographic mapping units of Wadi Garawla area

The interpreted and created physiographic mapping units of Wadi Garawla area are presented in Map (2) and Table (1). In this work, three physiographic mapping units, namely inner (NP121), near outer (NP122) and far outer (NP123) of Northern Plateau valley were subjected to study the relation between soil salinity and EMI readings within these units. Figs (1 and 2) show the surface collection points of soil samples and the geographical distribution of the EMI instrument readings.

The relation between EMI readings and analyzed soil properties:

Table (2) shows the correlation of irregular distance for VDM and HDM reading with selected soil properties. The results illustrated that, the correlation between the EMI readings of irregular VDM orientation with the selected soil properties for Inner and Near Outer physiographic mapping units were highly significant at the 0.01 level (significant with 99% of the VDM EMI readings). The SP% of the Far Outer physiographic mapping unit was highly significant at the 0.05 level (significant with 95%

of the VDM profiler EMP-400 readings) and there is no significant with Clay%. In the other hand, the results of using irregular HDM readings show that, most of the correlations have no significant values with EC, SP%, $CaCO_3$%, and Clay% except with Sand%, and Silt%. Therefore, the EMI readings of VDM orientation were the most suitable to test the simple and multi regression for estimating the EC values using the EMI readings. The correlation of regular distance for VDM and HDM readings with the selected soil properties were different with using the regular VDM and HDM readings in the three physiographic mapping units. Therefore, the EMI readings of VDM orientation and irregular distance were the most suitable to estimate the EC values in the three physiographic mapping units. In addition, the results illustrated that, the measured EC values from laboratory analyses had the highest correlations at 0.01 levels with the VDM orientation and irregular distance of EMI readings in the three physiographic mapping units, spatially with the VDM readings of 15 KHz frequency. However, the correlation of the EC values gave very high significant at the 0.01 level (significant with 99% of the VDM EMI readings). Forethought this point the study were concentrated on the relation between EC values from laboratory analyses with the VDM EMI readings.

Table (1): The physiographic mapping units of Wadi Garawla area.

Landscape	**Relief**	**Lithology**	**Landform**	**code**	**Area in**	
					Fed.	**%**
Coastal Plain (CP)	Sand Beach (1)	Undifferentiated Quaternary Deposits (1)	Beach (1)	CP111	94	0.36
	Bar (2)		Bar (1)	CP211	1033	3.98
	Lagoon (3)		Swamp (1)	CP311	21	0.08
	Out Wash plain (4)		Out Wash plain (1)	CP411	5590	21.53
Northern Plateau (NP)	Coarse Valley (1)	El Hagif Formation Deposits (2)	Inner (1)	NP121	1244	4.79
			Near Outer (2)	NP122	1949	7.51
			Far Outer (3)	NP123	2210	8.51
	Plateau (2)	El Hagif Formation Deposits (2)	First Escarpment Relatively Low (1)	NP221	323	1.24
			First Table Relatively Low (2)	NP222	3544	13.65
			Second Table Relatively High (3)	NP223	816	3.14
			Second Escarpment Relatively High (4)	NP224	8005	30.83
			Rocky Area (5)	NP225	1136	4.38
Total Study area					25965	100.00

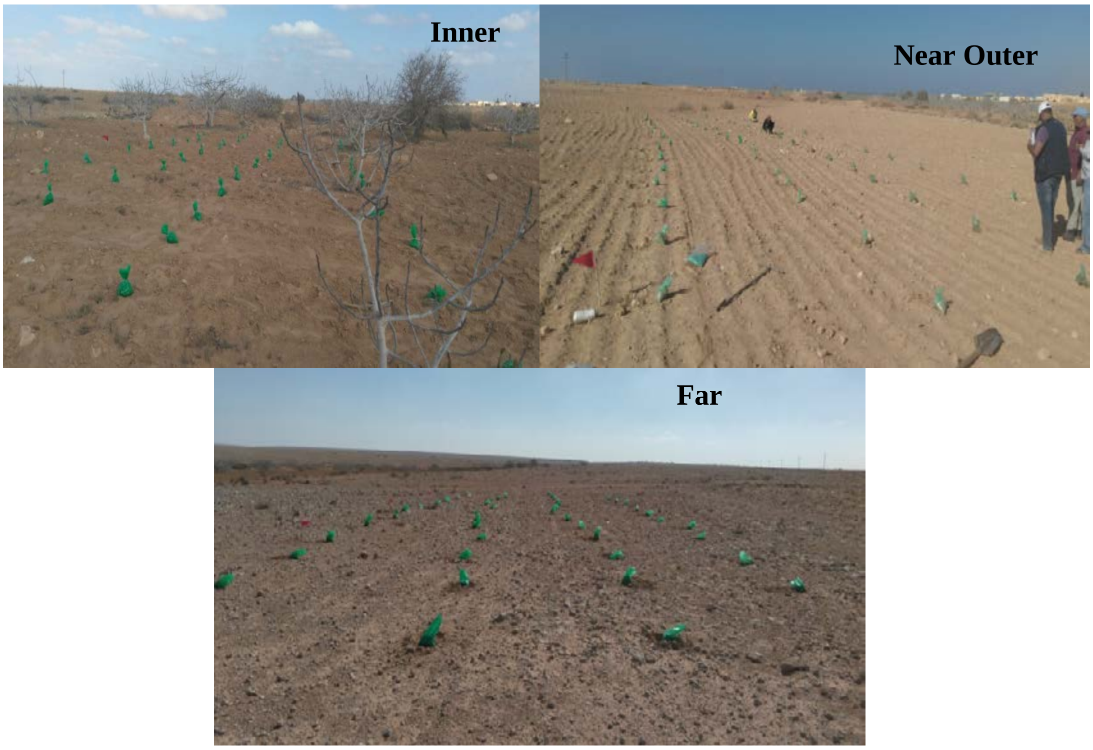


Fig (1): Surface soil samples collection pointes in wadi Garawla basin.

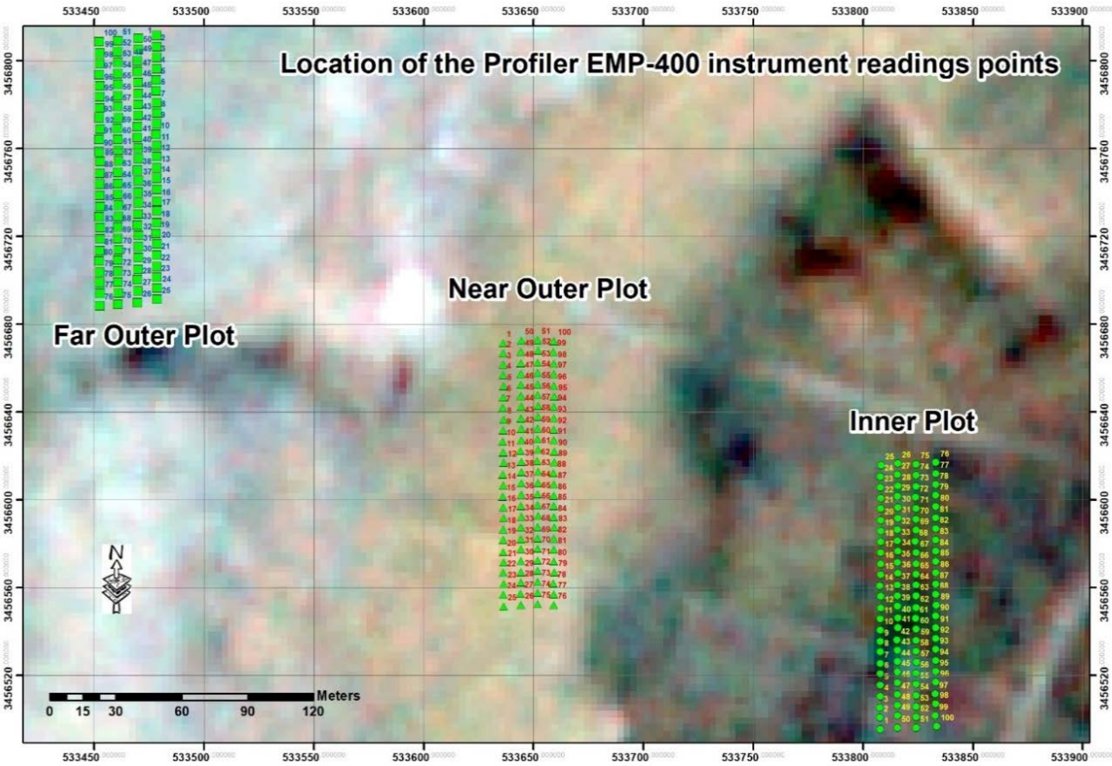


Fig (2): Geographical distribution of the EMI instrument readings points.

Table (2): The correlations of irregular and regular distance for VDM and HDM readings.

Physiographic mapping units	Soil properties	Irregular VDM readings at			Regular HDM readings at		
		13KH	14KH	15KH	13KH	14KH	15KH
Inner distance	EC Lap	0.699**	0.717**	0.865**	0.721**	0.497*	0.732**
	SP %	0.335**	0.252*	0.446**	0.207	0.067	0.408*
	$CaCO_3$%	0.354**	0.306*	0.491**	0.248	0.168	0.442*
	Sand%	-0.646**	-0.681**	-0.791**	-0.652**	-0.408*	-0.781**
	Silt%	0.645**	0.376**	0.496**	0.559**	0.393	0.378
	Clay%	0.668**	0.669**	0.747**	0.697**	0.577*	0.369*
Near Outer Irregular distance	EC Lap	0.789**	0.780**	0.840**	0.464**	0.454**	0.735**
	SP Lap	0.691**	0.664**	0.696**	0.416*	0.442*	0.427*
	$CaCO_3$%	0.608**	0.665**	0.611**	0.458*	0.479*	0.460*
	Sand%	-0.711**	-0.716**	-0.719**	-0.416**	-0.437*	-0.520**
	Silt%	0.719**	0.713**	0.709**	0.464*	0.497*	0.484*
	Clay%	0.703**	0.681**	0.677**	0.496*	0.499*	0.479*
Far Outer Irregular	EC Lap	-0.626**	-0.625**	-0.695**	-0.464**	-0.454**	-0.549
	SP Lap	0.280*	0.289*	0.277*	0.226	0.233	0.235
	$CaCO_3$%	0.354**	0.366**	0.354**	0.299	0.309	0.312
	Sand%	-0.313**	-0.305**	-0.396**	-0.30**	-0.306*	-0.498*
	Silt%	0.419**	0.402**	0.400**	0.301**	0.311*	0.402*
	Clay%	0.183	0.19	0.178	0.339**	0.330*	0.422*

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Calibrate EMI readings:

The results of the determined lap EC values were used to change the instrument readings from general value format to dS/m units. To calibrate the EMI readings using the EC values of calibrated instrument point the following formula were applied:

1- Calibration of 13 KHz readings = EC value of point calibration *readings ratio (readings of 13 KHz/average readings of 13, 14, and 15KHz of calibrated point).
2- Calibration of 14 KHz readings = EC value of point calibration*readings ratio (readings of 14 KHz/ average readings of 13, 14, and 15KHz of calibrated point).
3- Calibration of 15 KHz readings = EC value of point calibration *readings ratio (readings of 15 KHz/ average readings of 13, 14, and 15KHz of calibrated point).

Table (3) represents the correlation between collected EMI instrument readings (relative) and calibrated EMI using Profiler EMP-400 instrument readings (in dS/m values) with the determined EC values of soil sample analyses. The results of correlation show that, there is a highly significant at the 0.01 level with 99% between the VDM EMI readings and calibrated instrument readings with the lab determined EC values of the three physiographic mapping units, spatially with the VDM readings at 15 KHz frequency.

Table (3): The correlation between instrument and calibration readings with lab EC values.

Soil unit	Correlation	CR13KHz	CR14KHz	CR15KHz	Lab EC
Inner	R13KHz	0.812**	0.725**	0.797**	0.830**
	R14KHz	0.725**	1.000**	0.837**	0.888**
	R15KHz	0.797**	0.837**	0.988**	1.000**
Near Outer	R13KHz	1.000**	0.905**	0.890**	0.689**
	R14KHz	0.905**	1.000**	0.939**	0.780**
	R15KHz	0.890**	0.939**	1.000**	0.811**
Far Outer	R13KHz	1.000**	0.990**	0.899**	0.895**
	R14KHz	0.990**	1.000**	0.991**	0.898**
	R15KHz	0.899**	0.991**	1.000**	0.995**

** Correlation is significant at the 0.01 level (2-tailed).
R13KHz and CR13KHz: instrument readings and calibration of frequency 13KHz.
R14KHz and CR14KHz: instrument readings and calibration of frequency 14KHz.
R15KHz and CR15KHz: instrument readings and calibration of frequency 15KHz.
Lab EC: Determined EC values of soil sample analyses in the laboratory.

Calculation the multi regression formula

The results of ANOVA operation illustrated that, the correlations were very high between the Lab EC values with calibrated EMI readings using 13, 14, and 15 KHz frequencies of Inner, Near Outer, and Far Outer mapping units. Table (4) shows the ANOVA (analyses of variances) between the lab EC values with calibrated EMI readings of the three mapping units. Based on the results of ANOVA, three multi linear regressions were applied for Inner, Near Outer and Far Outer mapping units. Formula 1, 2, and 3 represent the multi regression formula of the three physiographic mapping units using calibration instrument readings of frequencies 13KHz, 14KHz, and 15KHz. Formula 4, 5, and 6 represent the simple regression formula of the three physiographic mapping units using calibration of frequency 15KHz. The applied formulas were done as following:

EC estimated all (1) = 0.67 + (0.015*CR13KHz) + (-0.12*CR14KHz) + (0.55*CR15KHz). Inner

EC estimated all (2) = -1.727 + (-0.206*CR13KHz) + (0.702*CR14KHz) + (0.242*CR15KHz). Near Outer

EC estimated all (3) = 0.363 + (-0.502*CR13KHz) + (0.343*CR14KHz) + (0.506*CR15KHz). Far Outer

EC estimated with 15KHz (4) = 0.64 + (0.0.48* CR15KHz). Inner

EC estimated with 15KHz (5) = -0.859 + (0.959* CR15KHz). Near Outer

EC estimated with 15KHz (6) = 1.17 + (0.833* CR15KHz). Far Outer

The correlation between lab EC values and estimated EC values:

Table (5) shows the correlations between the multi and simple estimated EC values with the EC values of the surface soil samples in the three mapping units (Inner, Near Outer and Far Outer). The results showed that, there was an increase in the significance of the relationship between the determined soil salinity in laboratory and the estimated EC values using calibrated instrument readings of VDM EMI measurements (at 13, 14, and 15 KHz). The highest relationship was found when using the calibrated 15 KHz readings in the three mapping units. Only small changes were observed in the relationship of the Near Outer mapping unit for the VDM EMI measurements (at 13, 14, and 15 KHz).

Table (4): The correlation between the lab EC values and calibrated Profiler EMI readings.

Soil unit	Frequency*	ANOVA	Sum of Squares	df	Mean Square	F	Sig.
Inner	CR13KHz	Between Groups	435.083	26	16.734	8.351E+32	.000
		Within Groups	7.414E-31	37	2.004E-32		
		Total	435.083	63			
	CR14KHz	Between Groups	412.469	26	15.864	476.437	.000
		Within Groups	1.232	37	.033		
		Total	413.701	63			
	CR15KHz	Between Groups	435.371	26	16.745	1.291E+33	.000
		Within Groups	4.798E-31	37	1.297E-32		
		Total	435.371	63			
Near Outer	CR13KHz	Between Groups	4306.219	58	74.245	10.608	.003
		Within Groups	34.993	5	6.999		
		Total	4341.212	63			
	CR14KHz	Between Groups	5260.667	58	90.701	12.960	.002
		Within Groups	34.993	5	6.999		
		Total	5295.660	63			
	Cr15KHz	Between Groups	4604.177	58	79.382	17.014	.001
		Within Groups	23.329	5	4.666		
		Total	4627.506	63			
Far Outer	CR13KHz	Between Groups	435.083	26	16.734	8.351E+32	.000
		Within Groups	7.414E-31	37	2.004E-32		
		Total	435.083	63			
	CR14KHz	Between Groups	412.469	26	15.864	476.437	.000
		Within Groups	1.232	37	.033		
		Total	413.701	63			
	CR15KHz	Between Groups	435.371	26	16.745	1.291E+33	.000
		Within Groups	4.798E-31	37	1.297E-32		
		Total	435.371	63			

* CR13KHz, CR14KHz and CR15KHz: calibration instrument readings of frequencies 13KHz, 14KHz, and 15KHz.

Table (5): Pearson correlation between lab EC with estimated EC values of multi and sample regression using calibrated EMI readings.

soil unit	Pearson Correlations	Lab EC[1]	EC estallc[2]	EC est15CKHz[3]
Inner	EC lap	1	.989**	1.000**
	EC estallc	.989**	1	.989**
	ECest15CKHz	1.000**	.989**	1
Near Outer	EC lap	1	.799**	.851**
	EC estallc	.799**	1	.957**
	ECest15CKHz	.851**	.957**	1
Far Outer	EC lap	1	.995**	.998**
	EC estallc	.995**	1	.999**
	ECest15CKHz	.998**	.999**	1

** Correlation is significant at the 0.01 level (2-tailed).
Lab EC[1]: Determined EC values of soil samples in the laboratory.
EC estallc[2]: Estimated EC values using all calibration instrument readings at frequencies 13KHz,14KHz, and 15KHz.
EC est15CKHz[3]: Estimated EC values using calibration instrument readings at frequency 15KHz.

Create the spatial distribution of calibrated EMI readings, lab EC values and estimated EC values (multi and simple regression):

The capability of interpolation operation of ILWIS 3.7 software were used to create the maps of lap EC values, calibrated EMI readings, and estimated EC values (multi and simple regression) of the Inner, Near Outer, and Far Outer mapping units (Table, 6). The results of the geographical distribution of soil salinity showed that, there is a direct relationship between the determined salinity in laboratory analyses and the soil salinity results resulting from the use of mathematical simple and multi equations of three physiographic mapping units. The results also showed that, the use of calibrated instrument readings of VDM EMI measurements (at 13, 14, and 15 KHz) values gave clearer details of the salinity distribution in the soil, especially with using the calibrated 15 KHz readings in the three mapping units. Table (7) showed the minimum, maximum, mean, median, predominate, and stander Deviation of the interpolated soil salinity maps. Table (7) showed that, the use of the calibrated 15 KHz reading values gave the lowest standard deviation. This confirms that, using the frequency wave 15 KHz is the most appropriate readings to produce the values of soil salinity that are not present.

Conclusions

Through this study, it could be recommended to use the EMI instrument readings to produce soil salinity in an easy, inexpensive and time-bound way. Measurements can also be repeated for monitoring the differences in soil salinity degrees at intervals of time as needed. Also, the derivation of mathematical equations, multiple or simple regression, contributed to the salinity maps production in easily and high accuracy in short time, as their significance increased than the produced soil salinity from the laboratory analysis. However, this should do under the same environmental conditions in which the measurement was carried out, such as soil type, texture and humidity levels. It remains for us to test these mathematical equations using the instrument measurements for two areas in same environmental conditions to measure and collect surface samples about 50% of the readings and for the second area without surface samples only collect the surface sample of instrument calibration point.

Table (6): Geographical distribution of soil salinity maps using lab EC values and estimated EC values from Multi and simple regressions of the three physiographic mapping unit.

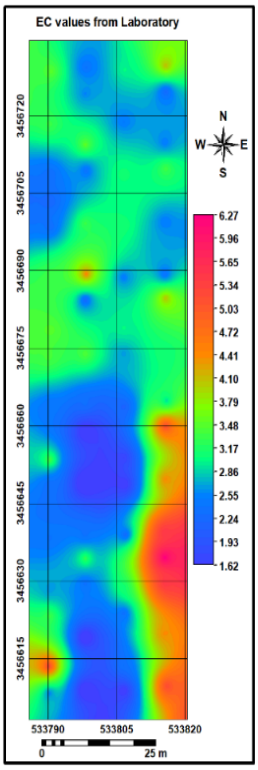
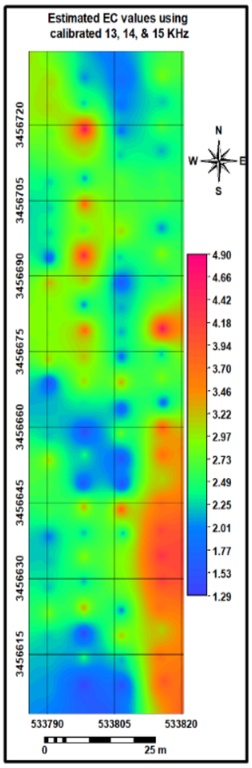
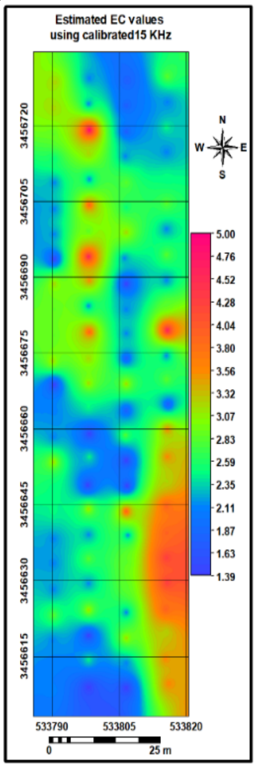
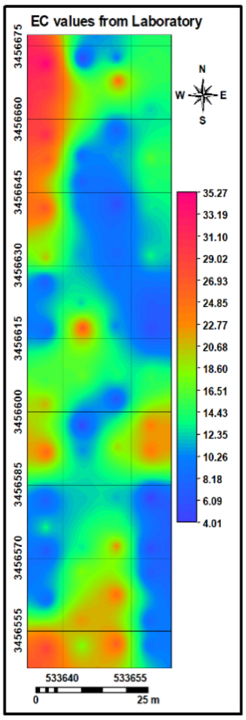
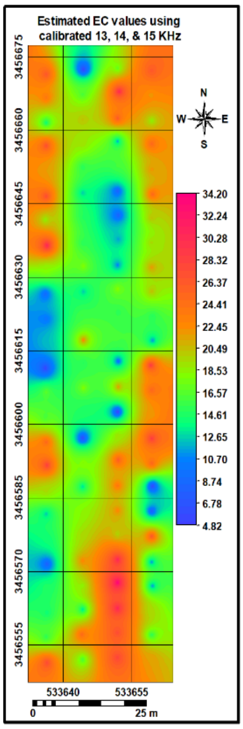
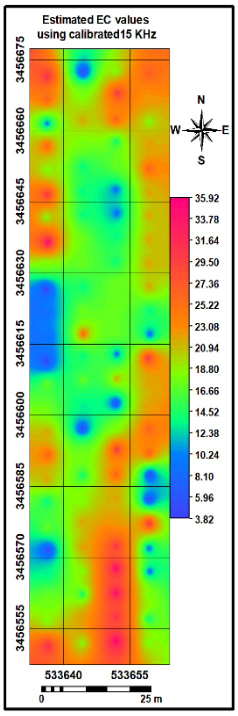
<table>
<tr><th>Physiographic Mapping Units</th><th>Lab EC values</th><th>Estimated EC values at 13, 14, & 15 KHz</th><th>Estimated EC values at 15 KHz</th></tr>
<tr><td>Inner</td><td></td><td></td><td></td></tr>
<tr><td>Near Outer</td><td></td><td></td><td></td></tr>
</table>

Table (6): Cont.

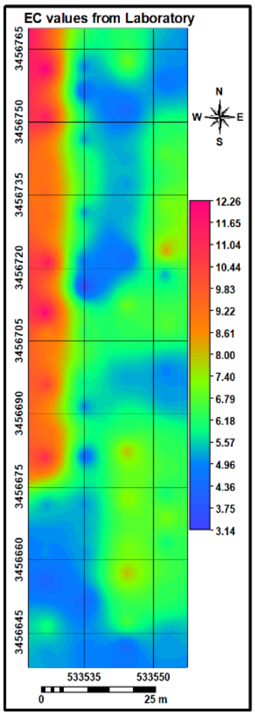
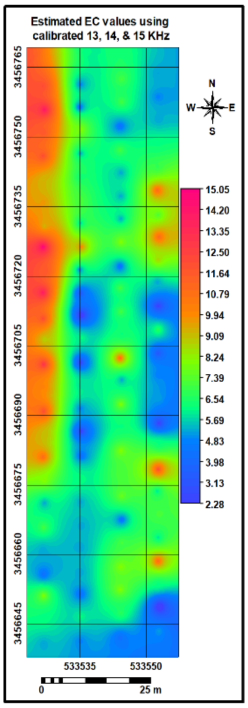
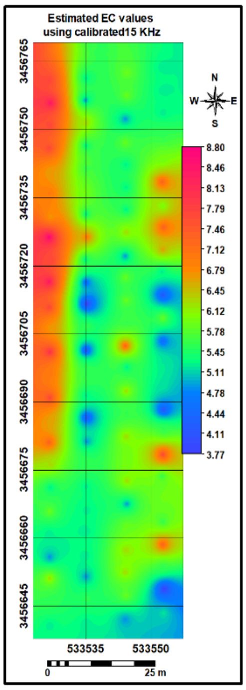
Physiographic Mapping Units	Lab EC values	Estimated EC values at 13, 14, & 15 KHz	Estimated EC values at 15 KHz
Far Outer			

Table (7): Minimum, maximum, mean, median, predominate, and Stander Deviation of the interpolated soil salinity maps.

Mapping unit	Estimated EC	Min.	Max.	Mean	Median	Predominate	Sta Dev.
Inner	Laboratory	1.62	6.27	3.00	2.89	2.68	0.78
	Calibrated 13, 14, 15 KHz	1.29	4.90	2.65	2.58	2.90	0.48
	Calibrated 15 KHz	1.39	5.00	2.63	2.54	2.46	0.39
Near Outer	Laboratory	4.01	35.27	14.77	13.48	12.52	5.31
	Calibrated 13, 14, 15 KHz	4.82	34.20	18.56	18.56	15.77	3.86
	Calibrated 15 KHz	3.82	35.92	18.94	18.74	17.22	2.48
Far Outer	Laboratory	3.14	12.26	6.46	6.09	5.27	1.35
	Calibrated 13, 14, 15 KHz	2.28	15.05	6.88	6.30	5.37	1.89
	Calibrated 15 KHz	3.77	8.80	5.84	5.62	5.26	0.69

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تقدير ملوحة التربة في بعض الوحدات الفيزيوجرافية لوادي جراولة، مطروح، مصر باستخدام الحث الكهرومغناطيسي

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وحدة الاستشعار عن بعد ونظم المعلومات الجغرافية – معهد بحوث الأراضي والمياه والبيئة

الملخص العربي

أدت الزيادات السريعة في ملوحة التربة في الأراضي الجافة إلى مزيد من الممارسات العديدة للصيانة وتحسين الحقول المتدهورة والحفاظ عليها، وتستغرق عملية مسح التربة وقتًا طويلاً ومكلفة، لذلك أصبحت تقنيات الاستشعار عن بعد الجديدة مهمة لرصد وتقدير ملوحة التربة بسرعة وسهولة بدون تكاليف عالية، كما يمكن تكرارها في أي وقت، ويستخدم جهاز الحث الكهرومغناطيسي (EMI) لتقدير ملوحة التربة بتقنية سهلة وسريعة، وتعتمد قراءات جهاز الحث الكهرومغناطيسي (EMI) التي تتم قياسها لتقدير ملوحة التربة على القيمة النسبية لنقطة معايرة الجهاز، ولذلك تحتاج القراءات إلى التحويل الى قيم مطلقة لملوحة التربة بوحدات ديسيسيمنز/المتر.

تهدف هذه الدراسة إلى إنشاء ورسم وحدات الخرائط الفيزيوجرافية لمنطقة وادي جراولة، مطروح، مصر لاختبار التوزيع المكاني لملوحة التربة باستخدام قراءات جهاز الحث الكهرومغناطيسي (EMI) بعد المعايرة، وقيم ملوحة التربة المقدرة في معمل التحليل.

كانت نتائج قراءات جهاز الحث الكهرومغناطيسي (EMI) باستخدام اتجاه VDM مع قيم ملوحة التربة الناتجة من التحليلات المعملية هي الأنسب لتقدير قيم ملوحة التربة لدراسة الانحدارات الإحصائية، واستنباط قيمتها باستخدام المعادلات المتعددة والبسيطة لقراءات جهاز الحث الكهرومغناطيسي المعايرة، ولقد أظهرت نتائج الارتباط وجود زيادة في دلالة العلاقة بين ملوحة التربة المقدرة معملياً مع قيم ملوحة التربة المقدرة باستخدام قراءات جهاز الحث الكهرومغناطيسي (EMI) المعايرة (عند ١٣، ١٤، ١٥ كيلو هرتز) باستخدام اتجاه VDM، ولقد أوضح التحليل الإحصائي الوصفي للخرائط المنتجة أن استخدام قيم معايرة عند ١٥ كيلوهرتز أعطت أدنى انحراف معياري، مما يؤكد أنها أنسب القراءات لتقدير خرائط قيم ملوحة التربة.