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ASSESSMENT OF SOIL DEGRADATION IN NORTHWEST NILE DELTA, A CASE STUDY: EL-BOUSILY DISTRICT

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ABSTRACT

The objective of the current research is to assess soil degradation in northwest Nile Delta, at Edfina governmental farm, El-Bousily region, using linkage between SALTMOD simulation model and spatiotemperol variability.

The soil salinity (EC dS/m) ranged from (2.62 to 16.40), (4.68 to 18.60) dS/m and (8.60 to 24.80) dS/m in current time (year 2000), predicted time (year 2005) and predicted time (year 2010), respectively. A coefficient of variance (CV) of soil salinity was 0.46, 0.36 and 0.27 for current and predicted times. These values illustrated the extent of heterogeneity. C.V. values decreased with time according order: current time (year 2000) > predicted time (year 2005) > predicted time (year2010). The water table level ranged from (65 to 118) cm, (40 to 105) cm, and (15 to 85) cm in current time (year 2000), predicted times (year 2005) and (year 2010), respectively. The mean and median values decreased with predicted time, while the variance and C.V. values increased with predicted time. Water table depth became closer to the surface indicating waterlogging to occur in the future.

Soil salinity fitted exponential model in current data. While, it fitted gaussian model in predicted data. Data reveal that the nugget variance values of EC increased with time. Its values were (0.60, 1.75 and 2.20 m) for current and predicted data, respectively. This trend indicates their strong spatial dependence and high-inherited variability with change time. The sill variance that illustrated the structural variance values of EC were (15.00, 16.85 and 17.79 m) for current and predicted data, respectively. The range values show that maximum interpolation distances for soil salinity were (588, 826 and 737 m) in current time and predicted times (2005 and 2010). Depth of water table was fitted to gaussian model. Data indicated that water table depth has highest nugget variance (32.2, 47.3 and 103.0 m) which indicates their strong spatial dependence and high-inherited variability. The sill variances of depth of water table (199.4, 255.6 and 379.6 m), for current and predicted times, respectively. The results of range which illustrated spatial dependence over specific lag distance show that maximum interpolations for depth of water table were (1016, 984 and 1481 m) for current and predicted time, respectively.

Salinity levels and water table depth shifted from average data (7.86 dS/m, 84 cm) at present to (9.93 dS/m and 65 cm) after 5 years and (14.10 dS/m and 45 cm) after 10 years. The dominant area of soil salinity values are in current time (4-7 dS/m) which represent (74.32 %) from total study area. While its values in prediction year 2005 are (9-14 dS/m) represent (83.46%) and in prediction (year 2010) from (16-24.90 dS/m) which represent (88%) from total study area. The dominant area of water table level values are in current time (65-85 cm), which represent (86.25%) from total study area. While its values in prediction year 2005 are (40-70 cm) which represent (91.62%) and in prediction year 2010 from (15-55 cm) which represent (94.8%) from total study area.

The Edifina farm, El-Bosuily is covered by soils displaying evident of gley soil. The occurrence and illustration of gleysols are influenced by many environmental factors, but the drainage condition is the most important one. It reflects the importance of water table level in pedogenesis through the exclusion of air (oxygen) and the

prevailing of reduction process, and consequently the development of gley phenomenon.
Key words: Soil degradation, North West Delta, Soil salinity, water table, Kriging, Simulation.

INTRODUCTION

Soil degradation is a major global issue because of its adverse impact on agricultural productivity and sustainability. It undermines the resource base by decreasing soil quality. The term " soil degradation" is used to describe short-to-medium term soil deterioration caused by different forms of land use. The major problem in the Egyptian soils in the last two decades to the rising of soil salinity, due to the elimination of soil leaching by Nile floods after the construction of the High Dam (1964-1969).

When the natural underground drainage of irrigated land in semi- arid regions is insufficient to leach the salts are brought in with the irrigation water, the land can be affected by twin problems of a shallow water table and high soil salinity. Not long ago, it was estimated that, worldwide, 52 million ha of irrigated land needed improved drainage systems (United Nations 1977).The total agriculture land of Egypt is about 7.8 million feddans, which is almost entirely dependent on irrigation. In brief, 2 million feddans in Egypt suffer from salinization problem. Sixty percent of cultivated lands of northern Delta region are salt affected, while twenty percent of the southern Delta and Middle region and twenty five percent of the soils of upper Egypt region are salt affected.

The Nile Delta is considered to be the most intensively cultivated area in Egypt. The fertile land, along the 50 km wide strip in northern part of the Nile Delta, is producing considerable yield of rice, wheat, maize and cotton. Most of the Delta terrain's elevation is less than 2 m above sea level, and a 1 to 2 km wide coastal sand belt serves as the only protection from sea word flooding (Said, 1962). The Nile Delta northern coastline, extending from the western borders of the Alexandria City to the eastern side of Port Foad City, is presently in a state of continuous struggle against the violent action of the Mediterranean waves and current. This erosion has resulted in the loss of some resort beaches, apparent flooding of coastal village, blocking of estuaries and navigation channels by accreting sediment, salt water intrusion into agriculture areas and possible encroachment on coastal lakes (SPA, 1985). Rasool (1988) stated that sea level rise due to thermal expansion of the oceans and melting ice may accelerate the coastal degradation in the Nile Delta as well as in other Deltas of the earth.

Spatial variations of soil properties tend to be correlated over space. Geostatics provide a tool for optimal unbasied estimation of the properties at unsampled location. Geostatistical analysis of spatial variability has been widely applied in soil science (Warrick et al., 1986). However, semi-variogram is considered the central tool of geostatistics. It depends only on the distance and direction that separate two places (Oliver and Webster, 1991). Kriging is the best local interpolation technique because it provides best liner unbiased estimates, and accounts for clustering when weighing surrounding data points.

Computational methods which make it possible to predict soil and water salinities and water table depth in agricultural land under different geo-hydrological conditions and varying water-management scenarios were developed. Oosterbaan and Abu Senna (1989) used the SALTMOD simulation model, after calibration, to simulate the impact of alternative water-management options (e.g. different drain depths) on irrigation, soil and ground water salinity, and depth of water table in a pilot area in the Nile Delta. Their results showed that drain depth of 1.0 m is acceptable for not increasing soil salinity and increasing field irrigation efficiencies. Ramadan (1997) used the SALTMOD simulation model to predict the best drain depth that reduces soil salinity and water table levels at three farms in the Nile Delta and Nubaria areas. The farms were mainly characterized with shallow (0.2m), moderate (0.6 to 0.9m), and moderate to deep (0.9 to 1.2m) water table levels. Results indicated that increasing drain depth twice its actual depth reduced soil salinity by more than 50% and increased water table depth three times of its original depth.

The coupling of the spatial data handling capabilities with simulation models offers the advantage of utilizing information content of spatially distributed data to analyze solute transport on a field scale in three dimensions, (Tim, 1996).

The objective of the current research is to assess soil degradation in northwest Nile Delta, at Edfina governmental farm, El-Bousily region using linkage between SALTMOD model and spatiotemperol variability.

AREA STUDIED

The formation of the Nile Delta had passed through two stages. During the first stage, a part of the Nile Delta had been formed and occupied the old Pleiocene bay. During the following second stage, and through the continuous discharge of the sediment load, the Northern lakes began to appear (Ball, 1939). Two main landforms have been distinguished the northern Nile Delta: the fluvio-marine flats and the coastal barrier plain and beaches. The fluviomarine flats are influenced by both the Nile and sea forming the natural extension of Delta`s clay top-set beds. Within this layer, different strata, namely young, old, and very old clay, have been recognized but their ages are unknown (FAO/SF, 1964). The soil around lake Idkuo (open with sea) is considered fluvio-marine flats (FAO/SF, 1964). Parts of the lake were dried and clay deposits of the lake floor could be observed at El-Bousaily village. The area varies in elevation and it may be distinguished into two main parts namely: the flat area and the high grounds. The flat areas are at maximum of about 2 meters above sea level and extend parallel to the seacoast and the low flood plain of Nile Rosetta branch and the ground Lake Idku. The second parts include the areas, which are characterized by sand accumulations and extend in north-west to south east directions. It varies in height from 5 to 10 meters above sea level with maximum of 20 meters in some scattered areas (El- Fayoumy 1974), (Map1).

Map (1): Location of studied area

MATERIALS AND METHODS

Field work:

The studied area is located at Edfina governmental farm (465 faddan), El-Bousily center to represent the Northwest Nile Delta. The soil profile of study area is characterized by the presence of heavy clay along the profile. Its main problem was inefficient drainage system that helped to build up a shallow water table and salt accumulation by capillary rise. The main cropping system is wheat, clover, barely, corn, rice and citrus trees. Forty nine soil samples were collected from surface layer (0-30 cm), in winter season 2000 according to grid systematic design (200 m x 400 m). The fluctuation of water table level measurements was done forty-eight hours after irrigation according to the same soil samples system, (Map 2).

Map (2): Location of soil observation sites at Edfina governmental farm, El-Bousily

Laboratory analysis:

The soil samples were air dried and gently crushed with a wooden pestle, sieved through 2 mm sieves, then stored for analysis. Electrical conductivity of soil saturation paste extract was determined (Page et al*.,* 1982).

Simulation of soil salinity and water table level using SATMOD model:

Soil salinity in the root-zoon and water table level for five and ten years were predicted using SALTMOD software (Oosterbaan, 1994). The input to the model include the salinity of the root-zone, the salinity of irrigation water, water table depth, the amount of water added, and the drainable porosity.

Soil variability:

Descriptive statistical parameters:

Minimum, maximum, mean, standard deviation, median, variance and coefficient of variance were calculated using SAS software (1985).

Geostatistical analysis:

Semi-variogram model:

The semi-variogram is the heartbeat of geostatistices. It is the basis for modeling the data set and for drawing contour maps. This function relates the similarity or difference, expressed as the semi-variance, between values at different places to their separation in both distance and direction. The semi-variance is defined as follows:

$$\gamma(h) = \tfrac{1}{2} \text{Var.} [Z(x) - Z(x + h)]$$

Where; Z (x) and Z (x + h) are the values of a random function representing the soil property of interest, Z, at places x and x + h separated by the vector h known as the lag, and Var. is the variance. The obtained semi-variance values for each lag were fitted to one of the semi-variogram functions using the GSPLUS geostatistical analysis software, Gamma Design (1990).

Fig (1): Typical variogram model and its parameters (adopted from Warrick et al., 1986).

γ : is the semi-variogram, Co: is the nugget variance,
Co+C : is the sill variance, A : is the range distance,
and h : is the lag distance.

The nugget (Co) is the semi-variance values due to short scale or inherited variability. The range (Ao) is the distance at which there is no spatial dependence among the samples, and within it interpolation is worth. The sill (Co+C) is the plateau (constant value) that the semi-variogram reaches (Issaka and Srivastava, 1989).

Kriging :

Kriging is a method of interpolation using the weighted local averaging. It is optimal in a sense that the weights are chosen to give unbiased estimates while keeping the estimation variance at minimum (Webster, 1985). Kriging maps were exported to Surfer software for final output (Golden Software Inc., 1990).

Coupling between SALTMOD and kriging:

The data obtained from SALTOMD was linked with surfer for kriging maps show the spatial and temporal distribution for interpolation of soil salinity and water table level.

RESULTS AND DISCUSSION

Descriptive statistical analysis:

Table (1) shows the summery statistics of the current and predicted time for soil salinity and water table level.

The soil salinity (EC dS/m) ranged from (2.62 to 16.40), (4.68 to 18.60) and (8.60 to 24.80) dS/m in year 2000, predicted year 2005 and predicated year 2010, respectively. The mean, variance and median values of soil salinity increased with simulated results. A coefficient of variance (CV) of soil salinity were 0.46, 0.36 and 0.27 for current and predicted times. These values illustrated the extent of heterogeneity. C.V. values decreased with time according to order: current time (year 2000) > predicted time (year 2005) > predicted time (year 2010). The reason of this trend is due to the suffer of area study from high soil salinity at present and in future.

The water table level ranged from (65 to 118) cm, (40 to 105) cm, and (15 to 85) cm in current time (year 2000), predicted time (year 2005) and predicted time (year 2010), respectively. The mean and median values decreased with predicted time, while the variance and C.V. values increased with predicted time. Water table depth became closer to the surface indicating waterlogging to occur in the future. This trend of deterioration is mainly due to the mal-maintenance of drainage system and soil management.

Table (1): Descriptive statistical analysis of soil salinity (EC dS/m) and water table depth (cm) at current and predicted time.

Properties	Current time (year 2000)		Predicted time (year 2005)		Predicted time (year 2010)	
	EC (dS/m)	WT (cm)	EC (dS/m)	WT (cm)	EC (dS/m)	WT (cm)
Minimum	2.62	65.00	4.68	40.00	8.60	15.00
Maximum	16.40	118.00	18.60	105.00	24.86	85.00
Range	13.78	53.00	13.92	65.00	16.20	70.00
Mean	7.86	83.79	9.93	66.12	14.04	45.69
Variance	12.88	184.12	12.88	231.69	14.53	306.22
St.devision	3.59	13.57	3.59	5.22	3.81	17.49
C.V.	0.46	0.16	0.36	0.23	0.27	0.38
Median	7.50	78.00	9.86	63.00	13.60	42.0

Geostatistical analysis:

Table (2) and Figs (2 & 3) show that the parameters of the semivariogram model for soil salinity (EC dS/m) and water table depth (cm).

Soil salinity fitted exponential model in current data. While, it fitted gaussian model in predicted data. Data reveal that the nugget variance values of EC increased with time. Its value were (0.60, 1.75 and 2.20 m) for current and predicted data, respectively. This trend indicates their strong spatial dependence and high-inherited variability with change in time. The sill variance that illustrated the structural variance values of EC was (15.00, 16.85 and 17.79 m) for current and predicted data, respectively. The result of nugget variance and structural variance values of soil salinity means that the predicted data year (2005 and 2010) are highly affected with fluctuation of high water table level. The range values show that maximum interpolation distance for soil salinity were (588, 826 and 737 m) in year 2000, predicted times year (2005 and 2010).

Depth of water table fitted to gaussian model. Data indicated that water table depth has highest nugget variance (32.2, 47.3 and 103.0 m) which indicates their strong spatial dependence and high-inherited variability (Warrick, et al., 1986). The sill variance of depth of water table are (199.4, 255.6 and 379.6 m), for current and predicted times, respectively. The results of range which illustrated spatial dependence over specific lag distance show that maximum interpolation for depth of water table are (1016, 984 and 1481 m) for current and predicted time, respectively. These distances are the ideal for showing the variability and shoud be considered in any further for these properties in the area under consideration.

Table (2): Semivariogram parameters: nugget (co), sill (co+c), range (Ao) and model type of soil salinity and water table depth in current and predicted time.

Properties	Model	Co	Co+C	Ao	R^2
Current Time (Year 2000)					
EC (Ds/m)	Exponential	0.60	15.00	588	0.92
WT (cm)	Gaussian	32.2	199.40	1016	0.91
Predicted Time (Year 2005)					
EC (dS/m)	Gaussian	1.75	16.85	826	0.93
WT (cm)	Gaussian	47.30	255.60	984	0.91
Predicted Time (Year 2010)					
EC (dS/m)	Gaussian	2.20	17.79	737	0.93
WT (cm)	Gaussian	103	379.6	1481	0.89

Coupling between kriging and SALTMOD:

The kriging maps and three dimensions (3D) which show the spatial and temporal variability of soil salinity and water table depth in current time (year 2000), predicted times (year 2005 and 2010). The output showed a general trend of soil degradation in both soil salinity and water table depth, Maps (3 & 4) and Figs (4 & 5). Salinity levels and water table depth were shifted from average data (7.86 dS/m, 84.00 cm) for current data to (9.93 dS/m and 65 cm) after 5 years and (14.10 dS/m and 45 cm) after 10 years. The dominant area of soil salinity values was in current time (4-7 dS/m) which represent (74.32 %) from total study area. While its values in prediction time (year 2005) were (9-14 dS/m) which represent (83.46%) and in prediction (year 2010) from (16-24.90 dS/m) which represent (88%) from total study area. The dominant area of water table level values was in current time (65-85 cm) represent (86.25%) from total study area. While its values in prediction time (year 2005) were (40-70 cm) represent (91.62%) and in predication (year 2010) from (15-55 cm) represent (94.8%) from total study area.

The Edifina farm, El-Bousily is covered by soils displaying evident of gley soil. The occurrence and illustration of gleysols are influenced by many environmental factors, but the drainage condition is the most important one.

fig2

fig3

map3

fig4

map4

fig5

It reflects the importance of water table level in pedogenesis through the exclusion of air (oxygen) and the prevailing of reduction process, and consequently the development of gley phenomenon.

The water table depth in these soils is usually subjected to seasonal fluctuations. This means that during, at least, part of the year the soil is free of the saturated conditions and oxidation process can proceed. During a part of the year however, the soil environment is in a state of chemical reduction. This situation normally leads to development of a mottled coloration, (Gewaifel, 1976).

It might be recommended to built a hydrostatic head on the Northern Nile Delta fringes to reduce or retard the progress of the sea salt water-front under the northern and middle Nile Delta land. This could be achieved through the winter storage of drainage water plus the extra winter Nile water used for both navigation and electrical power production, in the Northern Nile delta lackes. This also would reduce the pollutions of the Northern lakes. The hydrostatic head could be maintained in summer by the rice ponded water, which is necessary to leach the excess soil salinity of the Northern Nile Delta region. An efficient drainage system (channels and pump stations) in this areas is necessary for sustainable agriculture production (El-Attar, 1997).

REFERENCES

Ball, J. (1939). Contribution to the Geography of Egypt. Survey Dept., Cairo Gover, Press.

El-Attar, H. (1997). Land Reclamation in Egypt: Past, Present and Future. In: Abdel-Ghaffar, S., *etal.* 1997, “Integrated Land Development of Southern Egypt: Available Resources and Alternative Options” Proceedins of a workshop held in Alexandria, December, 1997.

El-Fayoumy, I.F. (1974). Geomorphology of Coastal Areas Between Abu-Qir and Rasheed (North West at the Nile Delta, E.A.R) Bull. Fac. Sci., Mamsoura Univ., 2:136-148.

FAO/SF, (1964). High Dam Soil Survey, U.A.R., United National Development Program, FAO, Rome.

Gamma Design, (1992). GSPLUS (GS+): Geostatistical for the Biological Science Version 1.2. User`s Manual. Plainwell, MI, USA.

Gewaifel, I.M. (1976). Morphological and Ped-Genetical Relationships of Some Egyptian Gleysols, as Related to Drainage Conditions. Alex. J. Agric. Res., 24 (3): 677-682.

Golden Software Inc. (1990). Surfer user`s manual, version 5, Richmond, VI, USA.

Issaka, E.D. and R.M. Srivastava (1989). An Introduction To Applied Geostatistics. Oxford University Press.

Oliver, M.A. and R. Webster (1991). How Geostatistics Can Help You. Soil Use and Management, 7 (4): 206:217.

Oosterbaan, R.J. and M. Abu Senna. (1989). Using SALTMOD to Predict Drainage and Salinity in the Nile Delta. International Institute for Land

Reclamation and Improvement (ILRI), Annual Report. Wageningen, the Netherlands.

Oosterbaan, R.J. (1994). SALTMOD user manual, ILRI, Wageningen, the Nertherlands.

Page, A.L.; R.H. Miller and D.R. Keeny (1982). Methods of Soil Analysis. Amer. Soc. Agr. Inc. Madison.

Ramadan, H. (1997). Spatial Interpolation And Simulation Of Soil Salinity And Water Table In Some Irrigated Soils In Egypt. Alexandria Science Exchange., 18:191-212.

Rasool, S.I. (1988). Understanding Global Change. Global Resources Information Database News. Vol. 1 No.2, 1988, pp. 1-2, Nirbi.

Said, R. (1962). The Geology of Egypt. Amsterdam. Elsevier Pub. Co., 377 P.

SAS Institute. (1985). SAS user`s guide: Statistics, Version 5 ed. SAS Inst., Cary, NC.

SPA (1985). Rosetta shore protection project. Prepared for: Ministry of irrigation shore protection Authority irrigation Building. Fum El-Ismailia, Shoubeta El-Masalat, Egypt.

United Nations (1977). Water for Agriculture. In: Water Development and Management Proceedings of the United Nations Water Conference. Part 3, Mardel Plata.

Tim, U.S. (1996). Coupling vados zone models with GIS: Emerging trends and potential bottlenecks. Journal Environmental Quality., (25) 3: 535-544.

Warrick, A.W.; D.E. Myers and D.R. Nielson (1986). Geostatistical Methods Applied To Soil Science. In: A. Klute (Ed.). Methods of soil analysis. Part 1 : Physical and Mineralogical methods. 2 nd Ed., Agronomy, 9: 53-81.

Webster, R. (1985). Quantitative Spatial Analysis of Soil In The Field. Advances in Soil Sci, 3:1-70.

التقييم الكمى لتدهور الاراضى – شمال غرب الدلتا: منطقة البوصيلى

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تهدف الدراسة الى تقييم تدهور الاراضى – شمال غرب الدلتا بمزرعة ادفينا الحكومية بمنطقة البوصيلى باستخدام الدمج بين برنامج التنبؤ بملوحة التربة ومستوى الماء الارضىSALTMOD والتغيرات الفراغية والزمنية. وذلك لزمن الدراسة عام ٢٠٠٠ والتنبؤ المستقبلى لخمسة سنوات وعشر سنوات وكانت اهم النتائج التى تم التوصل اليها كالاتى:

اولا: التحليل الاحصائى الوصفى:

أ- ملوحة التربة:

- تراوحت قيم التوصيل الكهربائى من (٢,٦٢ الى ١٦,٤) ديسيسيمينز/م و (٤,٦٨ الى ١٨,٦) ديسيسيمينز/م و(٨,٦ الى ٢٤,٨) ديسيسيمينز/م فى عام ٢٠٠٠ زمن الدراسة وعام ٢٠٠٥ و ٢٠١٠ على الترتيب وهى الازمنة المتنبئ بها.
- معامل الاختلاف للتوصيل الكهربائى كان ٠,٤٦ &٠,٣٦ &٠,٢٧ للاعوام ٢٠٠٠ & ٢٠٠٥ & ٢٠١٠ على الترتيب. وتشير قيم معامل الاختلاف انها تقل كالاتى: معامل الاختلاف للتوصيل الكهربائى عام ٢٠٠٠ > معامل الاختلاف للتوصيل الكهربائى عام ٢٠٠٥ > معامل الاختلاف للتوصيل الكهربائى عام ٢٠١٠.

ب- عمق مستوى الماء الارضى:

- تراوحت قيم مستوى الماء الارضى من (٦٥ الى ١١٨)سم & (٤٠ الى ١٠٥)سم و(١٥ الى ٨٥)سم فى اعوام ٢٠٠٠& ٢٠٠٥& ٢٠١٠ على الترتيب. ويتضح من ذلك ان قيم عمق الماء الارضى تقترب من سطح التربة وتشير الى ظروف الغدق المستقبلية.
- تشير النتائج الى ان التباين ومعامل الاختلاف تزداد مع الازمنة المتنبئ بها.

ثانيا: التحليل الجيواحصائى (الفراغى):

أ- ملوحة التربة:

- قيم التوصيل الكهربائى لملوحة التربة لموديل الـ Semivariogram تمثل المنحنى الاسى Exponential model وذلك لزمن الدراسة (عام ٢٠٠٠) بينما كان Gaussian model للازمنة المتنبئ بها وهى اعوام ٢٠٠٥& ٢٠١٠.
- تشير النتائج ان قيم اختلاف التباين (nugget variance) للتوصيل الكهربائى تزداد مع الوقت وكانت (٠,٦& ١,٧٥ & ٢,٢)م لزمن الدراسة عام ٢٠٠٠ والازمنة المتنبئ بها اعوام ٢٠٠٥& ٢٠١٠. وهذه النتائج توضح مدى شدة التغير مع المسافة والزمن.
- تشير نتائج الـ sill variance للتوصيل الكهربائى الى (١٥ & ١٦,٨٥ & ١٧,٧٩)م لزمن الدراسة عام ٢٠٠٠ والازمنة المتنبئ بها اعوام ٢٠٠٥ & ٢٠١٠.
- قيمة المدى للتوصيل الكهربائى لملوحة التربة كانت (٥٨٨ & ٨٢٦ & ٧٣٧)م لزمن وقت الدراسة والاعوام المتنبئ بها ٢٠٠٥ & ٢٠١٠.

ب- عمق مستوى الماء الارضى:

- قيم عمق مستوى الماء الارضى تمثل بالمنحنى Gaussian model لمختلف الازمنة.
- اوضحت نتائج اختلافات التباين لمستوى الماء الارضى الى اختلافات كبيرة مع المسافة والزمن وكانت (٣٢,٢ & ٤٧,٣ & ١٠٣,٠)م.
- كانت نتائج الـ sill variance لعمق مستوى الماء الارضى (١٩٩,٤ & ٢٥٥,٦ & ٣٧٩,٦)م لزمن الدراسة عام ٢٠٠٠ والازمنة المتنبئ بها عامى ٢٠٠٥ & ٢٠١٠.
- قيم المدى لمستوى الماء الارضى كانت (١٠١٦ & ٩٨٤ & ١٤٨١)م لزمن الدراسة والازمنة المتنبئ بها.

ثالثا: دمج نتائج برنامج التنبؤ SALTMOD مع خرائط Kriging لملوحة التربة ومستوى الماء الارضى:

اوضحت خرائط الـ Kriging الاتى:

أ- ملوحة التربة:

- ازاحة قيم ملوحة التربة وعمق مستوى الماء الارضى من ٧,٨٦ ديسيسيمينز/م و ٨٤,٠٠سم فى زمن الدراسة عام ٢٠٠٠ الى ٩,٩٣ ديسيسيمينز/م و٦٥سم بعد ٥ اعوام و١٤,١ ديسيسيمينز/م و٤٥سم بعد ١٠ اعوام من الدراسة.
- مساحة قيم الملوحة السائدة (٧,٤ ديسيسيمينز/م) فى زمن وقت الدراسة عام ٢٠٠٠ كانت تمثل (٧٤,٣٢%) من المساحة الكلية بينما القيم المتنبئ بها (٩-١٤ ديسيسيمينز/م) عام ٢٠٠٥ تمثل (٨٣,٤٦%) بينما القيم المتنبئ بها (١٦-٢٤ ديسيسيمينز/م) كانت تمثل (٨٨%) من المساحة الكلية عام ٢٠١٠.

ب- عمق مستوى الماء الارضى:

- مساحة قيم عمق مستوى الماء الارضى (٦٥-٨٥سم) فى زمن وقت الدراسة كان يمثل (٨٦,٢٥%) من المساحة الكلية بينما القيم المتنبئ بها (٤٠- ٧٠سم) عام ٢٠٠٥ كانت تمثل (٩١,٦٢%) بينما القيم المتنبئ بها (١٥-٥٥سم) كانت تمثل (٩٤,٨%) من المساحة الكلية ام ٢٠١٠.

ويتضح من خلال النتائج ان اراضى مزرعة ادفينا بالبوصيلى مثالا واضحا لاراضى الجلاى التى تعانى من سوء الصرف وارتفاع مستوى الماء الارضى الذى يساعد على حدوث عمليات التملح والجلاى والتى تؤدى الى تدهور الاراضى. وتعتبر مثل هذه الدراسة مهمة لمتخذى القرار فى معرفة التدهور المستقبلى لهذه النوعية من الاراضى لوضع البرنامج المناسب لتحسين واستصلاح هذه الاراضى.