7 Egypt. J. Soil Sci. 42, No. 1 , pp. 103 - 126 (2002)

Risk Assessment of Waterlogging Problem at Bustan 1 and 2 Areas, Egypt*

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THE NEWLY reclaimed sandy soils located between latitudes 30°35` and 30° 50` and longitudes 29° 30` and 29° 55`, represent a total area of 269,550 ha. Previous studies identified the main problems at El-Bustan sector to be:1) low soil fertility and poor physical properties, 2) lack of sustainable crop rotations, and 3) deep water table levels except water logging and soil salinity in some areas.

The water logging problem appeared in some areas in El-Bustan sector was mainly due to seepage from irrigation canals, change from modem (sprinkler and drip) irrigation systems to surface system, lack of information about crop water requirements and irrigation scheduling, and insufficient drainage system. This problem represents a major constraint for the sustainable agricultural production at the El-Bustan area since the waterlogged area is about 14.4% of the total cultivated area.

This study was conducted during July 1998 to August 1999 to determine the status of water table and its quality for reuse in irrigation, morphological features of the impermeable layer in the study area and to evaluate the zone of water logging in three villages (Ali Ibn Abu Taleb, Tawfeek El-Hakeem, and Mohammed Refaat) at El-Bustan 1 & 2 areas.

A network of ninety observation wells was installed in a grid system (300 x 300m) to cover the study area. Soil samples were collected on a 0.5m interval down to the impermeable layer to determine soil texture, pH, ECe, $CaCO_3$, and cations and anions contents. Water samples from the observation wells were collected for

*Funded by the Bustan Agricultural Development Project (BADP).

water quality parameter measurements. In addition, soil hydraulic conductivity values were measured.

Results revealed that the depth of impermeable layer varied from 2 to 9m from land surface. Water table level ranged from 0.0 to 4.2m. Soil texture ranged from loamy sand to sandy clay loam. The texture of the impermeable layer was sandy loam to sandy clay loam. Total $CaCO_3$ content ranged between 8.75 to 23.85% for the layer above the impermeable layer and reached 25.7% in the impermeable layer. Soil salinity was from 0.81 to 2.1 dS/m. average hydraulic conductivity value above the impermeable layer was 16.5 cm/hr, while it reached 3.8 cm/hr within the impermeable layer. For the water samples, the EC values were between 1.46 and 5.31 dS/m, the SAR values ranged from 3.21 to 12.54, and the NO_3-N concentration varied between 12.89 to 29.34 mg/l.

Field maps using Kriging technique were produced for the soil surface, depth of the impermeable layer and water table depth. The maps were used to locate the proper sites for the installation of field drainage network in the area to solve the waterlogging problem.

The SALTMOD simulation model was used to predict the proper depth of drains for keeping the water table levels below the root zone of the growing crops and trees in the area. Results indicated that the predicted values were in close agreement with the measured values at the deep drain depths (>4.0m).

Keywords: Waterlogging, drainage, impermeable layer, hydraulic conductivity, kriging, SALTMOD.

Waterlogging and salinity are universal problems of irrigated agriculture in arid and semi-arid regions. The risk of their occurrence has to be defined early in the planning, designing and construction processes of new systems (Bourrfa and Zimmer, 1994).

In Egypt, the agriculural land base totals about 7.8 million feddans (3.25 million hectars) covering three different production zones. The first is the old irrigated land with an area of 5.4 million feddans (2.25 million hectars) lying within the Nile Valley and Delta. The second production zone is the "newly" reclaimed land with an area of about 1.9 million feddans. This zone includes the newly reclaimed lands of sandy, calcareous and saline origin. The third zone is the rainfed area (about half a million feddans) located in the Northwest Coast and North Sinai, (Abdel Monem *et al.*, 1998). The newly reclaimed area at West Nubaria represents about 40% of the total area reclaimed since.

Schulze and Ridder (1974) indicated that the introduction of irrigated agriculture and horticulture on the newly reclaimed land in the Bustan 1&2, within a relatively brief period, created a series of problems and probably will generate more in the near future. Amongst the most severe problems is the steady rise in water table, accompanied by the formation of local groundwater mounds and reversals of groundwater flow directions and the outflow of saline groundwater into the principal irrigation canals. El-Shal and Ismail (1979) studied the effect of the present irrigation and drainage systems on the hydrogeophysical properties of the soils of the Mechanized Farm at West Nubaria area. Their results indicated that the field drainage system present in the area is insufficient and led to rapid rise of the ground water table and subsequently secondary salinization of almost half of the farm area. They indicated also that the problem was intensified by the salinization of ground and irrigation waters. The Bustan Agricultural Development Project (BADP, 1995) concluded that many constraints in the Bustan 1&2 area (*e.g.*, poor soil fertility and low organic matter content, poor soil physical charateristics, lack of appropriate cropping pattern and farming techniques, lack of propper skills, experience and extension advice and marketing problems) are common to smallholders throughout the New Land areas. Problems of high water table and waterlogging are particularly severe at Bustan 1&2. Over large parts of the area, the water table stands at 0.8 m or less below the ground surface and in few places it lays at ground level. The main reasons of such a problem were due to poor drainage conditions, seepage from irrigation canals, inefficient irrigation water management, and the change from modern to surface irrigation systems.

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 groundwater 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 charachterized 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 objective of this study was to investigate the causes of waterlogging problem at some sites at Bustan 1&2 area through:

1- Definning the depth of the impermeable layer in the waterlogged areas.

2- Definning the water table levels in the area.

3- Analysing some physical and chemical properties of soils in the study area.

4-Assessing water table quality for agricultural use .

5-Predicting salinity build-up in the area by the SALTMOD simulation program.

Material and Methods

1- Site description

The Bustan 1&2 areas are located to the west of Nile Delta. It is located between latitude 30° 11` 36" and 30° 43`12" north and 30° 23`19" and 30° 40` 23" east. It is bounded to the west by Bustan canal and to the east by the Nubaria canal (Fig. 1a). Geomorphologically, land elevation of the study area ranges between 5m above sea level (a.s.l.) in the east and 35m (a.s.l.) in the west, with an average east-west slope of 0.17%. The Bustan 1&2 areas consists of eleven villages covering about 50,000 feddans (1 feddan = 0.42 hectare). Three villages (Ali Ibn Abu Taleb, Mohamed Refaat and Tawfeek El-Hakeem) in this area suffered from shallow water table and waterlogging problems and were selected to conduct this study. The study started on July 1998 and ended on August 1999.

2- Field measurements

2.1- Pre-test

A pre-test was done to identify the causes of the shallow water table and waterlogging problems and to design a proper monitoring system for the drainage problems of the area as a whole. Twenty test-wells (five in each waterlogged zone) were drilled in a square arrangement. Four test-wells at the corners and one in the middle of each waterlogged zone (Fig. lb) were established to determine the depth of the impermeable layer, water table level and soil physical and chemical properties.

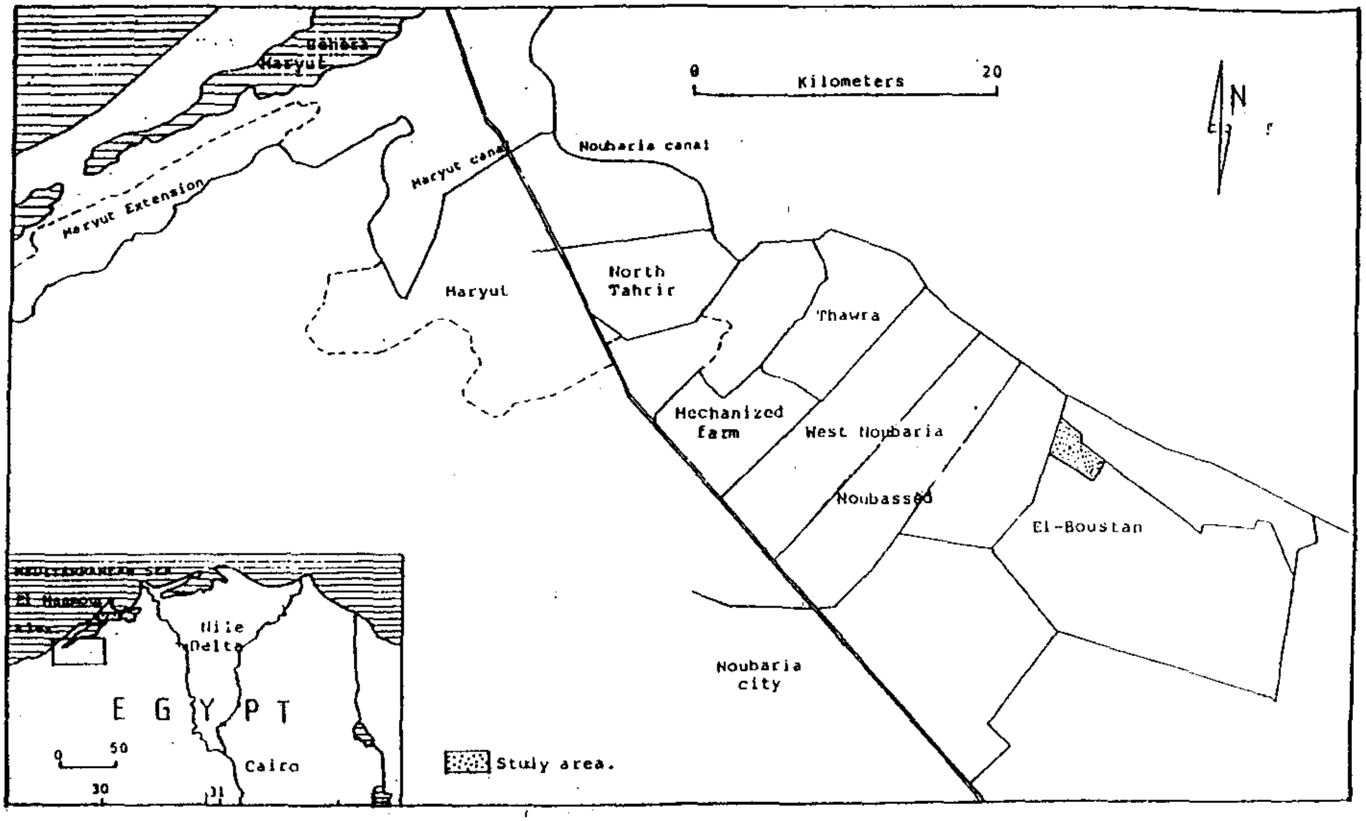

Fig. 1-a. Location of Bustan 1 & 2 areas.

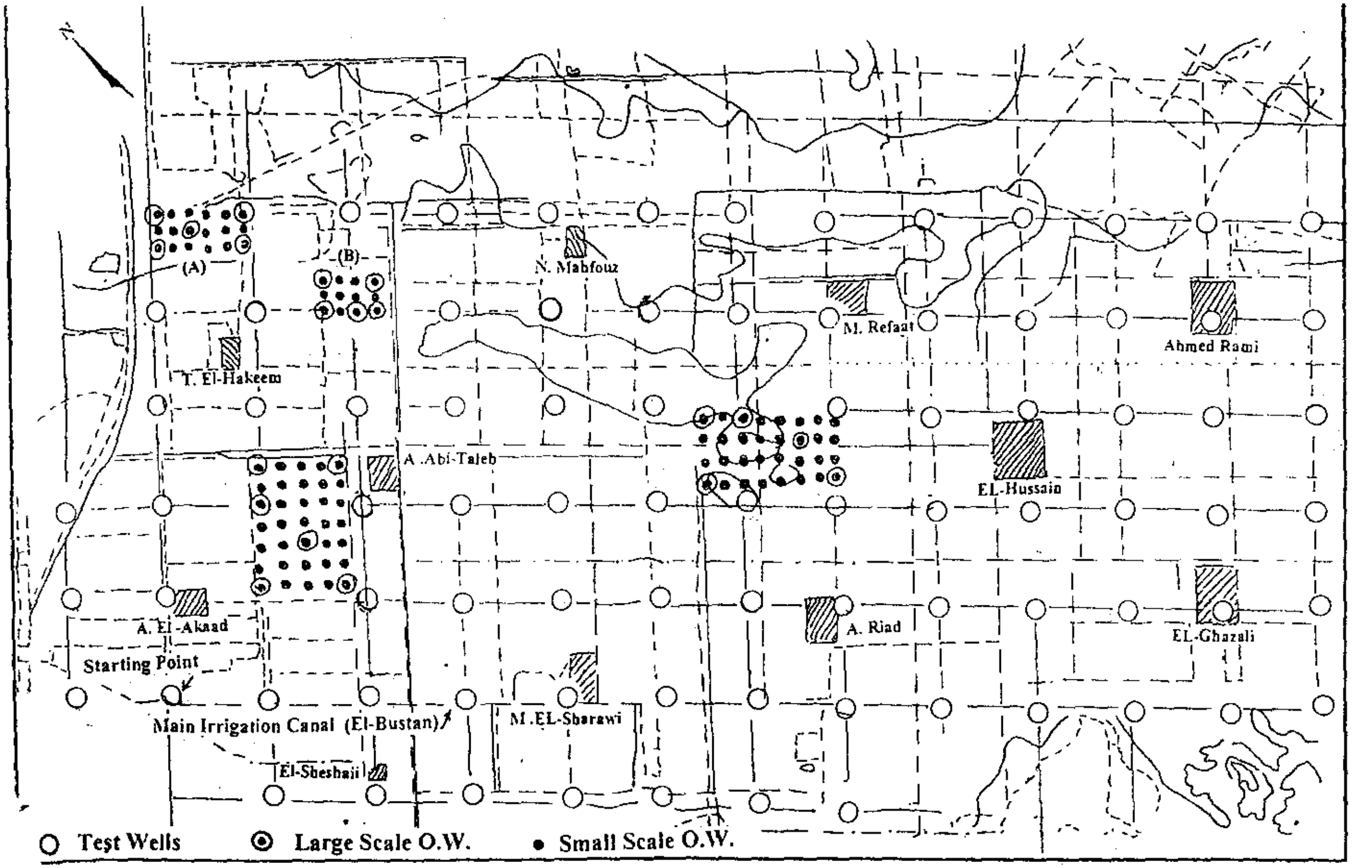

Fig. 1-b. Location of Bustan 1 & 2 areas including small and large-scale test wells.

2.2. Grid system

Based on the preliminary data obtained from the pre-test, two grid systems were designed. The first was to cover the Bustan 1&2 (eleven villages) with grid spacing of 1500 X 1500m. The second was to cover the waterlogged areas with grid spacing of 300 X 300m. A total of 132 observation wells (OW) distributed as 40 in the large scale for the whole area and 92 in the small scale as 34, 31 and 27 OW for Ali Ibn Abu Taleb, M. Refaat and T. El-Hakeem villages, respectively. The stem hydraulic auger was used to drill the observation wells for the two grid systems and soil samples were collected during drilling works. Sounders were used to measure water table depth.

2.3. Soil hydraulic conductivity

Soil hydraulic conductivity values for the saturated conditions were measured using the Auger-hole method, (Boersma, 1965).

3- Laboratory measurements

3.1. Soil samples

During the pre-test, the excavated soil from each test well was collected for mechanical analysis and soil texture class, total calcium carbonates, soil reaction, electrical conductivity determinations. For the first meter from soil surface, samples were collected on a 0.25m interval and then on 1.0 m intervals to just above the depth at which the impermeable layer was present. Samples were air dried, crushed with wooden pestle and sieved by a 2mm sieve. Mechanical analysis using the hydrometer method (Day, 1965) was used and soil texture classes were then identified. Total calcium carbonates ($CaCO_3$,%) was determined using calcimeter method, (Heald, 1982). Soil reaction (pH) in a 1:2.5 soil to water suspension was measured using Becman's pH-meter (Peech, 1982). The electrical conductivity values of the soil samples were measured using Hanna EC Meter (Bower and Wilcox, 1982). Also, disturbed soil samples were collected from the impermeable layer to determine the hydraulic conductivity values. The laboratory measurements were done according to Klute (1965).

3.2. Water samples

Random groundwater samples from nine test wells (three in each village) were collected for the determination of total soluble salts (TSS), soluble bicarbonates (HCO_3), nitrate-nitrogen (NO_3-N) and sodium adsorption ratio (SAR). Total soluble salts in dS/m were measured using the EC meter (Bower and Wilcox, 1982). Soluble bicarbonate in meq/l was determined using the acid titration method (Allison and Moodie, 1982). The NO_3-N was determined according to Bremner (1982). The SAR values were also calculated.

4- Data analysis

4.1- Spatial variability (Mapping using Kriging Technique)

Contour maps of soil surface, water table level and depth of the impermeable layer were developed according to Kriging technique. The Kriging method is optimal in a sense that the weights of local averaging are chosen to give unbiased estimates while keeping the estimation variance at minimum, (Webster, 1985). Surfer Software (1994) was used to draw the maps.

4.2- SALTMOD simulation model

SALTMOD is a computational method that makes it possible to predict soil and water salinity and water table depth in agricultural land under different geo-hydrological conditions and varying water-management scenarios. in this study, SALTMOD was used to estimate depths of main drains and the corresponding depths of water table and soil salinity. The estimated values were compared to the observed water table levels and soil salinity values obtained after the construction of main drain in the study area. The parameters used as inputs in the simulation model for Ali Ibn Abu Taleb, M. Refaat and T.El-Hakeem (a & b), respectively are presented in Table 1.

TABLE 1. Input parameters to the simulation model.

Input parameter	Values used
Amount of water applied to the irrigated crops in summer and winter seasons.	100 cm
Potential evapotranspiration of irrigated craps in summer and winter seasons	6.7summer (mm/d) 4.05 winter (mm/d)
Thickness of root-zone layer	100 cm
Porosity .	38 (%)
Drainable porosity of soil in root-zone layer.	0.08
Leaching efficiency in the root-zone.	1
Salt concentration of incoming canal irrigation water (EC_w).	0.7 (dS/m).
Initial salt concentration of sail moisture in root-zone (EC_e).	2.10, 2.60, 2.10 (dS/m).
Depth of water table.	0.3, 0, 0 (m).

Results and Discussion

I-Pre-test

I.1. Soil physical and chemical properties

Physical and chemical properties of the soil samples collected from the three villages at Bustan 1&2 are presented in Table 2. Results showed that the texture is generally coarse and tends to be heavier with depth as calcium carbonates

TABLE 2. Soil physical and chemical properties.

Village	Depth Cm	pH	EC dS/m	Mechanical Analysis Sand (%)	Silt (%)	Clay (%)	Text* Class	$CaCO_3$ (%)	Av. K_h (cm/hr)* Above	within
A. Taleb	0-25	7.60	2.10	84.60	2.60	12.80	LS	9.89	16.54	3.70
	25-50	7.80	1.05	84.60	2.50	12.90	LS	11.25		
	50-75	7.90	1.17	82.00	2.50	15.50	LS	12.20		
	75-100	8.00	1.20	79.40	2.60	18.00	SL	13.63		
	100-200	8.10	0.90	84.70	2.70	12.60	LS	11.35		
	200-300	8.00	1.40	79.60	5.10	15.30	SL	15.67		
	300-400	8.10	1.50	84.70	2.50	12.80	LS	10.35		
	400-450	7.80	1.85	79.60	5.10	15.30	SL	18.96		
	>450 **	8.10	1.60	84.80	2.60	12.60	LS	10.36		
M. Refaat	0-25	8.20	1.80	84.60	2.50	12.90	LS	8.75	17.20	3.96
	25-50	8.10	1.60	84.60	2.50	12.90	LS	8.75		
	50-75	8.20	1.20	84.60	2.50	12.90	LS	10.01		
	75-100	8.00	0.91	84.60	2.50	12.90	LS	10.11		
	100-200	8.00	1.00	71.70	5.10	23.20	SCL	21.58		
	200-300	7.80	0.80	82.00	2.60	15.40	SL	11.35		
	>300 **	8.00	0.93	82.00	2.60	15.40	SL	12.52		
Hakeem (a & b)	0-25	7.80	1.70	84.50	2.60	12.90	LS	11.64	16.12	3.94
	25-50	8.00	1.80	84.50	2.60	12.90	LS	15.62		
	50-75	7.95	1.20	84.25	2.55	13.20	LS	16.59		
	75-100	7.90	1.10	84.00	2.50	13.50	LS	17.56		
	100-200	7.90	0.90	82.00	2.60	15.40	SL	21.25		
	200-300	7.90	0.81	82.00	2.60	15.40	SL	20.65		
	300-400	8.00	0.90	82.00	2.60	15.40	SL	23.85		
	400-500	8.30	0.88	82.00	2.60	15.40	SL	22.67		
	500-600	8.10	1.10	79.60	5.10	15.30	SL	21.34		
	>600 **	8.10	0.95	74.30	5.10	20.60	SCL	25.67		

*SL = sandy loam, LS =Loamy sand and SCL = sandy clay loam.

**Depth of the impermeable layer.

**Average hydraulic conductivity values above and within the impermeable layer.

increase. It differs from loamy sand to sandy clay loam. Calcium carbonate content varies from 8.76% to 25.67% and increases irregularly with depth. The relatively high content of $CaCO_3$ is due to calcareous parent material since limestone is the bedrock in this area. However, this calcareous nature affects both physical and nutritional soil properties and causes undesired condition through the formation of crust and hardpans. Soil reaction (pH) values ranged between 7.6 and 8.3. The variation with depth or from one site to another is irregular and very slight. This relatively high pH is mainly due to high $CaCO_3$ content. Chemical analysis of the saturated soil extracts indicated that electrical conductivity (EC_e) values varied from 0.8 to 2. 1dS/m which lie in the moderate soil salinity range (0.7 to 3.OdS/m). EC_e values were high at the top 0.5Om and decreased with depth. Results showed also that the average hydraulic conductivity (K_h) values were 16.54, 17.2 and 16.12 cm/hr for Ali Ibn Abu Taleb, M. Refaat and T. ELl-Hakeem (a,b) villages, respectively indicating the sandy nature of the soil at the region. The average K_h values for the impermeable layer were 3.70, 3.96 and 3.4 cm/hr for the same villages, respectively. The reduction of about 76.3% in K_h values in the impermeable layer as compared to the soil profile above it can be due to the increase in the fine fraction from the $CaCO_3$ content in the impermeable layer. The decrease in K_h values, the excess of irrigation water and the sloping feature of the impermeable layer can be the main reasons of the shallow water table and waterlogging problems in the area.

1.2. Groundwater analysis

The analysis of some groundwater samples collected from the test wells is presented in Table 3. Results indicated, according to Ayers and Westcot (1985) that, salinity ranges from moderately saline (1.46 dS/m) to high saline (5.31 dS/m) water. The calculated values of SAR show that no problems can be expected since the value are generally low. Nitratenitrogen concentrations are moderate (25.28 mg/l).

TABLE 3. Groundwater analysis for the three villages at West Nubaria-east road.

Village	EC dS/m	SAR	HCO_3 me/l	NO_3-N mg/l
Abi Taleb	1.46	3.21	7.43	12.89
M. Refaat	2.26	5.28	10.82	25.29
T. Hakeem (A,B)	5.31	12.54	24.50	29.34

1.3. Mapping (soil surface, watertable, and impernieable layer)

Soil surface, water table and impermeable layer maps for Ali Ibn Abu Taleb, M. Refaat and T. El-Hakeem (a & b) villages are illustrated in Fig. 2, 3 (a &b) and 4.

A. Abu Taleb: Elevation of Ali I. Abu Taleb ranged from 14.7 to 19 meters a.s.l.. It is clear that the elevation decreases in the middle of the village. Water table depth ranged from 14.7 to 18 meters a.s.l. Impermeable layer depth ranged from 11.24 to 16.5 meters a.s.l. (Fig. 2).

T. Hakeem A: Elevation of T. Hakeem in zone (A) village ranged from 11.5 to 14.9 meters a.s.l.. It is clear that the elevation decreases in the north direction of the village. Water table depth ranged from 11.5 to 13.7 meters a.s.l. Impermeable layer depth ranged from 6.95 to 13 meters a.s.l. (Fig.3a).

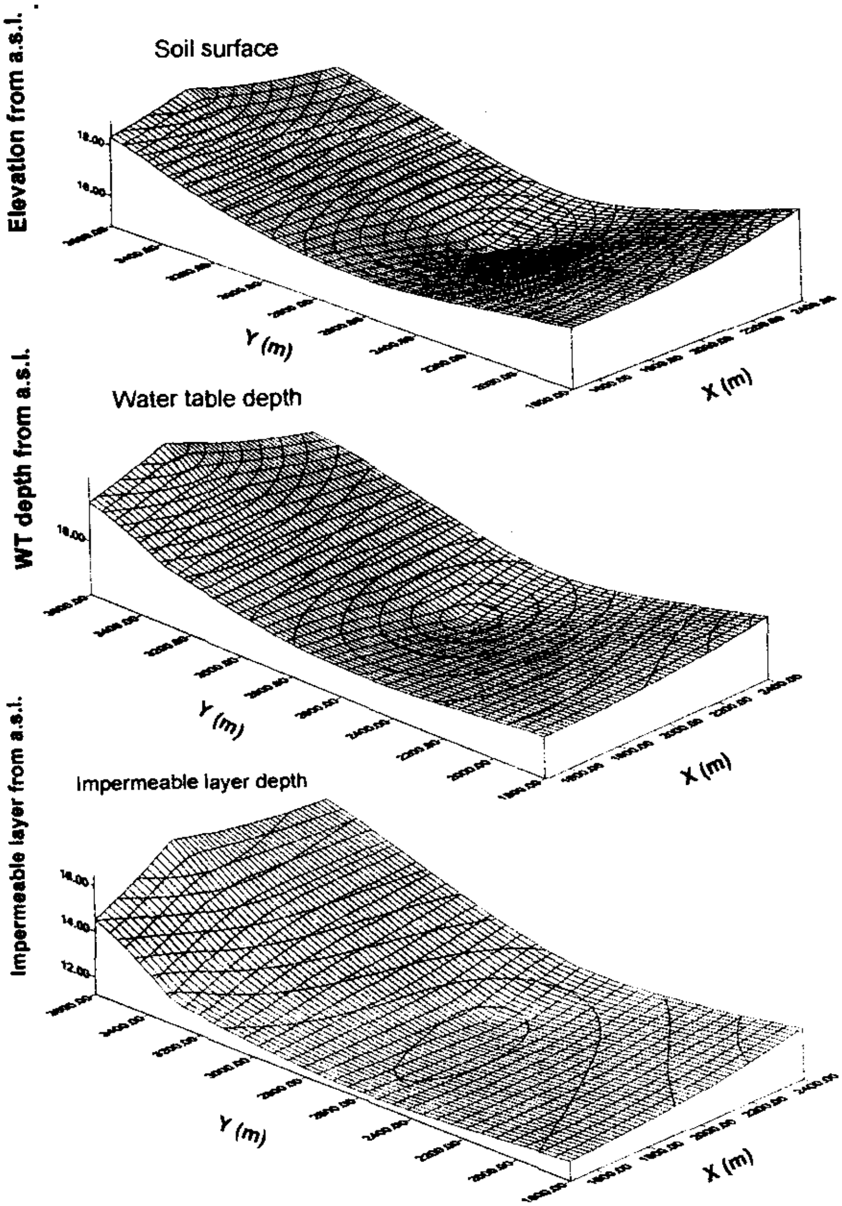

Fig. 2. Soil surface, watertable level and depth of impermeable layer for Ali I. Abu Taleb.

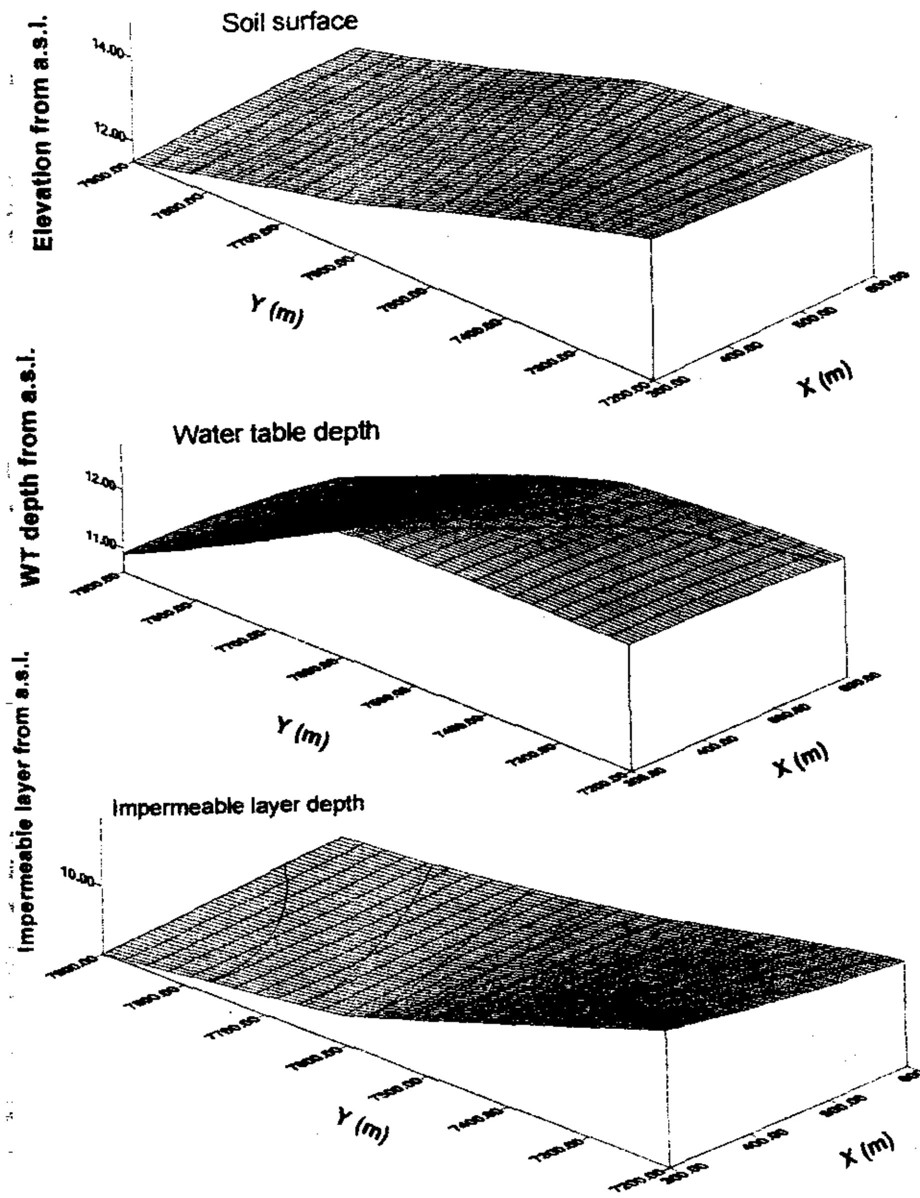

Fig. 3 a. Soil surface, watertable level and depth of impermeable layer for T. Hakeem (A) village.

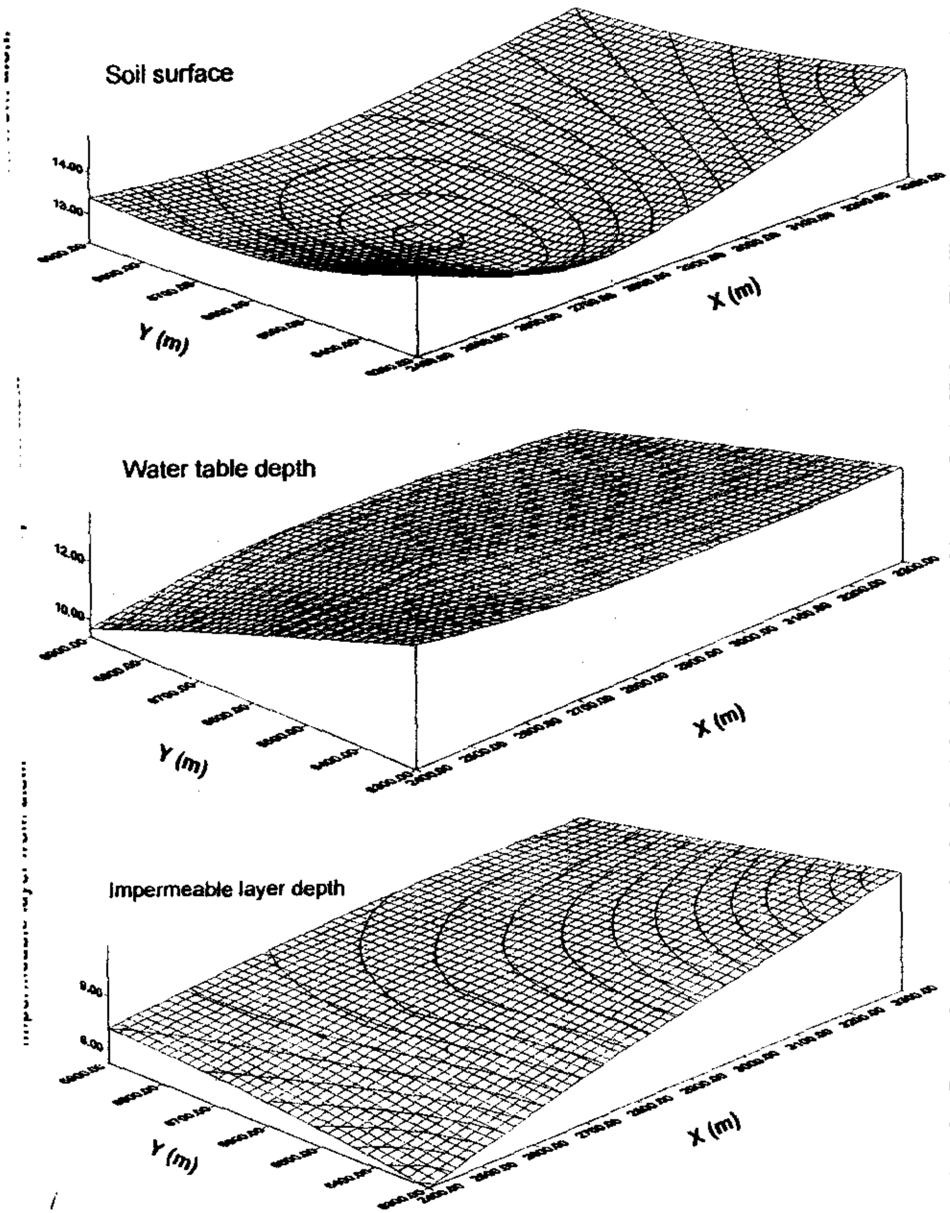

Fig. 3b. Soil surface, watertable level and depth of impermeable layer for T. Hakeem (B) village.

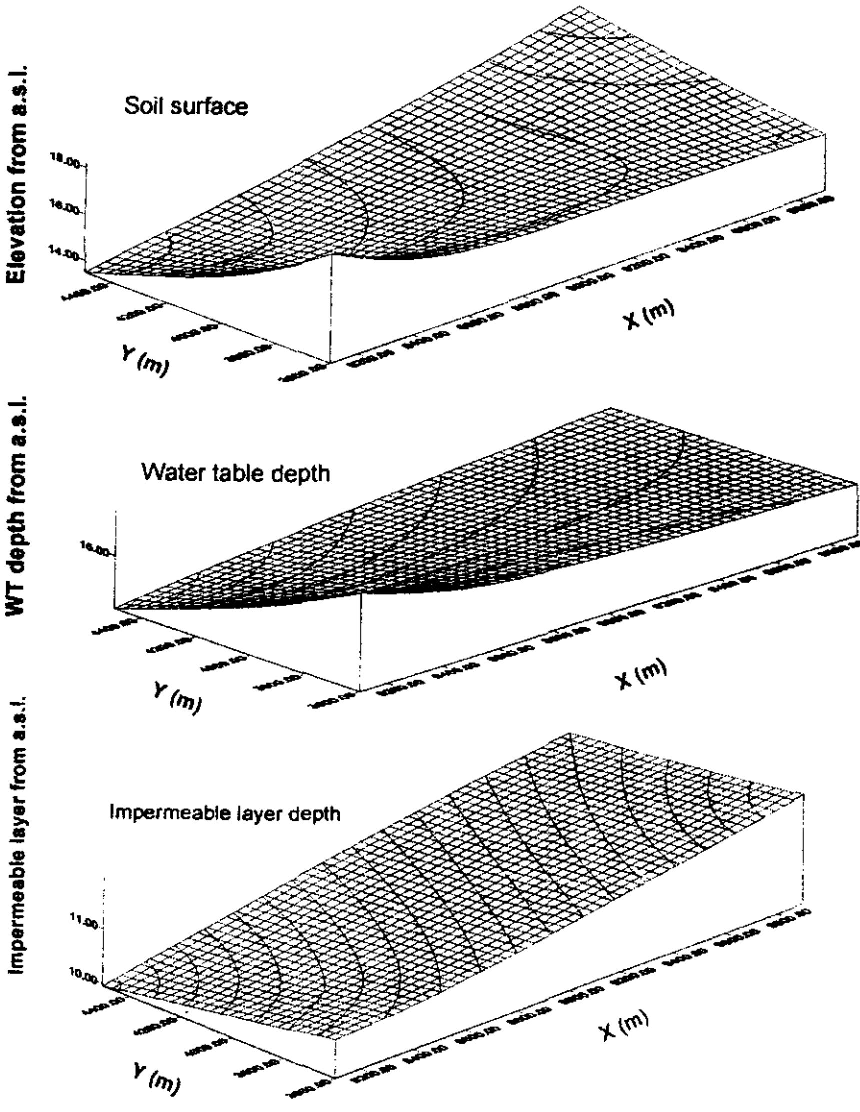

Fig. 4. Soil surface, watertable level and depth of impermeable layer for M. Rafaat village.

T. Hakeem B: Elevation of T. Hakeem village in zone (B) ranged from 12.3 to 14.9 meters a.s.l. Water table depth ranged from 12.3 to 13.7 meters a.s.l. Impermeable layer depth ranged from 7.5 to 10 meters a.s.l. (Fig.3b).

M. Refat: Elevation of M. Refat village ranged from 13.5 to 18.2 meters a.s.l. It is clear that the elevation decreases in the northeast direction of the village. Water table depth ranged from 13.5 to 18.3 meters a.s.l.. Impermeable layer ranged from 10 to 120 meters a.s.l. (Fig.4).

The overlay of soil surface, water table level and depth of the impermeable layer maps developed according to kriging method showed highly spatial correlation.

II- Effect of the construction of main drains on waterlogging problems

The Drainage Authority (Ministry of Irrigation and Public Works) constructed the main drains according to the pre test results. The main drains intercept the percolated water and water table problem was solved partially. Fig. 5a-d showed the effect of main drains construction at A. I. Abu Taleb, M. Refaat and T. Hakeem villages. The water table levels had decreased almost in most of the studied observation wells at the three studied villages.

III- Future aspects

Large scale meshed observation wells mapping for the Bustan 1 &2 area is presented in Fig. 6, which showed the following view:

1. Elevation of Bustan 1&2 generally ranged from 11.5 to 28.5 meters a.s.l. There is a highly elevation variability and it tends to decrease in the north direction of the area.
2. Water table depth ranged from 9 to 18 meters a.s.l.
3. Impermeable layer depth ranged from 7.3 to 20.7 meters a.s.l.

The fluctuation of water table with time for the A. I. Abu Taleb, M. Refaat and T. Hakeem villages is demonstrated in Fig. 7a-d. It is clear that there is a stability in water table level with time and that is due to the construction of sub-main drains beside the main drain (Husha drain) at all studied observation wells at A.I.A.Taleb. The same trend was observed at village M. Refaat, except well No.1, that means that the area represented by well No. 1 needs field drains

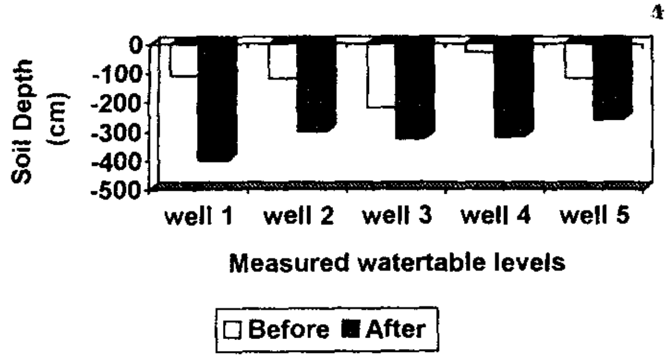

Fig. 5a. Water table levels before and after the construction of the main drain at Ali I. Abu Taleb village.

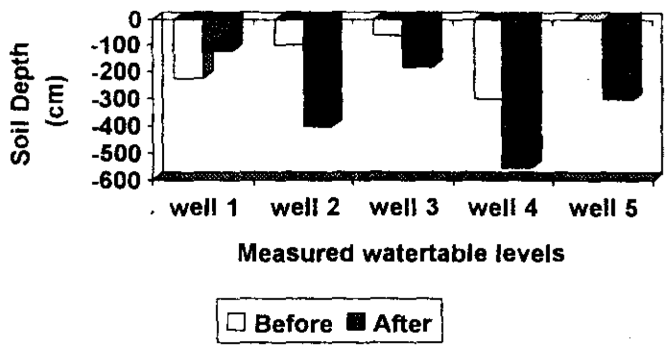

Fig. 5b. Water table levels before and after the construction of the main drain at Mohamed Refaat village.

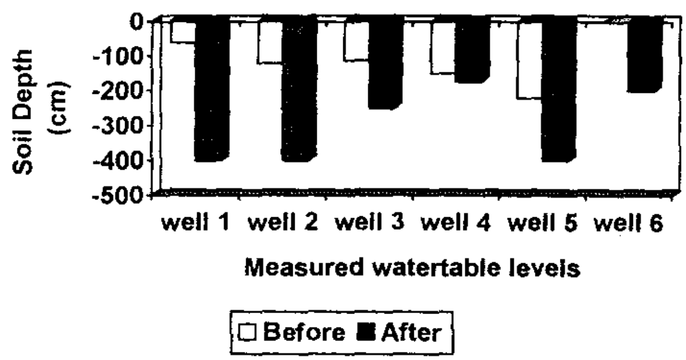

Fig. 5c. Water table levels before and after the construction of the main drain atTawfik El-Hakeem (B) village.

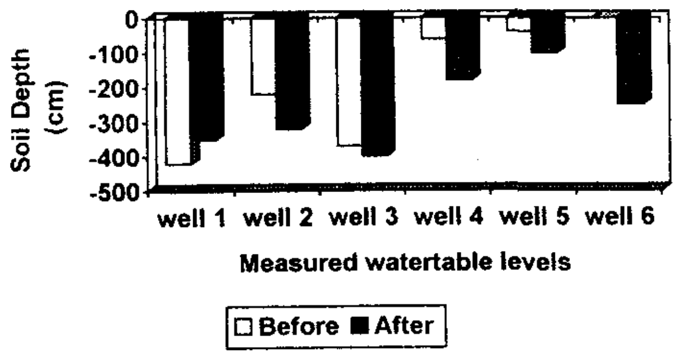

Fig. 5d. Water table levels before and after the construction of the main drain at Tawfik El-Hakeem (B) village.

(smaller drains) to overcome the waterlogged area. Similar T. Hakeem village zone (a) showed the same trend of M. Refaat. T. Hakeem village zone (b) showed fluctuation that water table began to rise again in test wells which reflect that sub-drains needs to be installed at this zone to control water table rising in this zone. The installation of a complete network of ditch, sub main and main drains in Bustan 1&2 area is essential to avoid waterlogging problem in future.

IV- SALTMOD simulation results

Simulation results of soil salinity and water table level with varying drain depth for Ali I. Abu Taleb, M. Refaat and T. Hakeem villages are presented in Table 4. The output values of the simulation model indicated that increasing drain depth from 1 to 5 meters resulted in a decrease in the values of soil salinity above water table from 3.2, 6.6 and 5.3 dS/m to 0.52, 0.7 and 0.7 dS/m for Ali I. Abu Taleb, M. Refaat and T. Hakeem villages, respectively. The reduction in soil salinity values was accompanied by similar reduction in water table levels. As drain depth increases, water table depths of 0.30, 0.0 and 0.0m (input values) increased to 3.80, 4.20 and 3.90 m for the three villages, respectively. Results showed also that for drains with depths less than 4 m, the predicted soil salinity values above water table were much higher than the measured values. The comparison between the predicted and measured soil salinity and water table levels for the three selected villages is presented in Table 5. For drains with deeper depths (>4.0m), results indicated that the predicted soil salinity and water table levels were in close agreement with the measured values for the two

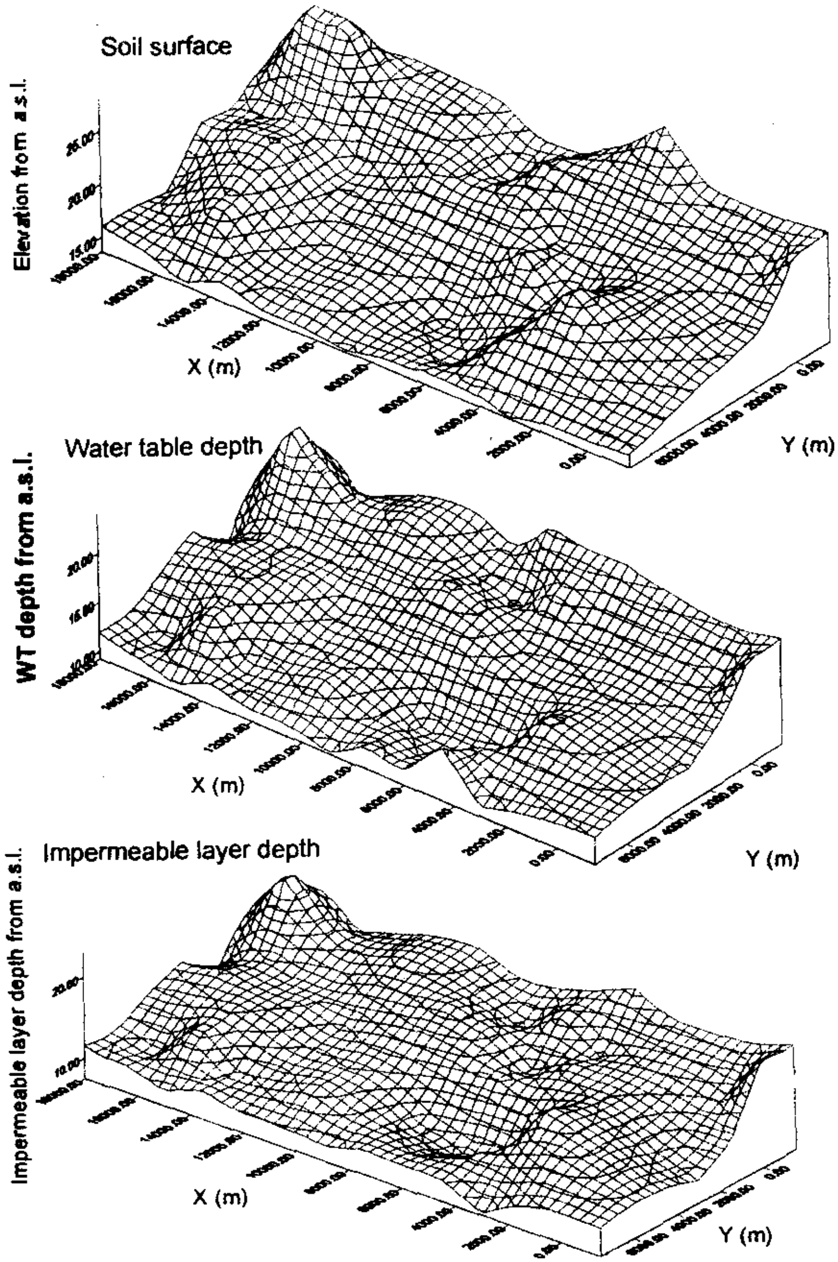

Fig. 6. Soil surface, watertable level and depth of impermeable layer for Bustan 1&2 areas.

villages indicating the possibility of using the SALTMOD simulation model to predict the appropriate drain depth that control both soil salinity and water table levels.

TABLE 4. The predicted soil salinity and water table levels at different drain depths.

Drain depth (m)	Soil salinity above water table (dS/m)			Depth of water table (m)		
	Ali E. Taleb	M. Refaat	T. Hakeem (a & b)	Ali E. Taleb	M. Refaat	T. Hakeem (a & b)
1.0	3.20	6.60	5.30	0.30	0	0
1.2	2.90	5.65	4.80	0.42	0.20	0.30
1.4	2.60	5.30	4.20	0.58	0.50	0.60
1.6	2.40	4.80	3.90	0.62	0.70	0.80
1.8	2.10	3.90	3.50	0.70	1.10	1.10
2.0	1.80	3.60	3.10	0.76	1.40	1.50
2.2	1.60	3.20	2.60	0.83	1.70	1.80
2.4	1.30	2.80	2.20	0.92	2.10	2.20
2.6	1.20	2.20	1.80	1.32	2.40	2.60
2.8	0.90	2.10	1.60	1.80	2.80	300
3.0	0.90	1.50	1.20	2.20	3.00	3.30
4.0	0.60	1.10	0.90	3.60	3.60	3.60
4.5	0.56	0.90	0.70	3.75	3.80	3.80
5.0	0.52	0.70	0.70	3.80	4.20	3.90

TABLE 5. The predicted and measured soil salinity and water table levels at the three villages.

Parameter	Ali E. Taleb		M. Refaat		T. Hakeem (a & b)	
	Predicted	Measured	Predicted	Measured	Predicted	Measured
Soil Salinity (dS/m)	0.54	0.55	1.50	0.73	0.70	0.61
Water table level (m)	3.80	4.20	3.00	4.13	3.90	4.10

Conclusion

The main causes of shallow water table and waterlogging problems at Bust an 1 and 2 areas were identified to be the presence of impermeable layer close to the soil surface, seepage from irrigation canals, use of surface irrigation system and inadequate drainage system in the area.

The constructions of main drains were insufficient to meet the drainage requirements of the area. The installation of a complete network of ditch-, sub-and main-drains is essential to avoid any future problems of waterlogging.

SALTMOD simulation model proved to be a good tool for predicting the proper drain depth that control both soil salinity and water table levels at Bustan 1 and 2 areas when the drain depth exceed 4 meters.

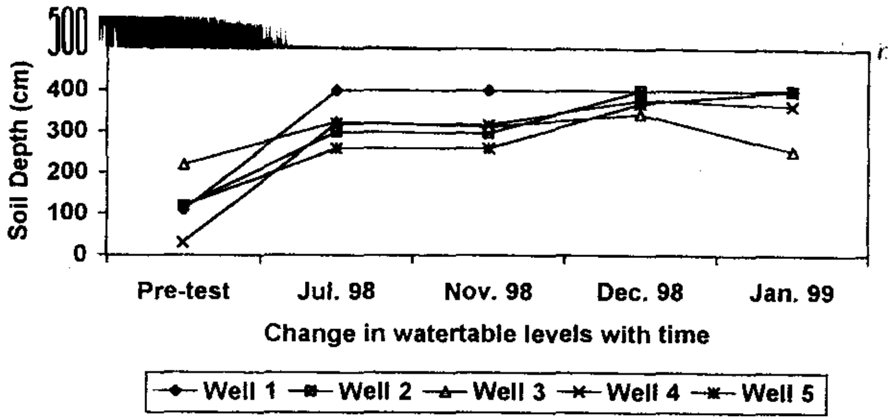

Fig. 7a. Change in water table levels with time at Ali I. Abu Taleb village.

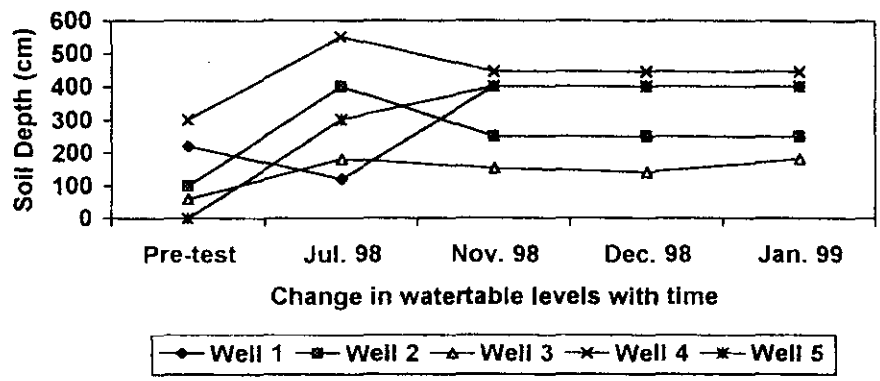

Fig. 7b. Change in water table levels with time at Mohamed Refaat village.

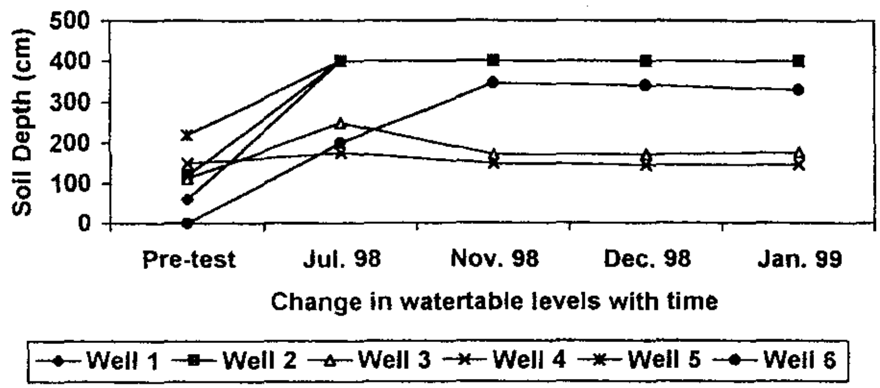

Fig. 7c. Change in water table levels with time at Tawfik El-Hakeem (A) village.

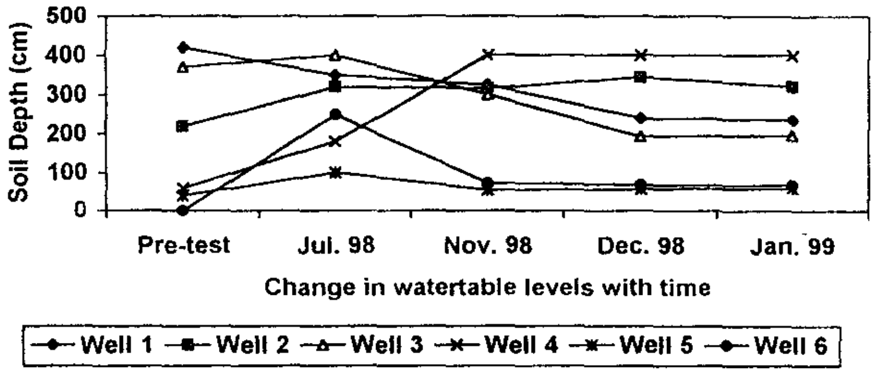

Fig. 7d. Change in water table levels with time at Tawfik El-Hakeem (B) village.

Aknowledgment: Authors wish to express their deep appreciation to engineer Farouk El-Saiedy (executive director), Mr. Samir Badawy (technical manager) and all staff members of the Bustan Agricultural Development Project (BADP) for their help and support during the conductance of this study.

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(Received 9 / 2000)

تقييم خطورة مشكلة الغدق بمنطقتى البستان ١و ٢ بمصر

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تقع الأراضى المستصلحة حديثا بين خطوط عرض ٣٠° ٢٥َ و٣٠° ٥٠َ وخطوط طول ٢٩° ٣٠َ و ٢٩° ٥٥َ والتى تمثل إجمالى مساحة ٢٦٩،٥٥٠ هكتار. حددت الدراسات السابقة المشاكل الرئيسية لقطاع غرب النوبارية وهى: ١-إنخفاض خصوبة التربة وسوء الخواص الطبيعية لها ،٢- عدم إستدامة الدورات الزراعية، ٣- إنخفاض فى مستوى الماء الأرضى عدا بعض المناطق التى تعانى من الغدق وتملح التربة.

ظهرت مشاكل الغدق فى بعض مناطق غرب النوبارية والبستان أساسا نتيجة الرشح من قنوات الرى وتغير نظم الرى الحديثة (الرش والتنقيط) الى نظام الرى السطحى (غمر) ونقص المعلومات عن الإحتياجات المائية وجدولة الرى وعدم وجود نظام صرف كافى وتمثل هذه المشكلة أحد معوقات إستدامة الانتاج الزراعى بمنطقة غرب النوبارية التى تعانى بعض مناطق منها ظروف الغدق بحوالى ١٤.٤٪ من إجمالى المساحة المنزرعة.

بدأت هذه الدراسات من يوليو ١٩٩٨م وحتى يوليو ١٩٩٩م بهدف قياس مستوى الماء الأرضى ونوعية هذه المياه لإعادة إستخدامها فى الرى والمظاهر المورفولوجية للطبقات الصماء وتقييم مناطق الغدق وذلك بثلاثة قرى وهى على بن أبى طالب ومحمد رفعت و توفيق الحكيم الواقعة بمنطقة البستان ١و٢.

كونت شبكة من ٩٠ بئر ملاحظة فى نظام شبكى (٣٠٠x٣٠٠م) لتغطية منطقة الدراسة وأخذت عينات التربة لعدة أعماق حتى الوصول الى عمق الطبقة الصماء. وتم تقدير قوام التربة ورقم الحموضة والقلوية ودرجة التوصيل الكهربائى والنسبة المئوية لكربونات الكالسيوم. وتم تقدير التوصيل الهيدروليكى فوق الطبقة الصماء وللطبقة الصماء وأخذت عينات مياه من ابار الملاحظة لتقدير درجة صلاحيتها.

أوضحت النتائج أن عمق الطبقة الصماء تراوح من ٢ الى ٩ متر من سطح التربة ومستوى الماء الأرضى تراوح من صفر الى ٤.٢ متر. وقوام التربة تراوح من اللومى الى الرملى اللومى ولوحظ أيضاً ان قوام الطبقة الصماء رملى لومى ومحتوى كربونات الكالسيوم الكليه من ٨.٧٥ الى ٢٣.٨٥ ٪ فوق الطبقة الصماء بينما بلغ ٢٥.٧٪ فى الطبقة الصماء. وملوحة التربة تراوحت من ٠.٨١ الى ٢.١ ديسميز/م. وبلغت متوسط قيمة معامل التوصيل الهيدروليكى ١٦.٥ سم/ساعة للطبقة التى تعلوا الطبقة غير المنفذة للقرى الثلاثة. وبلغت ٣.٨ سم/ساعة للطبقة غير المنفذة. وبالنسبة لتحليل عينات المياه تراوحت نسبة الصوديوم المدمص تراوح من ٣.٢١ الى ١٢.٥٤ وتركيز النترات تراوح من ١٢.٨٩ حتى ٢٩.٣٤ ملليجرام/لتر. تراوحت درجة ملوحة المياه من ١.٤٦ الى ٥.٣١ ديسيسمتر/م.

تم إعداد الخرائط بنظام kriging لكل من طبوغرافية سطح التربة وعمق الطبقات الصماء وعمق مستوى الماء الأرضى. إستخدمت الخرائط فى تقييم خطورة المناطق التى تعرضت للغدق وتصميم شبكة الصرف لتقديم الحلول لهذه المشكلة.

إستخدم برنامج SALTMOD فى التنبؤ بملوحة التربة والمياه وعمق الماء الأرضى فى ظل تواجد أعماق مصارف مختلفة. وأوضحت النتائج أن هناك اتفاق بين القيم المتنبأ بها مع القيم التى تم قياسها.