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IMPACT OF EXCESSIVE PUMPING ON GROUNDWATER QUALITY AT GOLF EL SOLMANIYA AREA, KM 56 CAIRO-ALEXANDRIA DESERT ROAD, EGYPT

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Abstract

The studied area represents one of land reclamation projects on both sides of Cairo-Alexandria Desert Road. Groundwater of the Lower Miocene aquifer plays an essential role for satisfying water requirements for different purposes. The people have now over-pumping the aquifer due intensification of cultivation. The well field comprises 23 wells; ten of them were abandoned during the last few years, while the others are subjected to salt water problem.

The objective was to assess the impact of excessive pumping on groundwater quality of the Lower Miocene aquifer and evaluating water suitability for different purposes. To achieve that, thirteen groundwater samples were collected and chemically analyzed. Computer programs are used for graphical presentation of chemical analyses and re-evaluation of step drawdown tests for some selected

wells. Construction of depth to water, water level and salinity maps, besides hydrogeological section were also carried out.

Results indicate that most of wells are operated at relatively high pumping rates accompanied with low efficiencies and specific capacities. Besides, decline of well yields and water deterioration. Therefore, reduction of groundwater withdrawal from such wells is recommended to obtain the highest well efficiency and to achieve long operation life with good water quality.

The hydrogeochemical studies revealed that the total salinity of groundwater ranging from 543 to 871ppm, with the exception of a water sample (well No. 2), that has salinity content reaches 1982ppm. The majority of groundwater is characterized by the presence of $NaHCO_3$ *and* Na_2SO_4 *water types of meteoric origin. The presence of* $MgCl_2$ *type in sample No. (2) indicates mixing of meteoric water with marine water, due to local effects. The hydrochemical coefficient* (rCl/rCO_3+HCO_3) *indicates the presence of local salt-water problems at some localities. Possible sources of salt-water enrichment in the Lower Miocene aquifer are either from leakage of saline water from shale and clay inter-beds or due to upward-leakage of old marine water along fault planes from the underlying Oligocene aquifer. Generally, the groundwater in the studied area is suitable for drinking, irrigation, livestock and poultry purposes, except well No (2), which suffers from high salinity water.*

Introduction

The area under consideration lies southwest of the Nile Delta at km 56 Cairo – Alexandria Desert Road. It is bounded by 30° 8', 30° 10' latitudes N and 30° 47', 30° 49' longitudes E. (Fig. 1). The study area (70 Km^2) has the form of a long strip of land, extending along the NE-SW direction. It represents one of land reclamation projects carrying out now on both sides of Cairo-Alexandria Desert Road. Groundwater of the Lower Miocene aquifer plays an essential role for satisfying water requirements for different purposes. The well field comprises 23 wells, their depth range between 280 and 335m, and they are designed to tap the Lower Miocene aquifer. Their discharge rate ranges from 85 to 100 m^3/hr. During the last few years, ten wells were abandoned and the others are subjected to salt water problem due to inadequate discharge. Groundwater discharges in and around the study area exceeds natural recharge, thereby causing a water level lowering and water deterioration.

Aim and methods of study

The present study deals with the impacts of excessive pumping on groundwater quality of the Lower Miocene aquifer and evaluating water suitability for different purposes. Thirteen groundwater samples were collected (Fig. 1) and chemically analyzed (Table 1). The pH, electric conductivity and total dissolved salts were measured directly in the field. Computer program GWW software was used for graphical presentation of chemical analyses and re-evaluation of step drawdown tests for some selected wells. Construction of depth to water, water level and salinity maps, besides hydrogeological section were carried out.

Geologic setting

Stratigraphy

The Moghra Formation is well represented in the study area. It belongs to the Lower Miocene, and it is mainly composed of coarse sand with shale and clay inter-beds (Fig. 2a). Three Members were recognized within the Moghra Formation (Omara and Sanad, 1975), these are:

i. El Raml Member is composed of alternating multicolored sands, sandstone and gravel of different compositions with scarce intercalating clay bands. This Member lies unconformably on basaltic flow at different depths.

ii. Bait Owian Member covers El Raml Member, and. is mainly composed of cross-bedded and ferruginous sandstone inter-bedded with clay bands. Its average thickness ranges between 25 and 30m.

iii. Monqar El Dowi Member is composed of sandy limestone and calcareous sandstone; with average thickness ranges between 2 and

8 m. This Member caps unconformably El Raml Member along the southern periphery of W. El Farigh.

Geologic structures

Generally, the surface and subsurface structures of the western Nile Delta area were discussed by many workers among them Said (1962), El Shazly, et. al, (1975), Omara and Sanad (1975) and El Ghazawi and Atwa (1994). These studies revealed that the southwestern part of Nile Delta area (in which the studied area exists) had affected by fold and fault systems.

Fold systems

Two fold systems had affected the southwestern part of the Nile Delta area; these are the NE-SW system (Syrian Arc) and the NW-SE system (Clysmic). The first system is exposed on the surface as Abu Roash anticline (Said, 1962), whereas the second one is represented by Wadi El Farigh and Wadi El Natrun anticlines (Omara and Sanad 1975).

Fault systems

According to the study made by El Ghazawi and Atwa (1994), two systems of faults had affected the southwestern part of the Nile Delta area; these are the NE-SW system (Aqaba) and the NW-SE system (Clysmic). These two systems are represented by normal faults cutting both the Oligocene and the Lower Miocene beds.

a. The NE-SW system is represented by the following faults:

i. Series of normal-faults (F1) with small vertical displacement have been recorded along Wadi El Farigh (Fig. 2b).

ii. A normal fault bounding the southern flank of Wadi El Farigh (F2) extending for a distance of more than 10 Km in a N 45° E direction and throws NW for about 40 m (Fig. 2b). The area located between this fault (F2) and Wadi El Farigh (F1) is structurally graben-like. This was confirmed by the presence of the top Oligocene basaltic sheet at deeper level (-160m) than the northern and the southern boundaries.

iii. A normal fault bounding the southern side of Gabal Hamza (F3) extending for a distance of more than 8 Km in a N 45° E and throws in SW direction for about 35 m. Gabal Hamza area is bounded by F3 and F2 faults and is structurally horst-like. This was confirmed by the presence of the top Oligocene basaltic sheet at shallow level (-78m).

iv. Ras El Hodhod Gbal-El Mansouria fault (F4) was detected in the subsurface at the southeastern portion of the southwestern part of the Nile Delta area. It extends for more than 10 Km in N70° E and throws NW for about 150 m.

b. The NW-SE Fault system is occasionally dissected by the NE-SW system and is longer than them. It is assumed to be older than the

NE-SW or of the same age. These faults are Garet El Nagar (22-Km length in N 45° W direction) and Khashm El Kalb faults (8-Km length in N 20° W direction). These faults brought the Oligocene basaltic sheet at shallow level (-27m in the up-thrown side of Khashm El Kalb fault).

Local geologic structures

It is worthy to mention that the investigated area is located north of Gabal Hamza and south of Wadi El Farigh. El Ghazawi and Atwa (1994) recorded the basaltic sheet at level -78m in Gabal Hamza (Fig 2b) and -160m at Wadi El Farigh, whereas the author detects it at levels -234 and -248m in the studied area (Fig. 2a). This confirms the presence of a normal fault between the studied area and Gabal Hamza. The basaltic sheets exist at different levels at the boundaries of the investigated area, consequently, the basaltic sheets and the underlying clay and sand inter-beds (Oligocene aquifer) come in contact with the Lower Miocene sediments (Lower Miocene aquifer).

Hydrogeology

The Lower Miocene aquifer (Moghra aquifer) covers a wide area in W. El Farigh area and extends westward to Moghra Depression. The recharge takes place through lateral seepage from the Nile Delta aquifer. Dahab et. al. (1998) added that, the groundwater is considered as mixture of paleo-water and renewable water. The amount of recharge was estimated 84×10^{6} m^3/year (Diab, et al. 1992). The discharge of the Lower Miocene aquifer mainly takes place through the extraction from the sporadic wells in Wadi El Farigh and along Cairo-Alexandria Desert Road, which were drilled by different authorities and private sector. Moreover, the Lower Miocene groundwater is relatively discharged into the Pliocene aquifer, particularly at the southern portion of Wadi El Natrun, where the two aquifers are connected (Gomaa, 1995). High extraction rate (20-30$\times10^{6}$ m^3/year/Km^2) was found along Cairo-Alexandria desert road. The extraction of large volumes of groundwater allows the formation of several cones of depression. Since the extraction rates are still increasing, the lowering of the water level will continue in the future (RIGW/IWACO, 1990b).

The Lower Miocene aquifer in the study area is mainly composed of sand with shale and clay inter-beds. Its thickness ranges between 184 and 243 m. The saturated thickness of this aquifer decreases in some places due to the presence of faults, which are responsible meanwhile for elevating the Oligocene basaltic sheets (Fig. 2a & b). Accordingly, this aquifer is hydraulically connected with the underlying Oligocene aquifer. The transmissivity values of the Lower Miocene aquifer ranges between 46.9 and 855.3 m^2/hr, which indicates a low to high potentiality. The calculated values of hydraulic conductivity varies from 0.24 to 4.65 m/hr (El Refae, 2001).

The depth to water increases to the south of the investigated area (104m) and decreases (87m) to the north (Fig. 3). The water level contour map (Fig. 4) shows that high water level (2m) is recorded southwest of the study area and the lower one (-5m) is detected at the south. The interference of cones of depression are pronounced in the central portion of the investigated area, this is referred to excessive withdrawal from the aquifer.

Hydraulic parameters of some selected wells

More than 23 well have been drilled in the study area. During the last few year some wells were abandoned due to inadequate discharge. As a matter of fact the yield of any well depends on the aquifer characteristics, well parameters and the pump efficiency. A decline in the well yield is due to change in one or more of these elements (Hamill and Bell, 1986). As the aquifer is proved to be of high potential, then the well design may be responsible for the inadequate water discharge. For this reason the well parameters of some wells, for which the data of step-drawdown tests are available, have been calculated and evaluated using the GWW software. The parameters include specific capacity, well loss and well Efficiency. Specific capacity of a well is the yield per unit of drawdown and is determined by dividing the pumping rate at any time during the test by the drawdown of the same time. Well efficiency is an important consideration in well design and in well construction and development. Well efficiency (E) is defined as the ratio of drawdown in the aquifer (s_a) at the radius of the pumping well to the drawdown inside the well (s_t).

The total drawdown in a well (s_t) is often represented by an equation (Jacob, 1947) of the form:

$s_t = s_a + s_w$

$E = (s_a/s_t) \times 100$

Where s_w is the well loss and E is well efficiency

The results of the analyses of step pumping tests for some selected wells are represented graphically in (Fig. 5). The general observations are summarized as follows: -

1-Well loss and aquifer loss increases with increasing pumping rate.

2-Well specific capacity and well efficiency decrease with increasing pumping rate.

3- The actual production rates of well Nos. 2, 4, and 7 are 95.7, 89.36, and 90.15 m^3/hr; the corresponding well efficiencies are 47.4%, 58.2% and 59.4%, respectively. This indicates that these wells are operated at relatively high pumping rates accompanied with relatively low efficiencies and specific capacities, high well loss and aquifer loss.

Proper well design and suitable production rate can minimize well loss and increases specific capacity and efficiency of wells. So, the present pumping rates must be corrected to obtain the highest well efficiency and well specific capacity to achieve long operating life.

Hydrogeochemistry

Total salinity

The iso-salinity contour map of the Lower Miocene aquifer constructed by Diab, et. al (1992) indicates that the salinity ranges between 200 and 400ppm in the southeastern part of Wadi El Farigh area. El Ghazawi and Atwa (1994) recorded that the salinity of the Lower Miocene aquifer in the southwestern part of the Nile Delta, in which the studied area exists, ranges between 281.6 and 823pp.

Results of chemical analyses of groundwater samples indicate that the salinity ranges from 543 to 871ppm, with an average of about 660ppm (Table 1), this reflects good water quality. With exception of water sample at well No. 2, which has salinity content reaches to 1982ppm and is classified as fairly fresh water. The salinity distribution map (Fig. 6) and the hydrochemical profiles (Fig. 7) show low salinity (ranges between <600 and 700ppm) at southern half of the study area, whereas the highest one (> 1000ppm) is recorded at the northwest. Possible sources of saltwater enrichment in the lower Miocene aquifer are either from the leakage of saline water from shale and clay inter-beds or due to upward-leakage of old marine water along fault planes from the underlying Oligocene aquifer, which characterized by relative high salinity. It is worthy to mention that El Ghazawi and Atwa (1994) recorded that the salinity of the Oligocene aquifer in the southwestern part of the Nile Delta reached 2566ppm.

Hydrochemical parameters

rNa/rCl

The ratio rNa/rCl reflects the continental atmosphric water type when the value is greater than one, while the genesis of water will be of the marine origin when the values is less than one (Sulin, 1948; Hounslow, 1995). The rNa/rCl ratio varies between 1.03 and 2.6 (Table 1); this indicates the continental origin of the groundwater. With exception of well number 2, the rNa/rCl ratio is less than unity (0.93). This indicates that the groundwater of Lower Miocene aquifer is suffering from salt-water problem due to excessive withdrawals.

[r(K+Na)-rCl]/rSO_4

The ratio[r(K+Na)-rCl /rSO_4] represents the $NaHCO_3$ water type of shallow meteoric origin when the value is greater than one, while it represents the Na_2SO_4 water type of meteoric genesis when the value is less than one (Sulin, 1948). About 53.84% of the investigated water samples have [r (K+Na)-rCl]/$rSO_4<1$ (Table 1), where the ionic concentration of both Potassium and Sodium is higher than Chloride but lesser than the total concentration of Chloride and Sulphate ions. This reflects Na_2SO_4 water type of meteoric origin. 38.46% of water samples have [r (K+Na)-rCl]/$rSO_4>1$ in which the total ionic concentration of potassium and sodium is greater than that of chloride and sulphate. This reflects $NaHCO_3$ water type of meteoric genesis.

[rCl-r(K+Na)]/rMg

The ratio [rCl- r(K+Na)/]rMg represents the $CaCl_2$, water type of old marine origin when the value is greater than one, while it represents $MgCl_2$ water type of marine genesis when the value is less than one (Sulin, 1948). 7.7% of water samples has [rCl-r(K+Na)]/rMg<1 (Table 1) and reflect $MgCl_2$ water type of marine origin. The presence of $MgCl_2$ water type (well No. 2) indicates washing of shales and clays inter-beds by the meteoric water percolation, or due to mixing with relative saline water discharges along fault planes.

rCl/r(CO3+HCO3)

The Revelle coefficient is defined as the ratio of rCl/r (CO3+HCO3) ion concentration in meq/l (Revelle, 1941). Values of more than 10 are considered to be indicative of the presence of seawater in aquifer, whereas values less than one imply good quality fresh water (Tavitian, 1994). The Revelle coefficient of well numbers 2, 4, 12 and 13 vary from 1.121 to 7.78 (Table 1), indicating salt-water problem in these wells.

Hypothetical salt assemblages

The ion dominance reveals the occurrence of three salt assemblages in groundwater of the Lower Miocene aquifer (Table 1) as following:

1. KCl, NaCl, Na_2SO_4, $NaHCO_3$, Mg $(HCO_3)_2$ and Ca $(HCO_3)_2$ (38.46% of samples).
2. KCl, NaCl, Na_2SO_4, $MgSO_4$, Mg $(HCO_3)_2$ and $Ca(HCO_3)_2$ (53.84% of samples).
3. KCl, NaCl, $MgCl_2$, $MgSO_4$, $CaSO_4$ and Ca $(HCO_3)_2$. (7.7% of samples)

The presence of $MgCl_2$ water type, which characterized marine origin in well no. 2, is mainly due leakage of saline groundwater from shale and clay intercalation as result of over pumping.

Semi-logarithmic representation

The plotting of hydrochemical data on Schoellar's diagram (Fig. 8) shows that 92.3% of groundwater samples have similar pattern, where the sequence of cation dominance has the order: $Na^+ > Ca^{++} > Mg^{++}$ and the sequence of anion dominance has the order: $HCO_3^- > Cl^- > SO_4^{--}$. Such pattern reflects fresh water of meteoric origin. On the other hand, sample No. (2) 7.7% has different pattern, where the sequence of cation dominance has the order: $Na^+ > Mg^{++} > Ca^{++}$ ++ and the sequence of anion dominance has the order: $Cl^- > SO_4^{--} > HCO_3^-$. Such pattern is similar to that of seawater and reflects the mixing process of meteoric water with marine water in well number 2.

Groundwater Quality assessment

Groundwater Quality assessment for different purposes is very important, particularly when taking into consideration the future spread of population into the desert areas where the groundwater is the main source of water. This is based on the comparison of chemical analyses of groundwater samples (Table 1) with the international standards.

Suitability of groundwater for domestic purposes

Since groundwater is the only available source of fresh water in the area, it is widely used for drinking. According to the WHO (1984a) standard, drinking water should not contain more than 1000ppm TDS, 250ppm chloride and sulphate, 150ppm magnesium, and 200ppm sodium and calcium. The comparison between the chemical analyses of groundwater samples (Table 1) with the recommended limits (WHO, 1984a) reveal that the groundwater is suitable for drinking, except for sample No 2.

It is worthy to mention that hardness in water is attributable to the presence of calcium and magnesium ions. According to the limits published by Hem (1979), the groundwater is ranged from hard to very hard, where the total hardness ranges between 166ppm and 416ppm (Table 1).

Suitability of groundwater for irrigation purposes

The increase of TDS in irrigation water causes an excessive increase in its content in the soil which in turn affects badly the growth and yield of plants. The TDS should not generally exceed 1000ppm, but it has been found that this limit does not hold well when the salts are present in the form of carbonates and bicarbonates. Hence, the groundwater of the Lower `Miocene aquifer is suitable for irrigation purpose, except for well No 2.

The increase of sodium ions in irrigation water cause a reduction in soil permeability and cause soil to be hardens. Both effects are attributed to cations exchange of calcium and magnesium by sodium ions on clay minerals and colloids (Hamill and Bell, 1986). The U.S. Salinity Laboratory Staff (1954) illustrated on figure (9) is taken into consideration. Results revealed that the groundwater samples are suitable for irrigation purposes except for sample No. 2, where it lies in the intermediate water class (SAR > 18)

The increase of chloride ions in irrigation water hinders the uptake of phosphoric acid and phosphates and the excessive absorption is toxic for some plants. According to the limits published by Ayers (1975), the groundwater samples are suitable for irrigation purposes except for sample No. 2, where chloride ions >355ppm and cause severe problem.

Suitability of groundwater for livestock and poultry

According to the classification of water for livestock and poultry published by the National Academy of Science (1972), the groundwater samples of Lower Miocene aquifer are suitable for livestock and poultry, except for sample No. 2. High salinity values may cause temporary and mild diarrhea in livestock or watery dropping in poultry.

Conclusions

1-The Lower Miocene aquifer in the study area is mainly composed of sand with shale and clay inter-beds. Its thickness ranges between 184 and 243 m. The saturated thickness of this aquifer is decreased in some places due to the presence of faults, which are responsible meanwhile for elevating the Oligocene basaltic sheet. Accordingly, this aquifer is hydraulically connected with the underlying Oligocene aquifer, where both aquifers come in contact with each other.

2-Most of wells are operated at relatively high pumping rates accompanied with low efficiencies and specific capacities. Besides, decline of well yields and water deterioration.

3-The Hydrogeochemical studies reveal that the total salinity of groundwater ranging from 543 to 871ppm, with exception of water sample (well No. 2) has salinity content reaches to 1982ppm. The majority of groundwater is characterized by the presence of $NaHCO_3$ and $Na_2 SO_4$ water types of meteoric origin. The presence of $MgCl_2$ type in some wells indicates mixing of meteoric water with marine water, due to local effects. The hydrochemical coefficient (rCl/rCO_3+HCO_3) indicates the presence of local saltwater problems at some localities. Possible sources of saltwater enrichment in the Lower Miocene aquifer are either from leakage of saline water from shale and clay inter-beds or due to upward-leakage of old marine water along fault planes from the underlying Oligocene aquifer.

4-Generally, the groundwater in the studied area is suitable for drinking, irrigation, livestock and poultry purposes, except well No (2) which suffers relative increase of salinity.

Recommendations

1-Proper well design and suitable production rate can minimize well loss and increases specific capacity and efficiency of wells. So, the present pumping rates must be corrected to get the highest well efficiency and well specific capacity to achieve long operating life with good water quality.

2-It is vital that a groundwater quality-monitoring program must be established as a matter of priority.

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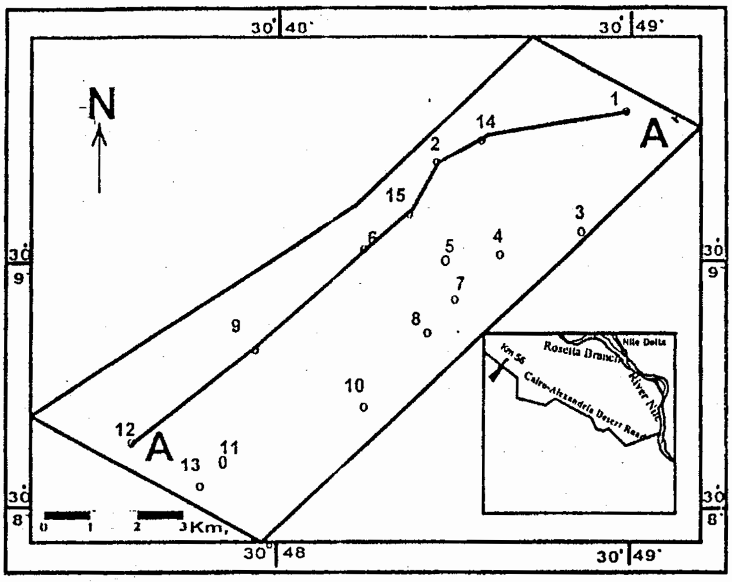

Fig. (1) Location map of the study area and well sites

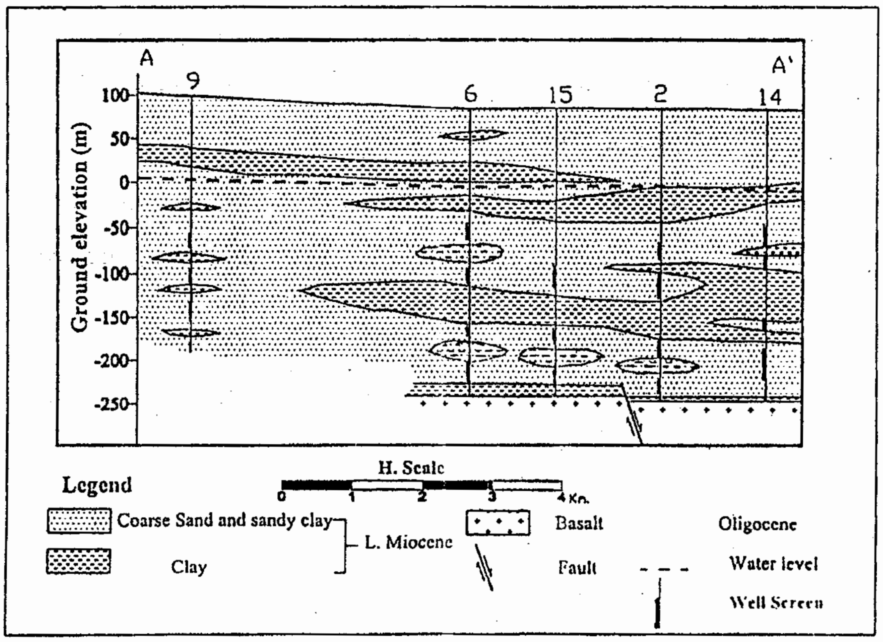

Figure (2a) Hydrogeologic cross-section (A - A').

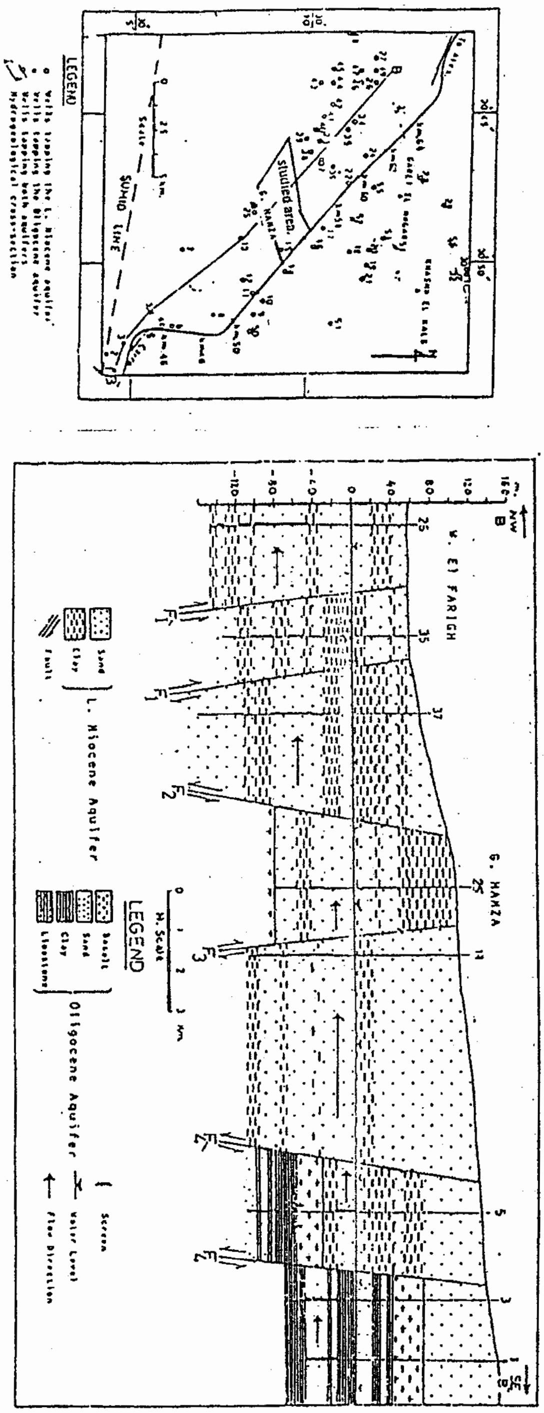

Figure (2b) Hydrogeologic cross-section (B - B) . (after El Ghozawi and Atwo 1994)

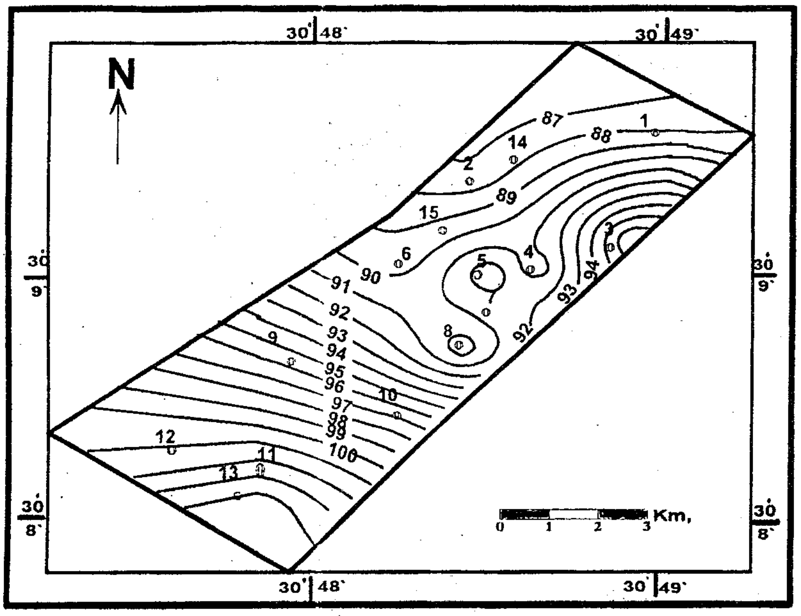

Fig. (3) Depth to water map of Lower Miocene aquifer

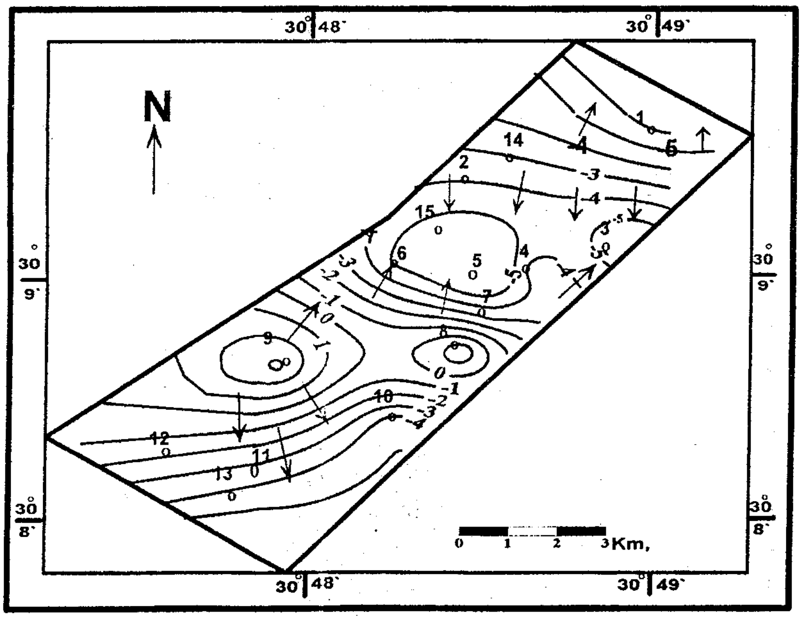

Fig. (4) Piezometric level map of Lower Miocene aquifer

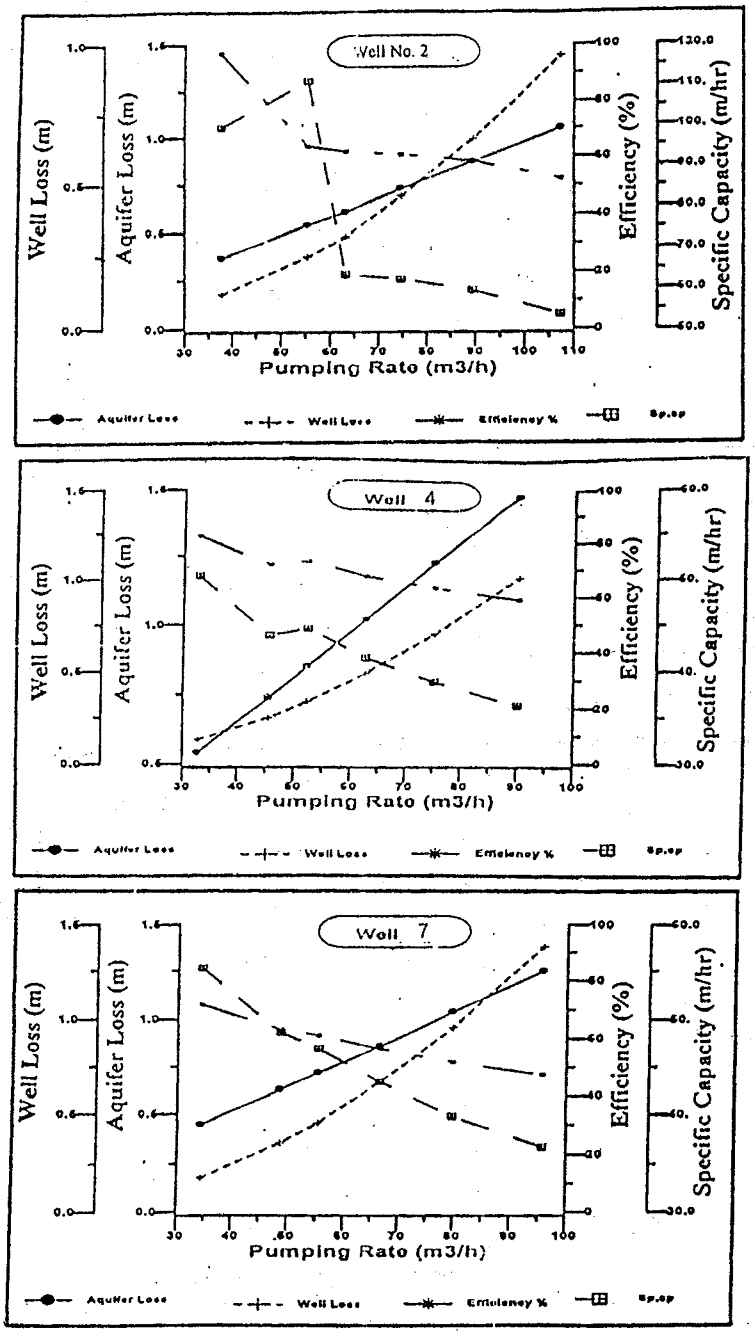

Figure (5) Relationship between pumping rate and specific capacity, aquifer loss, well loss, and efficiency of selected wells.

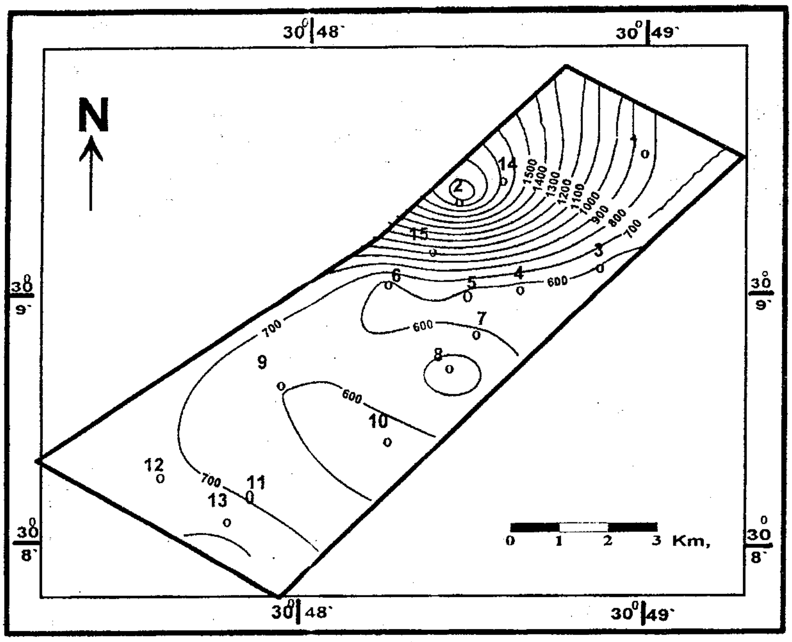

Fig. (6) Salinity content distribution map of the the L Miocene aquifer

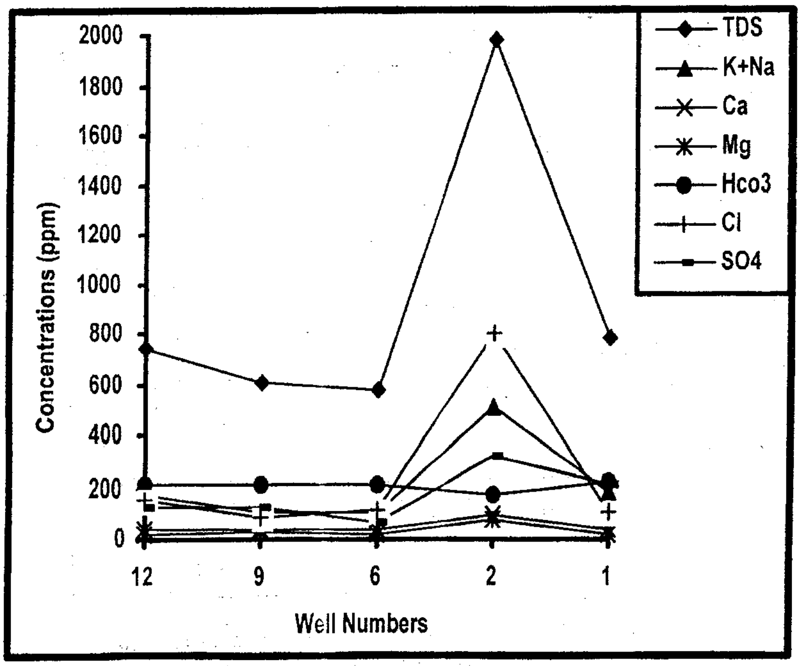

Fig. (7) Hydrochemical profile (A-A`) of the L. Miocene aquifer

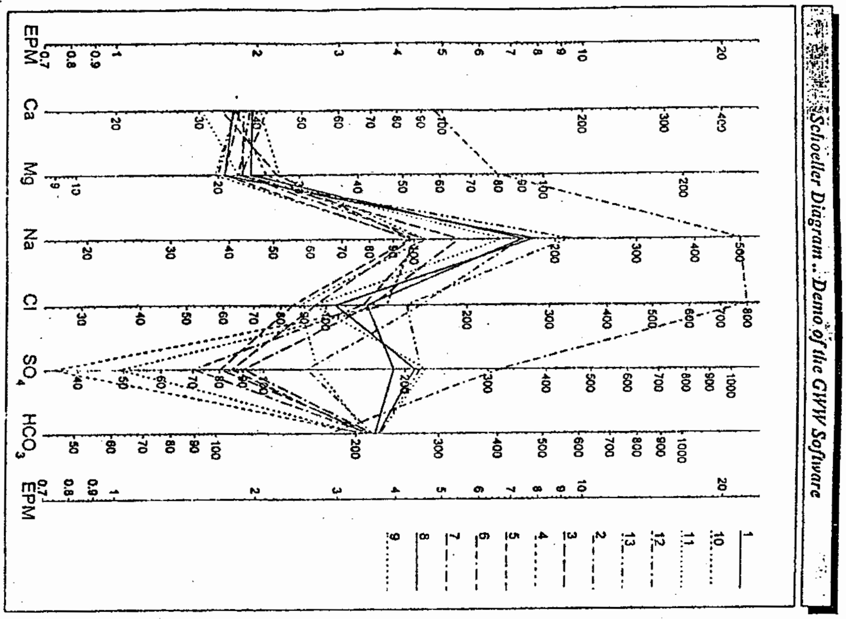

Figure (8) Schoeller's diagram for groundwater samples presentation.

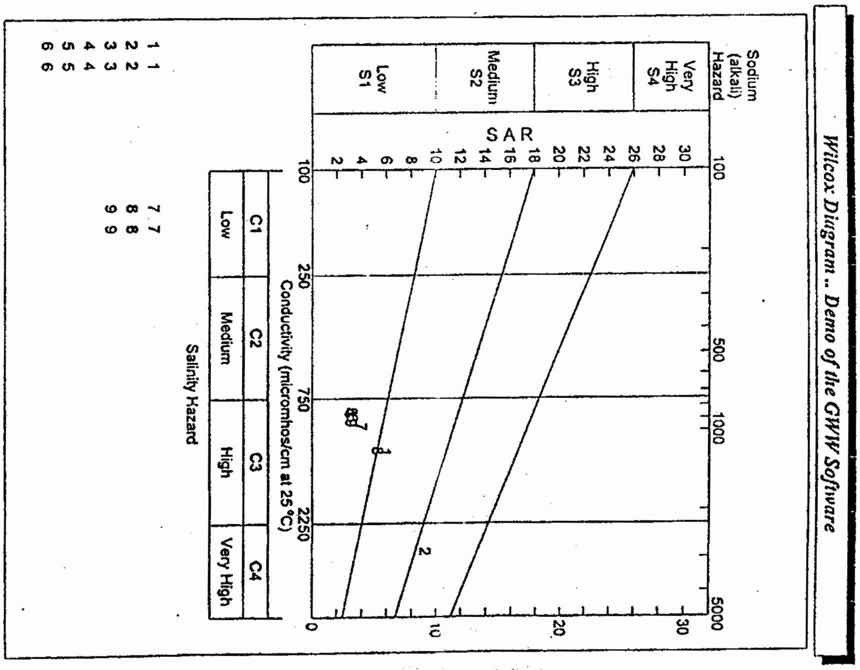

Figure (9) U.S Salinity diagram for classifying groundwater.

Table (1) Results of chemical analyses of groundwater samples

Serial No.	pH	Total Hardness	Ec Us/Cm at 25°C	TDS mg/L	unit	K^+	Na^+	Mg^{+2}	Ca^{-2}	Cl^-	SO_4^{-2}	HCO_3^-
1	7.2	166	1196	778	ppm	6.45	180	20.7	35.6	105	210	223.3
					epm	0.16	7.6	1.6	1.67	2.96	4.4	3.65
					epm%	1.45	68.9	14.51	15.14	26.88	39.96	33.16
2	8.5	416	2872	1982	ppm	7.8	500	79.7	96	800	320.7	176.9
					epm	0.19	20.87	6.39	4.79	22.5	6.68	2.89
					epm%	0.59	64.73	19.82	14.86	70.16	20.82	9.01
3	8.3	196	861	560	ppm	6.5	99.2	26.9	33.6	95	85.3	211.1
					epm	0.16	3.88	2.21	1.67	5.67	1.77	3.46
					epm%	2.02	48.99	27.9	21.08	33.8	22.4	43.8
4	8.7	188	841	547	ppm	6.1	100.5	25.5	36	135	35.5	207.4
					epm	0.15	3.93	1.93	1.79	3.8	0.74	3.39
					epm%	1.92	50.38	24.75	22.95	47.92	9.33	42.75
5	8.2	170	838	545	ppm	6.4	98	20.7	36.8	85	80.6	217.2
					epm	0.16	4.13	1.53	1.83	2.39	1.67	3.56
					epm%	2.1	53.98	20	23.92	31.36	21.92	46.72
6	7.8	200	892	580	ppm	6.5	105.2	22.5	42.4	120	70.4	213.5
					epm	0.16	4.4	1.85	2.1	3.4	1.46	3.5
					epm%	1.88	51.7	21.74	24.68	40.66	17.5	41.84
7	7.9	184	964	627	ppm	6.3	125	22.6	37.6	125	90.6	217.2
					epm	0.16	5.2	1.78	1.87	3.52	1.88	3.58
					epm%	1.77	57.81	19.71	20.71	39.28	20.98	39.73
8	7.9	184	1189	773	ppm	6.6	170	23.6	39.2	122	189.1	219.6
					epm	0.17	7.17	1.69	1.95	3.44	3.93	3.59
					epm%	1.5	65.3	15.4	17.8	31.38	35.88	32.74
9	8.4	212	930	605	ppm	6.5	105.6	27.2	40.8	88	130.7	211.1
					epm	0.16	4.3	2.2	2	2.5	2.7	3.46
					epm%	1.85	49.65	25.4	23.1	28.87	31.15	39.95
10	7.8	172	835	543	ppm	6.2	100	19.7	36	134.5	49.2	204.9
					epm	0.16	4.34	1.62	1.79	3.52	1.02	3.36
					epm%	2.02	54.86	20.5	22.62	44.5	13	42.5
11	8.2	168	1164	757	ppm	6.35	155	22.1	30.4	95	220.7	225.7
					epm	0.16	7.6	1.6	1.67	2.68	4.7	3.7
					epm%	1.4	69	14.5	15.1	24.41	41.89	33.7
12	8.1	168	1136	739	ppm	7.5	170	22.24	38.8	160	124.5	217.2
					epm	0.19	7.17	1.5	1.83	4.51	2.59	3.58
					epm%	1.78	67.07	14.03	17.12	42.3	24.3	33.4
13	7.9	174	1340	871	ppm	6.6	215	20.16	36	149	215.8	225.7
					epm	0.16	8.87	1.66	1.8	4.2	4.49	3.69
					epm%	1.28	71.01	13.3	14.41	39.92	36.27	29.81

Serial No.	Hydrochemical Parameters							Hypothetical Salt Combinations									
	$\frac{rNa^+}{rCl^-}$	$\frac{rMg^{++}}{rCl^-}$	$\frac{rCa^{++}}{rCl^-}$	$\frac{rSO_4^{--}}{rCl^-}$	$\frac{rCl^-}{rCO_3^{--}+}$	$\frac{rCl^- - r(K+Na)}{r\,Mg}$	$\frac{r(K+Na)-rCl^-}{rSO_4}$	KCl	NaCl	Na_2SO_4	Na HCO_3	Mg Cl_2	Mg SO_4	$Mg(HCO_3)_2$	Ca Cl_2	Ca SO_4	Ca $(HCO_3)_2$
1	2.56	0.45	0.56	1.48	0.81		1.1	1.45	25.4	40	3.51			14.5			15.1
2	0.93	0.28	0.21	0.296	7.78	0.22		0.59	64.7			4.48	15			5.85	9.01
3	1.45	0.82	0.62	0.66	1.64		0.77	2.02	31.8	17.2			5.19	22.7			21.1
4	1.03	0.5	0.47	0.2	1.12		0.378	1.92	46	4.38			4.95	19.8			23
5	1.7	0.64	0.76	0.7	0.67		1.137	2.1	29.3	21.9	2.8			20			23.9
6	1.29	0.54	0.62	0.43	0.97		0.79	1.88	38.8	12.9			4.58	17.2			24.7
7	1.48	0.5	0.53	0.53	0.99		0.99	1.77	37.5	20.3			0.68	19			20.7
8	2.08	0.49	0.56	1.1	0.96		0.99	1.5	29.9	35.4			0.46	14.9			17.8
9	1.72	0.88	0.8	1.08	0.72		0.72	1.85	27	22.6			8.55	16.9			23.1
10	1.23	0.46	0.5	0.29	1.05		0.989	2.02	42.5	12.4			0.62	19.9			20.7
11	2.6	0.55	0.58	1.6	0.72		1.06	1.4	23	41.9	41			14.5			15.1
12	1.6	0.33	0.4	0.57	1.26		1.1	1.78	40.5	24.3	2.25			14			17.1
13	2.11	0.39	0.42	1.07	1.14		1.07	1.28	32.6	36.3	2.1			13.3			14.4

أثر الضخ الزائد على نوعية المياه الجوفية فى منطقة جولف السلمانية طريق القاهرة –الإسكندرية الصحراوي (كم ٥٦) ، مصر.

محمد عبد الله الفخرانى
قسم الجيولوجيا–كلية العلوم–جامعة بنها

تمثل منطقة الدراسة احد مشروعات التنمية القائمة على استغلال المياه الجوفية المستخرجة من خزان الميوسين السفلي. ولكن فى السّنوات القليلة الماضية تعرضت بعض الآبار لمشكلة تملح المياه مما سبب عدم صلاحيتها للأغراض المختلفة.

يهدف البحث الى دراسة اثر الضخّ الزائد على نوعية المياه الجوفية وتقييمها للاستخدام فى الأغراض المختلفة . ولتحقيق ذلك أعيد تقييم تجارب الضخ على مراحل لبعض الآبار لدراسة تأثير زيادة السحب على كفاءتها. بالإضافة الى جمع وتحليل ١٣ عينة من المياه الجوفية ودراستها من الناحية الهيدروجيوكيميائية ومقارنتها بالمقاييس العالمية للاستخدام فى الأغراض المختلفة. وقد كان من أهم نتائج الدراسة الآتي:

ودراستها من الناحية الهيدروجيوكيميائية ومقارنتها بالمقاييس العالمية للاستخدام فى الأغراض المختلفة. وقد كان من أهم نتائج الدراسة الآتي:

١- الضخ الجائر للمياه الجوفية من خزان الميوسين السفلي يسبب زيادة في انخفاض منسوب المياه ونقص كفاءة الآبار بالإضافة الى قلة الإنتاج وتغير نوعية المياه.

٢-المياه الجوفية فى منطقة الدراسة تكون عذبة(٥٤٣-٨٧١ جزء فى المليون) ومن اصل جوى ونوعيتها بكربونات الصوديوم $Na HCO_3$ وكبريتات الصوديوم ($Na_2 SO_4$) باستثناء مشاكل ارتفاع ملوحة المياه في بعض الآبار(١٩٨٢جزء فى المليون) وتغير نوعيتها الى كلوريد الماغنسيوم ($Mg Cl_2$) الذى يميز الأصل البحري للمياه. وقد ارجع مصدر ارتفاع ملوحة المياه وتغير نوعيتها الى تسرب المياه المالحة من الطفل والطين المتداخل مع مكونات الخزان أو إلى خلط المياه العذبة مع مياه بحرية قديمة صاعدة عن طريق فوالق من خزان الأوليجوسين.

٣-المياه الجوفية فى منطقة الدراسة تكون صالحة للاستخدام فى الأغراض المختلفة باستثناء منطقة البئر رقم (٢) حيث ان نتائج التحاليل الكيميائية قد تجاوزت المعايير العالمية. هذا وقد انتهت الدراسة إلى مجموعة من التوصيات.