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Evaluating the Groundwater Quality for Irrigation of the Western Limestone Plateau in Assuit Region, Egypt

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Abstract:

The western desert of Egypt is an area of the natural extension for agricultural, industrial, and civil activities. The expansion requires a great demand for groundwater on the western limestone plateau in the central part of Egypt. Ten groundwater samples were collected from limestone Eocene aquifer wells located in the western desert, Assiut region.to evaluate the quality of these well waters for irrigation. The area under consideration lies between latitudes 27^o 7' 540" – 27^o 34' 474" N and longitudes 30^o 39' 487" – 30^o 53' 244"E. The chemical properties of groundwater of the investigated aquifer wells were determined, such as, major ions, pH, EC, TDS, SAR, RSC, RSCB, SSP, magnesium hazard (MH), total hardness (TH) and permeability index (PI). The concentration of the cations in the groundwater of the study area is in the order of Na^+> Ca^{2+}> Mg^{2+}> K^+ and that of the anions is in the order of Cl^-> HCO_3^{2-}> SO_4^{2-} .Values of the groundwater quality show that the water is suitable for the irrigation use, except the EC values of some wells that have a moderately saline water.

Keywords: Limestone, groundwater quality, Eocene aquifer, irrigation purposes, Assiut.

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Introduction:

Agriculture in Egypt depends mainly on irrigation from the Nile River. The need to provide additional land to increase food production compels the farmers to use all available sources of water. Groundwater is the primary source of water for domestic, agricultural and industrial uses in many new reclamation areas. Therefore, the quantity and quality of groundwater is extremely important in maintaining these resources. In general, Assiut region is distinguished by limestone plateaus on both eastern and western sides. The limestone plateau in Assiut region is a part of the major Eocene plateau that covers major parts of the western and Eastern Deserts of Egypt. The study area is located to the north west part of Assiut city, and represents a part of reclaimed land in Assiut governorate. The area under consideration has coordinates between latitudes 27^o 7' 540" – 27^o 34' 474" N and longitudes 30^o 39' 487" – 30^o 53' 244"E (Fig.1).

The limestone aquifer is evaluating and defining by several authors; (Allam *et al*, 2002; Abou Heleika and Niesner, 2009; Dawoud, 2004; El Arabi, 2012; Kashouty, 2013; Elbeih, 2014; Mohamed, 2010). The karstified carbonate aquifer system, assigned to the Eocene and Upper Cretaceous strata, predominates essentially in the north and middle parts of the western desert. The fissured and karstified carbonate aquifer complex is the least explored and exploited in Egypt, although it occupies at least 50% of the total area of the country. (Allam *et al.,* 2002; El-Arabi, 2012). The depth of the wells is greater than 100 meters. These wells were drilled by percussion techniques to extract water from sedimentary sub-basin. (Dawoud, 2004).

The evaluation of groundwater resources for development requires an understanding of the hydrogeology and hydrogeochemical properties of the aquifer. The development of groundwater resources in these arid and semi-arid regions is a sensitive issue, and careful management is required to avoid water-quality degradation (Dassi 2010; Trabelsi *et al.* 2007).

Geology and Hydrogeology:

The area under investigation mostly consists of Eocene limestone of Thebes Formation or its equivalents (Thebes Group). These Eocene rocks constitute the most common outcrops capped by an alluvial cover. This cover consists of relatively flat, poorly consolidated sand, gravel, silt, and clay which belong to the Pleistocene and Holocene epochs.

Geomorphologically, the studied area is a moderately elevated plateau relative to the Nile banks and it consists mainly of limestone beds. The plateau elevation ranges between 120 and 300 m a.s.l. (the average elevation of the river banks is 35 m), with a gentle slope northward (Fig.2, a. and Table 1).

Osman (1980) pointed out that the Eocene lime stone plateau at Assiut region was influenced structurally by several joint systems and flexures (e.g. faults and folds) of different directions. The fault trends were arranged according to their decreasing order as, N 35 W, N-S, N45 E and E-W trends.

Mohamed (2010) pointed out that the average value of the transmissivity for the fractured Eocene limestone aquifer of Assuit district ranges between 85.089 and 408.07m^2/day reflecting that this aquifer is moderately potential.

Groundwater potential:

The groundwater of the fractured Eocene limestone aquifer on the western limestone plateau in the central part of Egypt varies between 15 and 94m from the ground surface. (Abou Heleika and Niesner, 2009, Mohamed, 2010).

The groundwater depth of the fractured Eocene limestone aquifer in the study area varies between 80 and 190m from the ground surface (Fig. 2b and Table 1).

The quaternary and limestone aquifers are hydraulically interconnected; the former is also interconnected with the Nile River (Maxey, 1964). Due to the scarcity of rainfall over the central part of Egypt, the recharging of the main aquifer is probably from nearby aquifers through cracks and fractures (Abou Heleika and Niesner, 2009). The water recharge to these aquifers depends essentially on the upward leakage from the underlying Nubian sandstone aquifer and occasionally from local rainfall (Allam *et al*., 2002; El Arabi, 2012).

Abou Heleika and Niesner (2009) reported that the interpreted results reveal a promising groundwater potential zone in the central part of Egypt with sizeable amounts of groundwater available for agriculture and/or industrial purposes.

Groundwater quality:

Amer *et al.* (2012) studied that groundwater quality and management in central eastern desert, and stated that the groundwater trapped in Duwi formation limestone and in the Nubian aquifer falls in the field of very high salinity (C4) and medium and high SAR (S2 and S3), respectively, and can only be used to irrigate organic soils with special soil management practices.

Mohamed (2010) studied that groundwater quality in the north-west area of Assiut District, and stated that the groundwater in the Eocene aquifer falls in the field of low, medium and very high salinity (C1, C2, C4) and low, medium, high and very high SAR (S1, S2, S3, S4), respectively.

Climate:

According to the climatological normal condition of Egypt, the western and eastern desert falls under an arid climate condition with an extremely low rainfall. The temperature and evaporation rates are very high. The average daily temperature ranges from 5 to 21 °C in winter (Min. temp. 5.0 to 9.5 °C) while in the relatively long summer, it ranges from 20 to 42 °C (Max. temp. 36.5 to 42.0 °C).

The total annual rainfall in Assiut is about 0.5 mm. The relative humidity increases gradually from Bani Suef (36%) to Aswan (38%) (Fanous, 1984; Marei, 1996).

Groundwater is the only water resource that is available for agricultural extension and land reclamation on the limestone plateau of the western desert in Assiut region. Therefore, the evaluation of the groundwater quality is considered the first step to a good, sustainable management for groundwater and soil resources. So, the current study aims to evaluate the quality of these waters in this area for irrigation and draw contour maps with respect of water quality parameters.

Material and Methods:

Ten groundwater samples were collected from a limestone Eocene aquifer wells located in the western part of the Nile river, Assiut area in November 2013(Fig1) (Table 1) to evaluate the water of these wells for irrigation. The borehole depth of the groundwater wells ranged from 130 to 250 m.

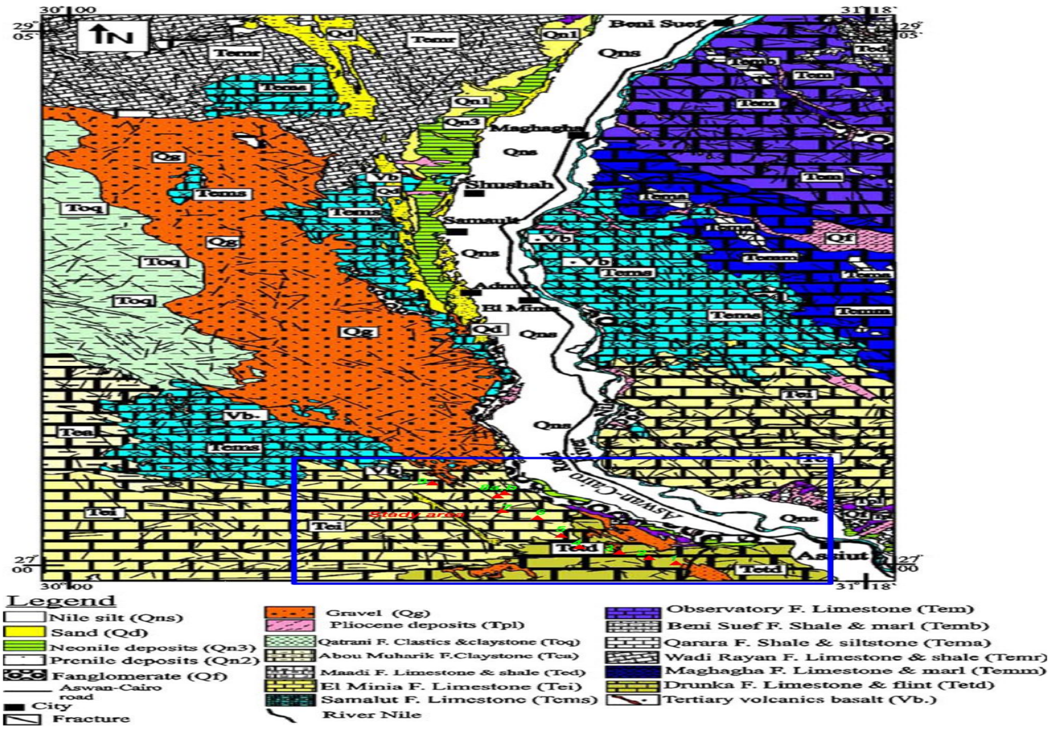

Fig. (1): A geologic map of the study area and its vicinities (modified after Conoco Coral Egypt 1987).

The groundwater samples were taken by means of well pumps after a pumping period of at least 1 h to avoid any local contamination or evaporation. GPS instrument is used to locate each well site. Pre-rinsed polypropylene bottles were filled with the samples and sealed tightly. The collected groundwater samples were analyzed in the laboratories for the major constituents using the standard methods. The measurements included the pH, electrical conductivity (EC), and the major ions (calcium, magnesium, potassium, sodium, chloride, carbonate, bicarbonate, and sulphate).

- Groundwater-pH was measured using a glass electrode as reported by Mclean (1982).

- Electrical conductivity (EC) was determined using the salt bridge method (Rhoades, 1982).

- Soluble cations: Calcium (Ca^{2+}) and magnesium (Mg^{2+}) were determined using the titration with a standard versenate (EDTA) solution, while sodium (Na^+) and potassium (K^+) were measured using the flamephotometery method (Jackson, 1973).

- Soluble anions: Carbonates (CO_3^{--}) and bicarbonates (HCO_3^-) were determined by the titration with a standard solution of hydrochloric acid; chlorides (Cl^-) were determined using a standard solution of silver nitrate and sulphates (SO_4^{--}) were spectrophotomety measured using the turbidmetery method (Jackson, 1973).

- The total hardness (TH) in mg/l (Todd, 1980; Ragunath, 1987) was determined by the following equation. 1:

$$TH=2.497xCa^{2+}+4.115xMg^{2+} \quad (1)$$

where the concentrations of Ca^{2+} and Mg^{2+} are represented in mg/l.

- The sodium adsorption ratio (SAR) was calculated for each well water by the following equation given by Richards (1954):

$$SAR=Na^+/((Ca^{2+}+Mg^{2+})/2)^{½} \quad (2)$$

where the ion concentrations are expressed in meq/l.

The sodium percentage (%SSP) was calculated using the formula given below (Todd and Mays, 2005):

$$\%SSP=(Na^+)x100/(Mg^{2+}+Ca^{2+}+Na^++k^+) \quad (3)$$

where all ionic concentrations are expressed in meq/l.

- The residual sodium carbonates (RSC) is calculated by the following equation (Ragunath, 1987):

$$RSC=(HCO_3^-+CO_3^{2-})-(Mg^{2+}+Ca^{2+}) \quad (4)$$

where all ion concentrations are reported in meq/l.

The residual sodium bicarbonates (RSBC), as defined by Gupta and Gupta (1987), is calculated by the following equation.

$$RSBC=(HCO_3^- - Ca^{2+}) \quad (5)$$

where ion concentrations are expressed in meq/l.

-The magnesium hazard (MH) is proposed by Szabolcs and Darab (1964) for irrigation water as the following formula.

$$MH=100x[Mg^{2+}\backslash(Mg^{2+}+Ca^{2+})] \quad (6)$$

where all ionic concentrations are expressed in meq/l.

-The permeability index (PI), as defined by Doneen (1964) and Ragunath (1987), is calculated by the following equation:

$$PI=[([Na+]+[HCO_3^-]^{1/2})]x100/(Mg^{2+}+Ca^{2+}+Na^++k^+) \quad (7)$$

where all ions are expressed in meq/l.

Table (1): location, water to depth and elevation of the groundwater samples

Sample No.	Well No.	Location	Total depth (m)	Depth to water (m)	Elevation (m.asl)	Designation
1	1	N27 07 540 E30 56 553	250	190	222	Irrigation
2	2	N 27 09 631 E 30 53 244	230	180	198	Irrigation
3	3	N27 11 216 E30 52 398	200	145	177	Irrigation
4	4	N27 13 645 E30 49 856	210	155	166	Irrigation
5	5	N27 15 855 E30 48 133	240	175	169	Irrigation
6	6	N27 20 835 E30 39 995	164	105	143	Irrigation
7	7	N 27 28 479 E 30 39 454	185	110	143	Irrigation
8	8a	N27 32 176 E30 40 794	130	80	149	Irrigation
9	8b	N27 32 176 E30 40 794	163	110	149	Irrigation
10	9	N27 34 474 E30 39 483	160	105	118	Irrigation

Geostatisctics method through kriging module in Surfer 10.2 was used to generate the groundwater variability map of each considered water parameter across the study area.

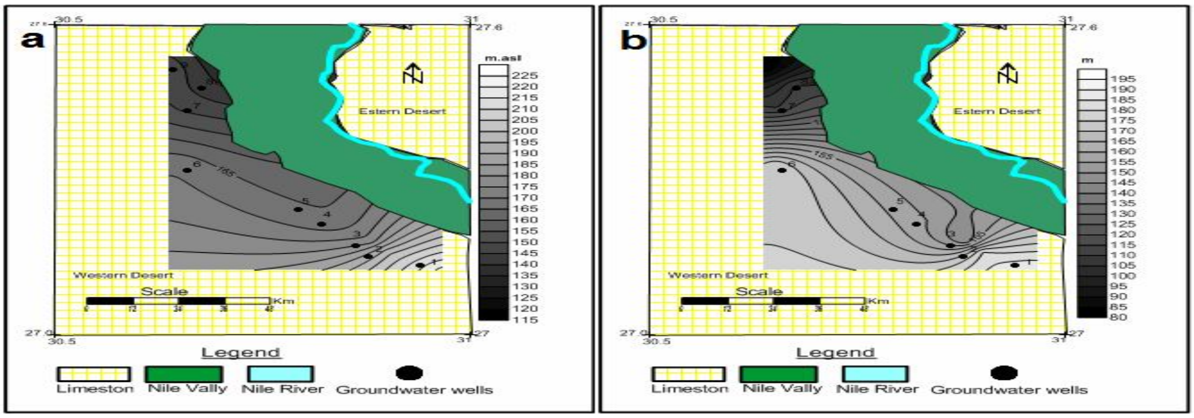

Fig.(2): the contour map of elevation(a) and depth to water(b) in the study area.

Results and Discussion:

The availability of dissolved ions in the groundwater system is influenced by different geochemical processes the operate in the subsurface hydrogeologic system , the relative abundance. Cations concentration in the groundwater within the study area increases in the order of Na^{+}> Ca^{2+}> Mg^{2+}> K^{+} while the anions is in the order of Cl^{-}> HCO_3^{-} >SO_4^{2-} (Table 2). Cation concentrations and aonion ratio can trace water-rock interaction processes, such as mineral weathering and cation exchange (Han *et. al*, 2009).

Calcium and magnesium concentrations in the groundwater vary from 2.03 to 3.55 meq/L and from 1.42 to 1.88 meq/L, respectively (Table 2 and Fig.3 a and b). Calcium can be derived from dissolution of carbonate minerals as well as carbonate cement within formation. The source of magnesium in groundwater is ferromagnesium minerals within igneous and metamorphic rocks and magnesium carbonate in the sedimentary rocks (Singh *et al*, 2012). In the study area the major source of Mg^{2+} in the groundwater is probably Mg-bearing minerals suck as dolomite and magnesium sulfate minerals

Potassium and sodium concentrations in the groundwater differ from 0.07 to 0.16 meq/L and from 2.77 to 6.22 meq/l, respectively (Table 2 and Fig.3 c and d). A low concentration of potassium in the groundwater would originate an alteration form of the silicates which have low solubility rate. Potassium distribution is influenced by the composition of the infiltration waters from the groundwater

The concentration of Cl^- ions of the ground water in the study area is between 4.47 to 7.42 meq/l (Table 2 and Fig. 4a). The Cl^- is the dominant ion of groundwater suggesting dissolution the salts.

The carbonate rock (limestone and dolomites are the main source of carbonate and bicarbonate ions in the groundwater. In the study area, the HCO_3^- concentration in groundwater ranged from 2.34 to 4.57 meq/l (Table 2 and Fig.4b). The value of HCO_3^- ions in groundwater attributed is due to dissolution of carbonate rocks by CO_2 in the soil zone. In the investigated area, the sulfate ion varies from 0.01 to0.02 meq/l (Tabe2 and Fig. 4c). that indicates a low concentration in this grounwater.

The pH of the groundwater samples ranges from 6.39 to 7.82 (Table 3 and Fig. 5,a). It shows that the groundwater of the study area is generally neutral.

The EC of groundwater samples is range between 689 and 1034 µS/cm (Table 3 and Fig.5b). The EC value of the groundwater of wells 8 and 8b shows a low salinity water so that it can be used for irrigating most crops on most soils, However, the EC value of the groundwater in the other wells has a medium salinity water. The groundwater under this condition can be used for irrigation if a moderate amount of leaching occurs and crops with moderate salt tolerance can be grown in most instances without special practices for salinity control.

Total dissolved salts (TDS) as a general indicator of the quality water. TDS is usually represented by the sum of major ione; calcium, magnesium, sodium, chloride, sulfate and alkalinity originating from decomposition of soil rocks. These ions constitute about 98% of the mineralization of most water. In the study area, the TDs value of groundwater samples varies between 282 to 954 mg/l. The TDS value in study area is considered a fresh water according to classification of water by Hem, (1970). The source of TDS is due to the dissolution of limestone and may be also attributed to leaching of halite and gypsum deposits.

Table (2): Some chemical properties of the analyzed groundwater samples

S. No.	Well No.	pH	TDS	E.c.	Cations				Anions		
					Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	Cl^{-}	SO_4^{2-}	HCO_3^{-}
			mg/l	(µS/cm)	(meq/l)						
1	1	7.82	652.0	1043	2.27	1.88	5.93	0.15	7.25	0.01	3.77
2	2	7.52	464.0	1009	2.54	1.58	5.77	0.15	6.36	0.01	3.74
3	3	7.2	480.0	1011	2.03	1.57	6.22	0.16	6.54	0.01	3.49
4	4	6.8	422.0	1001	2.77	1.60	5.41	0.14	5.41	0.01	4.57
5	5	6.85	450.0	1027	2.89	1.73	5.32	0.14	6.63	0.01	3.56
6	6	6.39	518.0	1054	3.55	1.47	4.88	0.12	7.42	0.01	3.03
7	7	7.33	438.0	1009	3.05	1.38	5.47	0.14	7.05	0.02	2.91
8	8	6.73	306.0	779	2.12	1.82	3.52	0.09	4.65	0.01	2.87
9	8b	7.34	282.0	689	2.16	1.77	2.77	0.07	4.47	0.01	2.34
10	9	7.69	586.0	1036	3.21	1.42	5.39	0.14	7.5	0.01	2.81

Sodium adsorption ratio (SAR) is a measure of the suitability of water for use in agricultural irrigation, as estimated using the concentrations of Na, Ca and Mg in the water. The SAR value was calculated in the investigated groundwater ranges from 2.8 to 5.8. So, according to the U.S.S salinity laboratory (Richards, 1954), these waters are suitable for irrigation uses (Table 3and Fig.5d). The groundwater in the study area can be used for irrigation on most soils with advent of low levels of sodium hazard.

Table (3): Irrigation water quality of the analyzed groundwater samples.

S. No.	Well No.	SAR	RSC	RSCB	PI	SSp	MH	TH
		(meq/l)			(%)			(mg/l)
1	1	5.8	-0.38	1.5	76.93	58.0	45.30	206.198
2	2	5.7	-0.38	1.2	76.75	57.5	38.35	204.868
3	3	6.6	-0.11	1.46	81.05	62.3	43.61	178.905
4	4	5.2	0.20	1.8	76.10	54.5	36.61	217.342
5	5	5.0	-1.06	0.67	71.53	52.8	37.45	229.754
6	6	4.4	-1.99	-0.52	66.04	48.7	29.28	249.876
7	7	5.2	-1.52	-0.14	71.46	54.5	31.15	220.461
8	8	3.6	-1.07	0.75	69.08	46.7	46.19	195.744
9	8b	2.8	-1.59	0.18	63.49	40.9	45.04	195.273
10	9	5.0	-1.82	-0.4	69.60	53.1	30.62	230.279

Residual sodium carbonate (RSC) has been calculated to determine the hazardous effect of CO_3^{2-} and HCO_3^{1-} on the quality of water for the agricultural purpose (Richards, 1954). The RSC in the groundwater understudy varies from -1.99 to 0.2 meq/l (Table 3 and Fig. 6a). Negative RSC indicates that Na^+ buildup is unlikely since sufficient Ca^{2+} and Mg^{2+} ions are in excess of what can be precipitated as CO_3^{2-} (Ramesh and Elango, 2012). All groundwater samples in the study area are within the good categories for irrigation.

Residual sodium bicarbonate (RSCB) has been estimated to determine the hazardous effect of HCO_3^- on the quality of water for the agricultural purpose (Gupta and Gupta, 1987). The RSCB in the groundwater ranges from 0.52 to 1.80 meq/l (Table3and Fig.6b). Most groundwater samples in the study area are within the good categories for irrigation.

Sodium soluble percentage (SSP) is important in classifying irrigation water because sodium reacts with soil to reduce its permeability. The SSP of these groundwater samples lies between 40.9 to 62.3 % (Table 3 and Fig. 6 c). It is observed that most of groundwater samples fall within the category of permissible for irrigation, except the sample No. 2 that is in the category of doubtful for irrigation.

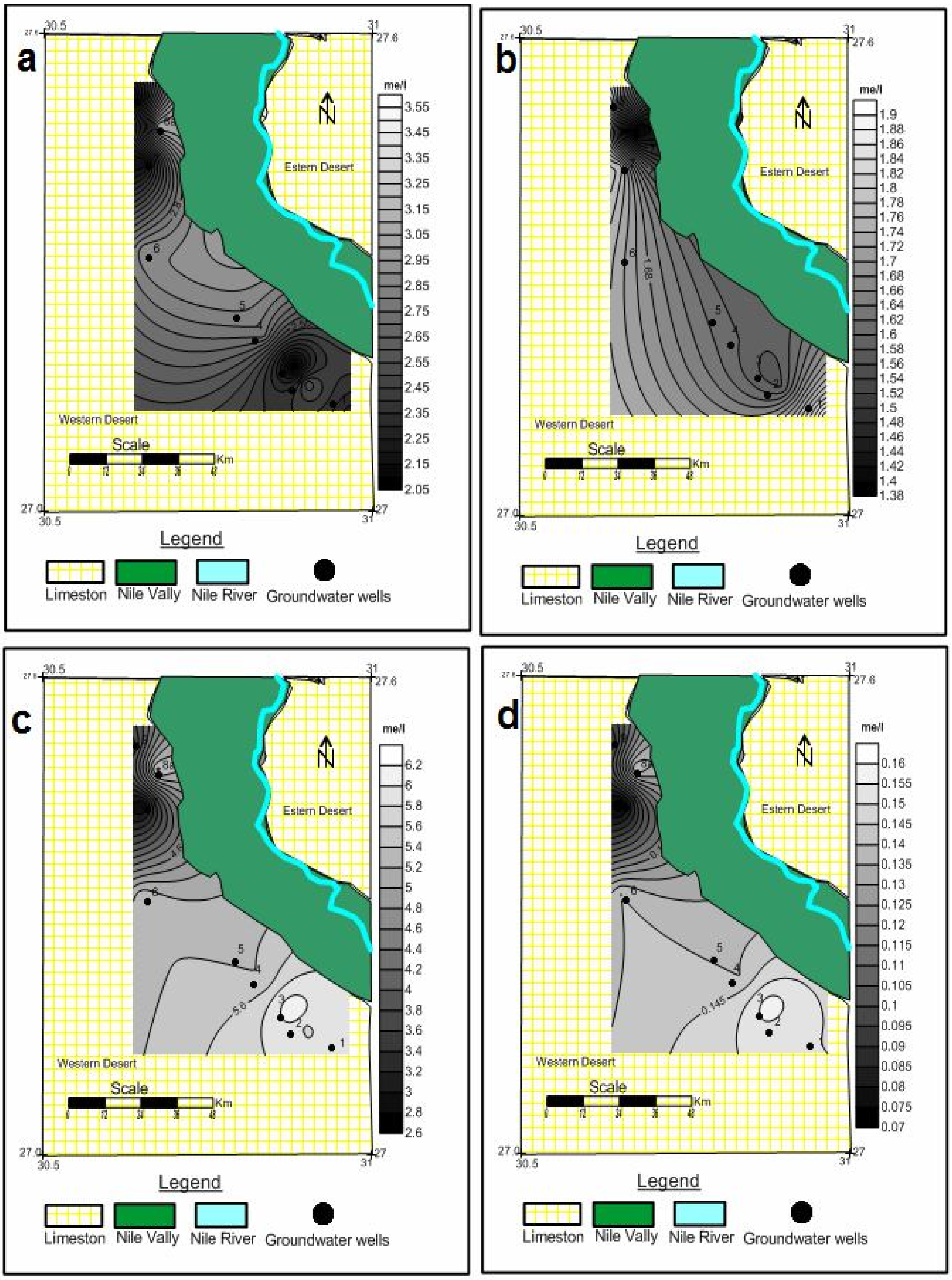

Fig. (3): The contour map of Ca(a), Mg(b), Na(c), andK(d) meq/l in the study area.

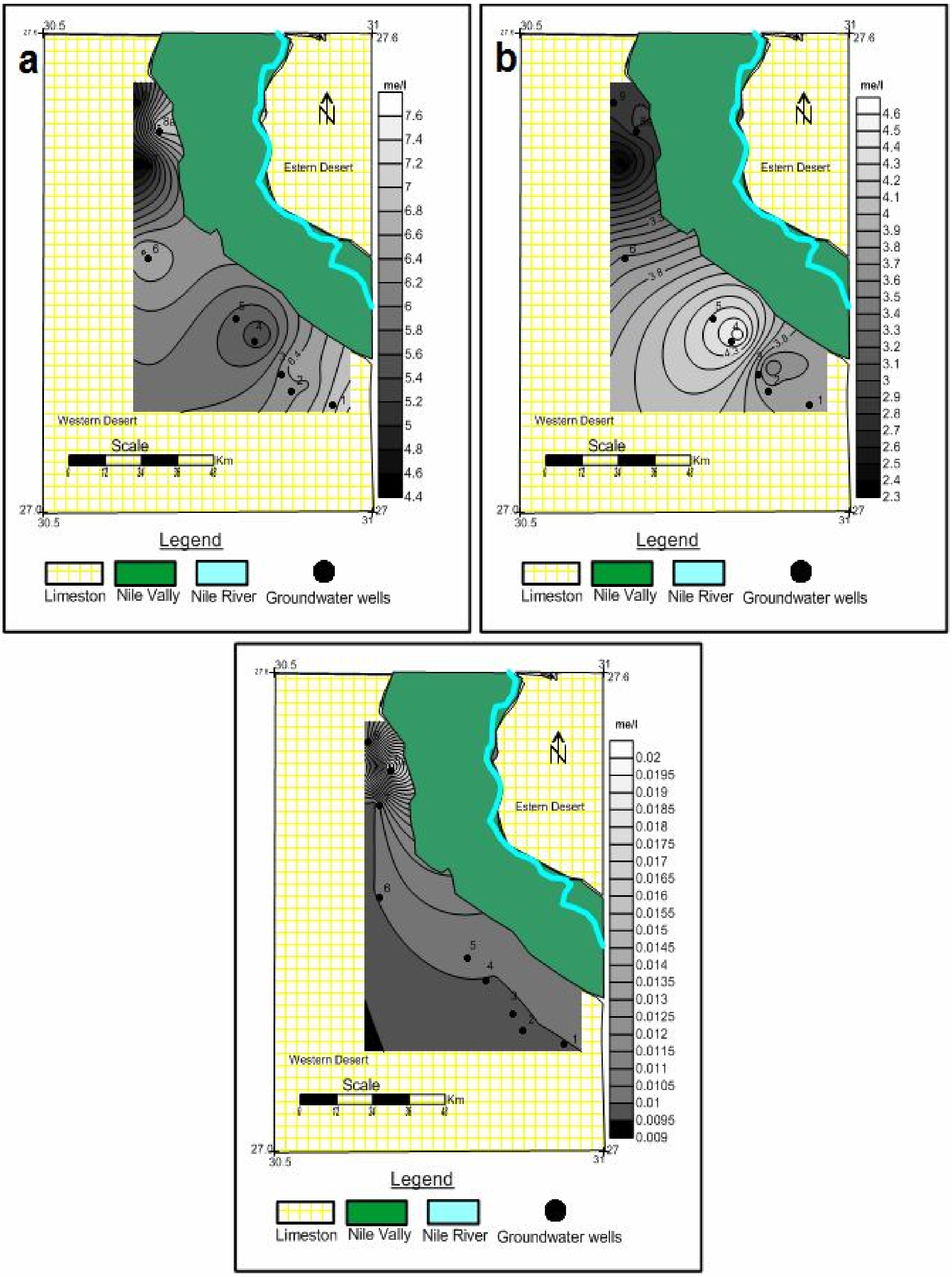

Fig. (4): The contour map of Cl (a), HCO_3(b), and SO_4(c) meq/l in the study area.

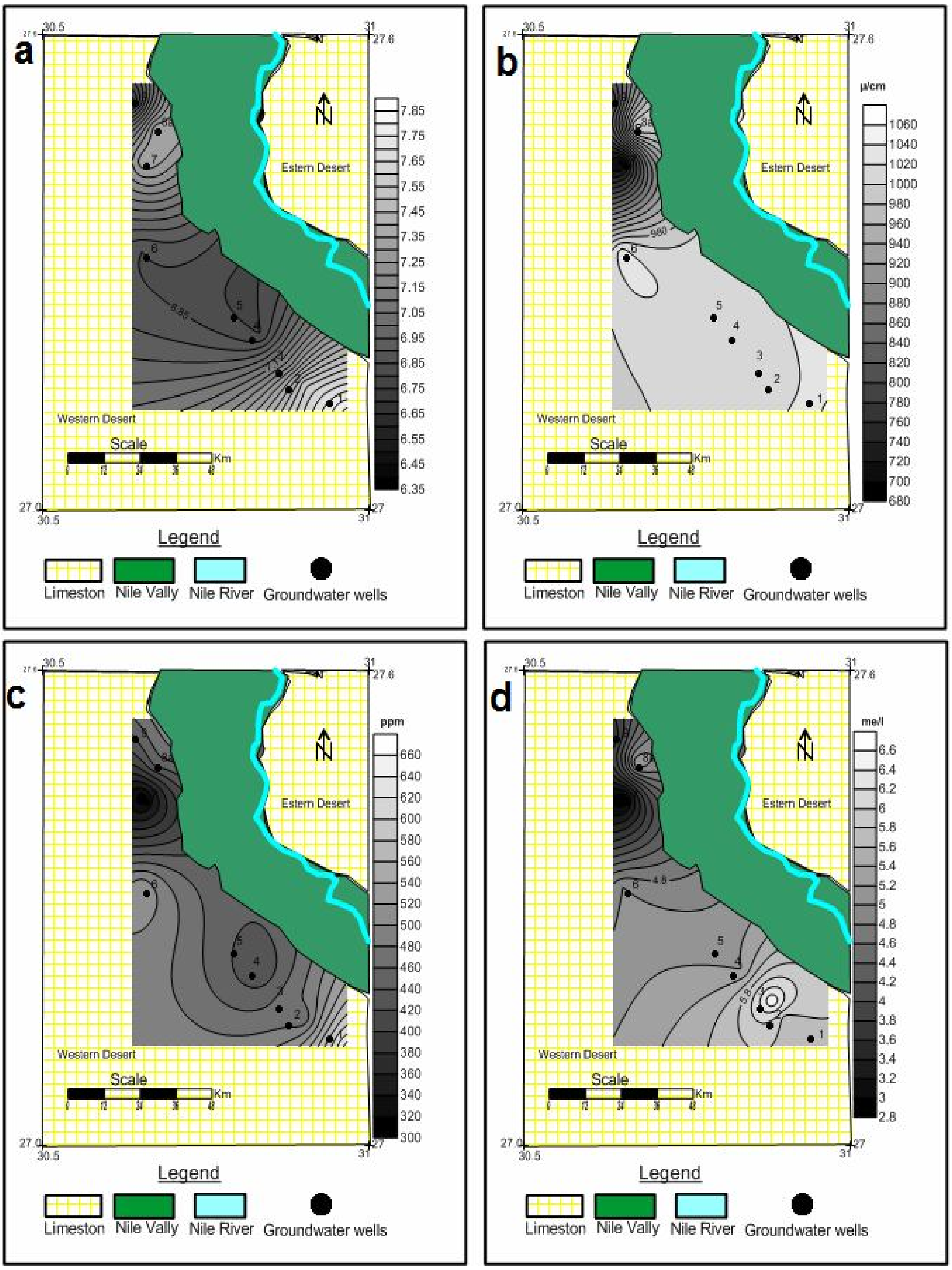

Fig. (5): The contour map of pH `(a) , EC (µS/cm) (b), TDS (mg/l) (c) , and SAR(d) in the study area.

The excess of Mg affected the quality of soil resulting in poor agricultural returns. The magnesium hazard (MH) is proposed by Szabolcs and Darab (1964) for irrigation water. MH value that is > 50 % is considered harmful and unsuitable for irrigation use. The MH value in the groundwater of the study area varies between 29.28 to 46.19 % (Table 3and Fig. 6d). The value of MH in all groundwater samples is <50%. The MH indicates that the groundwater is suitable for irrigation.

Permeability of the soil is affected by the long-term use of irrigation water as it is influenced by Na^+, Ca^{2+}, Mg^{2+} and HCO_3^- content of the soil (Ramesd and Elango, 2012). Who (1989) gave a criterion for assessing the suitability of groundwater for irrigation based on the permeability index (PI), where concentrations are in meq/l (Ragunath, 1987). The PI values of the groundwater in the study area range from 63.49 to 81.05 % (Table3 and Fig. 7b). The water of wells No. 5, 6, 7, 8, 8b and 9 that have PI value between 25 to 75% that represent class 2 are suitable for irrigation. Wells number 1, 2, 3, and 4 represented class 1(>75%) indicating that the groundwater are unsuitable for irrigation.

The total hardness (TH) value in the groundwater of the study area varies from 178.905 to 249.876 mg/l (Table 3 and Fig, 7a). The classification of groundwater based on total hardness (Sawyer and McMcartly, 1967) shows that all groundwater samples lie in the hard water category.

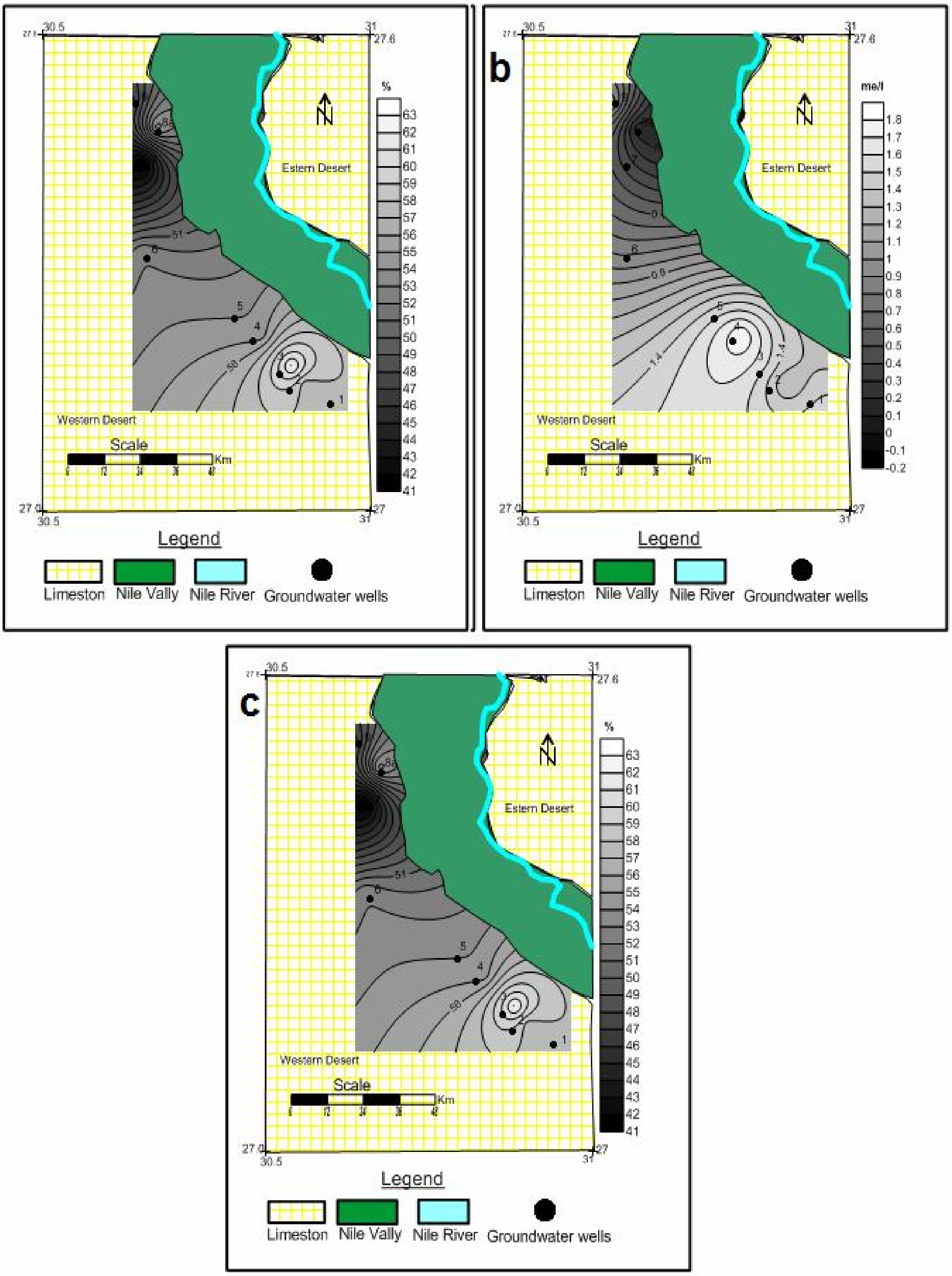

Fig. (6): The contour map of RSC(meq/l) (a), RSCB(meq/l) (b) and SSP(c) (%) in the study area.

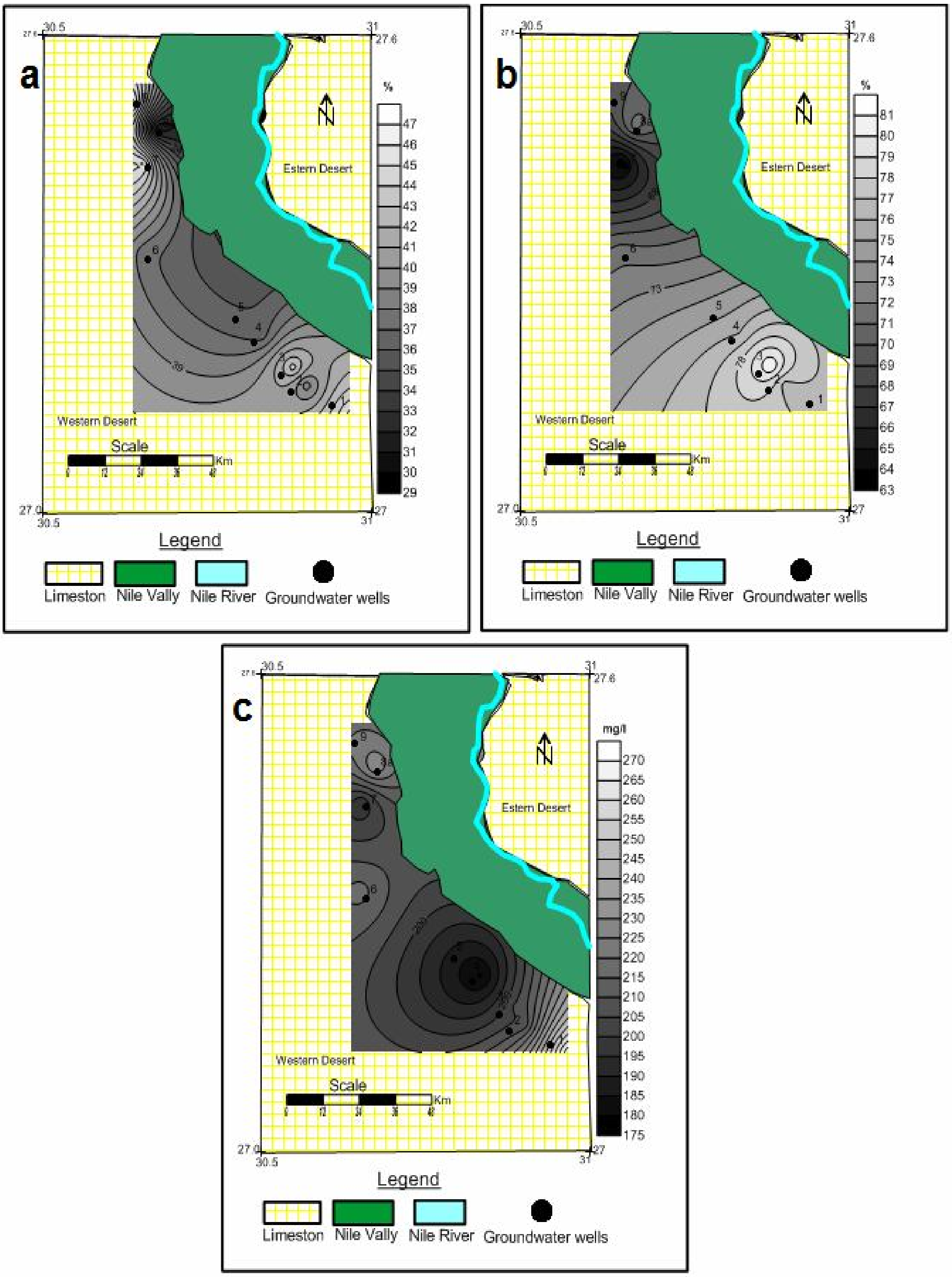

Fig. (7): The contour map of MH (%)(a), PI (%)(b) and TH (mg/l)(c) in the study area.

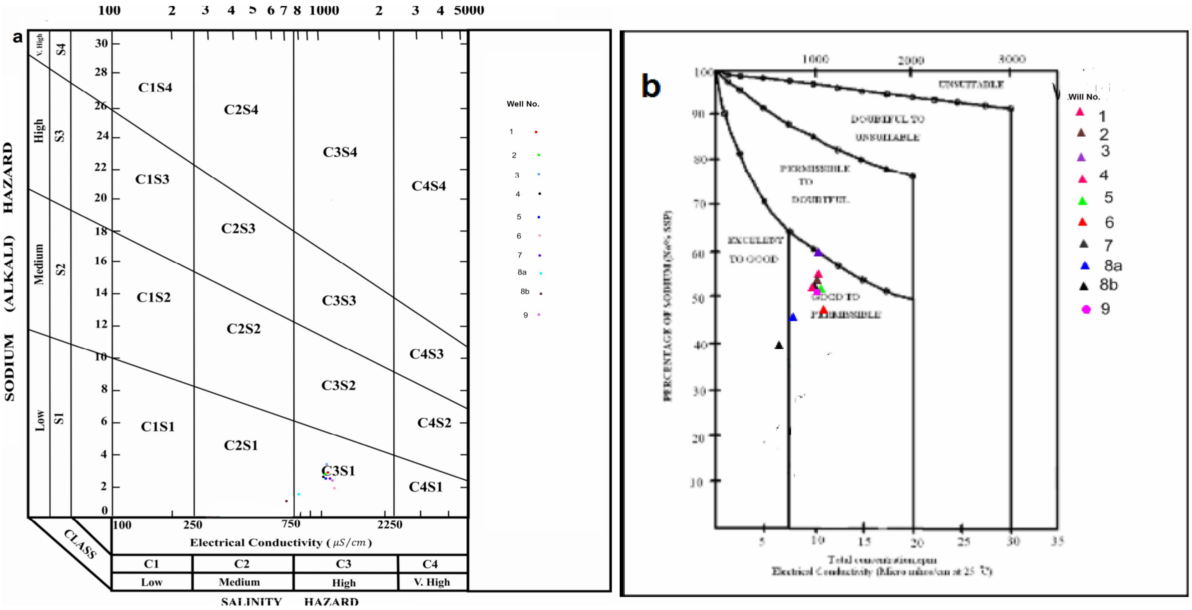

Fig. (8): The Classification of irrigation waters by USSL (a) after Richards (1954) and (b) after Wilcox, (1955).

The plot of data on the US salinity diagram (fig.8,a), in which the EC is taken as salinity hazard and SAR as alkalinity hazard, shows that majority of the water samples fall in the category C3S1, indicating high salinity and low alkali water. However, one groundwater sample (8b) falls in the zone of C2S1 indicating medium salinity and low alkali water. Such water can be used for irrigation in most soils and for most crops with little danger of the development of exchangeable sodium and salinity.

Wilcox (1955) diagram relates plot of Na% and EC to designate irrigation water quality. (Fig.8, b). It infers that all samples falls within excellent to permissible category of irrigation water use.

Conclusion:

Groundwater quality in the waster limestone plateau is strongly influenced by water-rock interactions and anthropogenic activity. The rock dominance of the major ion chemistry in the basin provide, an insight of chemical weathering in the drainage basin, since weathering of the different parent rocks (e.g., carbonates, silicates, an evaporates) yields different combination to dissolved cations and anions to solution.

Magnitude of the cations in the groundwater of the study area is in the order of $Na^{+} > Ca^{2+} > Mg^{2+} > K^{+}$ and that of the anions follows the order of $Cl^{-} > HCO_3^{-} > SO_4^{2-}$.

Quality assessment shows that, in general the waters are suitable for irrigation purpose. However, the of TH, PI and SSP values of most water samples, make them unsuitable for irrigation. According to SAR, RSC, RSCB and TDS values, of the groundwater are suitable for irrigation. The values of EC show that the groundwater in most samples is moderately saline.

References:

Abou Heleika, M. M. and E. Niesner. 2009. Configuration of the limestone aquifers in the central part of Egypt using electrical measurements Hydrogeology Journal 17: 433–446.

Allam A. R.; Saaf Ele-Jan and M. A. Dawoud. 2002. Desalination of brackish groundwater in Egypt. Desalination (152):19–26.

Amer, A.; R. Ripperdan; T. Wang and J. Encarnacin. 2012. Groundwater quality and management in arid and semi-arid regions: Case study, Central Eastern Desert of Egypt., Journal of African Earth Sciences 69, 13–25.

Dassi, L .2010. Use of chloride mass balance and tritium data for estimation of groundwater recharge and renewal rate in an unconfined aquifer from North Africa: a case study from Tunisia. Environ Earth Sci 60(4):861–871.

Dawoud, M. A. 2004. Design of national groundwater quality monitoring network in Egypt. Environmental Monitoring and Assessment 96: 99–118.

Doneen, L.D. 1964. Water quality for agriculture. Department of Irrigation, University of Calfornia, Davis, p 48.

El Arabi, N. 2012. Environmental management of groundwater in Egypt via artificial recharge extending the practice to Soil Aquifer Treatment (SAT). Int J Environ Sustain; 1(3) :66–82, ISSN 1927-9566.

Elbeih, S. F. 2014. An overview of integrated remote sensing and GIS for groundwater mapping in Egypt, Ain Shams Eng J, http:// dx.doi.org/10.1016 /j.asej.2014.08.008.

Fanous, N. E. 1984. Physical and mineralogical studies on some old valleys of the eastern desert Ph.D. Thesis, Soil Science Dept. Ain Shams Univ., Egypt.

Gupta, S. K. and I. C. Gupta, .1987. Management of saline soils and water. Oxford and IBM Publ. Co, New Delhi.

Han, D.; X. Liang; M. Jin; M. J. Currell; Y. Han and X. Song, .2009. Hydrogeochemical indicators of groundwater flow systems in the Yangwu River Alluvial Fan, Xinzhou Basin, Shanxi, China. Environ Manage 44:243–255.

Hem, H. D.1970. study and interpretation of the chemical characteristics of natural water, second Ed. U.S. Geol. Survey water supply paper. 1473,363 pp.

Jackson, M. L.1973. Soil chemical analysi . Prentice-Hall of India private limited New Delhi.

Kashouty, M. 2013. Modeling of limestone aquifer in the western part of the River Nile between Beni Suef and El Minia. Arab. J Geosci. 6:55–76.

Marei, A. M. H. 1996. Ecotypic variations of some desert plants growing in various habitats. M.Sc. Thesis, Faculty of Sci., Menoufiya Univ., Egypt.

Maxey, G. B. 1964. In: Chow VT (ed) Hydrogeology, handbook of applied hydrology. Chap. 4. McGraw Hill, New York.

Mcllean, E. O. 1982. Soil pH and lime requirement. In Page, A.L., R.H. Miller and D.R. Keeney (eds.) Methods of soil analysis. Part 2 - Chemical and microbiological properties. (2nd Ed.). Agronomy 9: 199-223.

Mohamed, M. H. F. 2010. Geophysical and hydrogeological studies in the area North-West of Assuit

District, Egypt. . M.Sc. Thesis, Minia Univ; 276.

Osman, H. Z. 1980. Geological studies on the northwest of Assiut, Egypt. M.Sc. Thesis, Assiut Univ; 276.

Ragunath H. M .1987. Groundwater, 2nd edn. Wiley Eastern Ltd., New Delhi.

Ramesh, K. and L. Elango, .2012. Groundwater quality and its suitability for domestic and agricultural use in Tondiar river basin, Tamil Nadu, India. Environ Monit Assess 184:3887–3899.

Rhoades, J. D. 1982. Cation exchange capacity p. 149-157 In A. L., page, R.H. Miller, and D.R. Kessney (eds.) Method of soil analysis. Part 2, 2nd edition. ASA and SSSA Inc. Medison, WI, USA.

Richards, L. A. (US Salinity Laboratory) 1954. Diagnosis and Improvement of Saline and Alkaline Soils [M]. US Department of Agriculture Hand Book, p. 60.

Sawyer, G. N. and D. L. McMcartly, .1967. Chemistry of sanitary engineers 2nd edn. McGraw Hill, New York, p 518.

Singh, A. K.; M. K. Mahato; B. Neogi; B. K. Tewary and A. Sinha, .2012.Environmental geochemistry and quality assessment of mine water of Jharia coalfield, India. Environ Geol 65:49–65.

Szabolcs, I. and C. Darab, .1964. The influence of irrigation water of high sodium carbonate content on soils. In: Szabolics I (ed) Proceedings of 8th international congress soil science sodics soils research ınstitute of soil science and agricultural chemistry, Hungarian Academy of Sciences, ISSS Trans II, 1964, pp 802–812.

Todd D. K. andL. W. Mays, .2005. Groundwater hydrology, 3rd edn. Wiley, New York.

Todd, D. K .1980. Groundwater hydrology, 2nd edn. Wiley, New York United State Salinity Laboratory Staff (1954) Diagnosis and improvement of saline and alkaline soil. US Department of Agriculture, Handbook 60, Washington DC.

Trabelsi, R.: Z. Zairi and H. Ben Dhia. 2007. Groundwater salinization of the Sfax superficial aquifer, Tunisia. Hydrogeol J 15(7): 1341–1355.

WHO, .1989. Health guidelines for the use of wastewater in agriculture and aquaculture. In: Report of a WHO scientific group: technical report series 778, WHO, Geneva, p 74.

Wilcox, L. V. 1955. Classification and use of irrigation waters, USDA Circular No. 969, p 19.

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تقييم جودة المياه الجوفية في الهضبة الجيرية الغربية بمنطقة أسيوط – مصر

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الملخص:

تعتبر منطقة الصحراء الغربية بمصر من المناطق الطبيعيـــة للزراعـــة أو الـــصناعة أو الأنشطة الأخرى والتي تمثل المياه الجوفية بها مصدرا هاما وخاصة في الهضبة الجيرية الغربية بمصر. تعتبر محافظة أسيوط من المحافظات الواعدة للزراعات المروية واستصلاح واســتزراع الاراضى التى تحيطها الهضاب الجيرية من الغرب والشرق وتغطى مساحة كبيرة من اجمـــالى مساحة المحافظة كما أنها تتميز بطبوغرافية مستوية أو شبه مستوية. وتمثــل الميــاه الجوفيــة المصدر الوحيد لاستصلاح واستزراع هذه الهضاب، لذا فأن تقييم جودة الميــاه الجوفيــة هـــي الخطوة الأولى نحو إدارة قويمة ومستدامة لموارد المياه الجوفية والتربة. من اجــل هــذا فــأن الدراسة تهدف إلى تقييم جودة المياه الجوفية ورسم خرائط كنتورية باستخدام ســيرفر ١٠ مـــن اجل استغلالها لأغراض الري.

أخذت عشرة عينات مياه جوفية من الخزان الجوفي للحجر الجيري. وتقع منطقة الدراســة بين خطى طول ٢٧° ٧' ٥٤٠" و ٢٧° ٣٤' ٤٧٤" شمالا وبين خطى عــرض ٣٠° ٣٩' ٤٨٧" و ٣٠° ٥٣' ٢٤٤"جنوبا.

تم تقدير الخواص الكيميائية وجودة المياه الجوفية في منطقة الدراسة وقد تم تقدير معظـــم الايونات و الــ pH والضرر الملحي (EC & TDS) والضرر الــصودى (SAR) وخطـــورة الكربونات والبيكربونات (RSC &RSCB) وضرر الماغنسيوم (MH) ودليـــل النفاذيـــة (PI) والعسر الكلى (TH). وكان تركيز الكاتيونات في عينات المياه الجوفيـــة علـــى النحـــو التـــالي الصوديوم > الكالسيوم > الماغنسيوم > البوتاسيوم. وترتيـــب الانيونـــات كالتـــالي كلوريـــد > بيكربونات > كبريتات. وأوضحت النتائج الخاصة بجودة المياه أن المياه الجوفية فـــي الخـــزان الجوفي للحجر الجيري بمنطقة الدراسة من الدرجة الآمنة في استعمالاتها للـــري. ماعـــدا قـــيم التوصيل الكهربي لبعض الآبار كانت متوسطة الملحية.