

EVALUATION OF GROUND WATER QUALITY IN AL-BAIDH FIELD, HODIEDA CITY, YEMEN

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Abstract:

Ground water is the main source for drinking water in Hodieda city, Yemen. This study discusses the chemical and physical characteristics of nineteen ground water wells in the Al-baidh field. Thus, the measurement of water quality parameters such as electrical conductivity EC, total dissolved solids TDS, pH, turbidity, color, total alkalinity, total hardness TH , NO₃⁻, SO₄²⁻, PO₄³⁻, Cl⁻ ,Na⁺, K⁺, Ca²⁺ and Mg²⁺ in addition to Mn, Cu, Fe and Cr were expressed. The results indicate unacceptable levels of TDS , Cl⁻, Na⁺ , Ca²⁺ and Mg²⁺ comparing with the maximum tolerable concentration given by World Health Organization (WHO) and Yemen standard (YS). Elsewhere, the measurement of SO₄²⁻ and NO₃⁻ exceeded the allowable values given by WHO and Y.S for most the samples which can be attributed to the nature of the geological and chemical structure of soil in Al-baidh field. In this study, measurement of the concentration for elements such as Cr, Fe, and Mn were carried out, the results indicate that the values for this elements were within the allowable ranges.

In this paper the concepts of star- refinement and strongly star- refinement of covering are extended to fuzzy topological space in the sense of Chang, basic theorem for covering dimension of normal fuzzy topological space is proved . Also, the small inductive dimension function is extended to fuzzy topological space, and some results for this inductive dimension in Chang^{'s} space are obtained .

Introduction

Yemen is the poor countries in water resources, where the groundwater is the main source of drinking water, which depends on the rainwater to offset the shortage resulting from the depreciation in the stock of the underground water wells(Qahtan.et al.,2005). Indeed the water is important element in nature, it is related to human health, and the quality of water can be affected by different kinds of pollutions, chemical, biological and physical pollution. In recent years the pollution of aquatic environment has been increased noticeably due to the increase of human activities, the characteristics of any water body may indicate its level of pollution(Eryani.et al.,1991).

The main source of drinking water in Hodieda city is only ground water, there are nineteen governmental wells in the Al-baidh field, which are located about 10 Km north-east of the city, along the north bank of the Al-qutai valley. The main aim of this study is to investigate the quality of the ground water multiple samples were collected from the wells, main chemical and physical water quality characteristics were determined analytically.

Experimental

The water samples were collected using 1L polyethylene

container after cleaned by acid (6MHNO₃), the pH meter and digital conductometer from (HACH) has been used for direct measurement of water samples. All samples were stored in cool environment (4°C) to prevent the vaporization and biodegradation, the temperature at the time of determination was 37-41°C. In this study we used spectrophotometer is used and reagents from (HACH) to determine the (Cu, Fe, Cr, Mn, NO₃⁻, SO₄²⁻ and PO₄³⁻).

The ions Na⁺ and K⁺ were determined by flam emission spectroscopy ,while the remaining alkalinity and ions(Ca²⁺,Mg²⁺ and Cl⁻) were analyzed by titration method (Digittal titrator)

Results and discussion

The values of the various parameters for nineteen wells in Tables (1a,1b,1c and 1d) were summarized.

Table(1a): The analytical results of ground water samples(Continue).

Parameters	WHO	YS	wells				
			1	2	3	4	5
T °C	--	--	39	40	41	37	39
E.C μScm ⁻¹		450-2500	3100	3640	5100	4340	3680
TDS mg/L	1000	650-1500	1860	2184	3060	2604	2208
pH	6.5-8.5	6.5-9	7.75	7.35	7.21	7.35	7.25
Turbidity(NUT)	5	--	4	1	Nil	2	7
Color	15		15	4	Nil	9	28

Parameters	WHO	YS	wells				
			1	2	3	4	5
Cl ⁻ mg/L	250	200-600	630	825	1435	1050	815
T.H mg/L	500	100-500	425	565	1030	670	530
Ca ²⁺ mg/L	200	75-200	66	86	412	100	74
Mg ²⁺ mg/L	--	--	26.4	84.0	97.2	100.8	82.8
T.Alkalinity mg/L	200-250	--	140	120	625	125	135
NO ₃ ⁻ mg/L	50	10-50	70	80.08	90	65	56
SO ₄ ²⁻ mg/L	250	200-400	500	600	530	450	410
Na ⁺ mg/L	200	Max400	450	636	860	730	650
K ⁺ mg/L	--	8-12	2.72	2.55	2.40	2.30	2.30
PO ₄ ³⁻ mg/L	--	--	0.30	0.18	0.16	0.34	0.35
Fe	0.3	0.3-1	0.01	Nil	0.02	0.01	0.05
Cu	1	0.5-1	0.01	Nil	0.16	0.2	0.01
Mn	0.1	--	0.01	0.01	0.02	0.01	0.01
Cr	0.05	--	0.01	0.01	0.02	0.01	0.01

Table(1b): The analytical results of ground water samples (Continue).

Parameters	WHO	YS	wells				
			6	7	8	9	10
T °C	--	--	41	39	39	39	39
E.C μScm ⁻¹	--	450-2500	3230	3050	2880	2900	2880
TDS mg/L	1000	650-1500	1938	1830	1728	1740	1728
pH	6.5-8.5	6.50-9	7.22	7.50	7.30	7.84	7.71
Turbidity(N.U.T)	5	--	3	4	Nil	1	Nil

Parameters	WHO	YS	wells				
			6	7	8	9	10
Color	15	--	19	11	Nil	5	Nil
Cl ⁻ mg/L	250	200-600	730	655	615	610	605
T.H mg/L	500	100-500	455	410	400	425	450
Ca ²⁺ mg/L	200	75-200	74	60	165	175	74
Mg ²⁺ mg/L	--	--	64.8	62.2	94.0	250	63.6
T.Alkalinity mg/L	200-250	--	270	125	120	50	122
NO ₃ ⁻ mg/L	50	10-50	64.24	65.00	80.52	62.42	56.32
SO ₄ ²⁻ mg/L	250	200-400	420	360	420	440	500
Na ⁺ mg/L	200	Max400	560.5	448	510	520	625
K ⁺ mg/L	--	8-12	2.85	2.70	2.70	2.60	2.80
PO ₄ ³⁻ mg/L	--	--	0.05	0.38	0.12	0.39	0.16
Fe	0.3	0.3-1	Nil	0.03	0.07	0.03	0.03
Cu	1	0.5-1	Nil	0.01	0.03	0.05	0.06
Mn	0.1	--	0.01	0.01	0.01	0.02	0.02
Cr	0.05	--	0.01	0.01	0.01	0.02	0.01

Table(1c): The analytical results of ground water samples (Continue).

Parameters	WHO	YS	wells				
			11	12	13	14	15
T °C	--	--	39	40	39.5	39	41
E.C μScm ⁻¹	--	450-2500	2490	2790	2560	2370	2700
TDS mg/L	1000	650-1500	1494	1674	1536	1422	1620
pH	6.5-8.5	6.50-9	7.80	7.74	7.55	7.45	7.34
Turbidity(N.U.T)	5	--	Nil	2	2	Nil	Nil

Parameters	WHO	YS	wells				
			11	12	13	14	15
Color	15	--	Nil	11	12	Nil	Nil
Cl ⁻ mg/L	250	200-600	510	610	540	505	640
T.H mg/L	500	100-500	375	445	435	375	375
Ca ²⁺ mg/L	200	75-200	62	63.2	76	66	58
Mg ²⁺ mg/L	--	--	52.8	104	58.8	50.4	55.2
T.Alkalinity mg/L	200-250	--	123	110	125	126	125
NO ₃ ⁻ mg/L	50	10-50	58.32	69.69	80.00	71.00	52.80
SO ₄ ²⁻ mg/L	250	200-400	400	530	290	290	290
Na ⁺ mg/L	200	Max400	430	462	370	345	460
K ⁺ mg/L	--	8-12	2.80	2.70	2.60	2.45	2.77
PO ₄ ³⁻ mg/L	--	--	0.33	0.41	0.20	0.23	0.21
Fe	0.3	0.3-1	0.24	0.03	0.01	0.01	0.02
Cu	1	0.5-1	0.01	0.04	0.06	0.08	Nil
Mn	0.1	--	0.01	0.02	0.01	Nil	0.01
Cr	0.05	--	0.01	0.02	Nil	0.01	0.01

Table(1d): The analytical results of ground water samples

Parameters	WHO	YS	wells			
			16	17	18	19
T °C	--	--	41	40	40	40
E.C μScm ⁻¹	--	450-2500	2760	2510	2590	2370
TDS mg/L	1000	650-1500	1656	1506	1556	1422
pH	6.5-8.5	6.5-9	7.36	7.39	7.31	7.40
Turbidity(N.U.T)	5	--	Nil	1	Nil	Nil
Color	15	--	Nil	5	Nil	Nil
Cl ⁻ mg/L	250	200-600	625	540	535	507

Parameters	WHO	YS	wells			
			16	17	18	19
T.H mg/L	500	100-500	410	390	405	375
Ca ²⁺ mg/L	200	75-200	66	60	64	64
Mg ²⁺ mg/L	--	--	58.8	57.6	58.8	51.6
T.Alkalinity mg/L	200-250	--	120	125	120	125
NO ₃ ⁻ mg/L	50	10-50	54.56	65.12	64.68	81
SO ₄ ²⁻ mg/L	250	200-400	380	370	390	350
Na ⁺ mg/L	200	Max400	450	430	400	345
K ⁺ mg/L	--	8-12	2.7	2.7	2.7	3.2
PO ₄ ³⁻ mg/L	--	--	0.27	0.28	0.39	0.25
Fe	0.3	0.3-1	0.05	Nil	0.02	0.01
Cu	1	0.5-1	Nil	Nil	0.01	0.08
Mn	0.1	--	0.01	Nil	0.01	0.01
Cr	0.05	--	0.01	0.01	0.02	0.01

The examined ground water samples characterized by slight to moderately alkaline (pH values ranged from 7.21 to 7.84 and very high of TDS from (1422-3060) in comparison with the maximum tolerable concentration given by WHO (World Health Organization, 2003) and YS, this can be attributed to the nature of the geological and chemical structure of soil in Al-baidh field, which follows the geological feature of Tihama plain near the Red Sea coast. The electrical conductivity ranged from (2370-5100) μScm^{-1} , these values are related to total dissolved solids. Water hardness the amount

of dissolved calcium and magnesium in water expressed in terms of calcium carbonate. The values of the hardness analysis ranged from (375-1030) mg/L. All wells have values within the permissible limit of WHO and YS, except well (2)565 mg/L, well(3)1030 mg/L, well(4)640 mg/L and well(5)530 mg/L which have values greater than the permissible limits, the average hardness water was more than 300 mg/L and this is considered very hard according to the guide line of WHO and Y.S.

Turbidity and color of ground water wells showed the permissible limits values, except well (5) and (6) were 28 units and 19 units respectively. Alkalinity of water may be due to the presence of one or more ions, these include hydroxides, carbonates and bicarbonates, the values of alkalinity were in the range(90-140) mg/L, and were within the permissible limits given by (WHO) except well(6) with a value 270 mg/L showed a close value to the maximum allowable 250 mg/L.

Almost all natural waters contain chloride, but in this work the values of chloride ion for nineteen ground water wells ranged (507-1435) mg/L, the values in wells (3and4) were 1435 mg/L and 1030 mg/L respectively, more than five times the permissible limit value of(250) mg/L , while the rest of the wells average was almost twice of the allowable value,

can be attributed to feature of Al-baidh field On the other hand, sodium ion showed range values(345-860) mg/L ,due to high concentration of chloride ion, while potassium ion range values(2.3-2.85) mg/L were found below the guidelines for drinking water given by Yemen Standard (YS).The phosphate ion gave range value (0.05-0.41) mg/L, while nitrate ion in the investigated samples were found to be in the range (52.8-81.0) mg/L, these results were relatively higher than the permissible limit given by (WHO) and (YS) , it is a dangerous indicator of pollution especially in children less than six months ages who drink water containing nitrate, symptoms include shortness of breath and blue-baby syndrome (GLWQD,Janury 2007).

Furthermore, the range of sulphate ion in the sample was (290-600) mg/L, for more than half of the wells, the average concentration were almost twice the permissible limit (250) mg/L given by (WHO), this can be attributed to the presence of gypsum components in the surrounding soil.

The concentration of trace metals Fe, Mn, Cu and Cr ions in the drinking water samples are presented in Tables (1a,1b,1c and 1d) the lowest and highest levels ranged between(0.00-0.24) mg/L Fe,(0.00-0.02) mg/L Mn, (0.00-0.16) mg/L Cu and (0.00 -0.02) mg/L Cr , these results were below the WHO and Y.S permitted limits.

Conclusion

- 1- The characteristics of examined ground water samples showed very high TDS ,TH ,chloride ion and sodium ion concentration compared by the permissible limits given by WHO and YS range.
- 2- The concentration of nitrate ion was relatively higher than WHO and Y.S guide lines
- 3- The average concentration of sulphate ion was almost twice the permissible limit given by (WHO)
- 4- The results indicate that, the water is very hard classification
- 5- The results of heavy metals were below the WHO permitted limits

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