Hydrochemical Aspects and Determination of Some Heavy Metals in AL-Haweja Canal, Kirkuk ,Iraq

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Abstract:

Nine samples of water have been collected from different sites at AL-Haweja canal. The hydrochmical data of dissolved solids show that these water are consists of fresh water ecosystem. The major cation and anion is Ca^{2+} and HCO_3^{2-}respectively. The water in generals is Mg-Na-Ca-HCO_3-Cl-SO_4 .The dominant hydrochemical process in the water of studied canal is chemical processing of recent sediment and dissolved mineral. Heavy metals pollution levels were also noticed. These water samples contain high value of heavy metal (Cd and Mn) with respect to EPA 2000 standards probably due to chemical and anthropogenic activities.

Introduction:

AL- Haweja stream is an artificial canal ,29 km long , located southwestern of Kirkuk (65 km) far from kirkuk . It takes the water from the left bank of Lesser Zab River at Al-Butma village and connected with Tigris River near Al-Zab village (figure1).The canal is encompasses an area of approximately 8000 ha. and its discharges approximately 1500 L /sec. It cuts through agricultural farms in its upper part and through urbanized area in its middle part and agricultural lands in its lower part. (personal communication).this is the first study dealing with hydrochemical aspects of the river and heavy metals and there was not any hydrochemical data on the area. The main objectives of this study are to determine of the hydrochemical properties of water and to evaluate the water pollution levels in Al-Haweja canal.

Climate and Geology of Studied Area:

The climate in the area is arid to semi-arid , cold wind , light rain, short Spring, long hot Summer and NE-SE wind direction with occasionally dust storm. According to the climate data of AL-Haweja area (table1) ,the maximum temperature (49)with the average yearly temperature is 20 C^o in the last fifteen years ago . August is the hottest month, January is the coolest. Average yearly rainfall in AL-Haweja area is about 172 mm. Average yearly evaporation is about 230 mm. The dry season.

Table (1) Climate data between 1990 - 2005 in AL-Haweja area
(From: Al-Haweja Irrigation office)

Climate element	Minimum	Maximum	Average
Temperature Co	-3	49	20
Rainfall (mm)	45	310	172
Evaporation (mm)	31	440	230

occurs in Summer (May through October) and the wet season occurs in Winter (November through April). occurs in Summer (May through October) and the wet season occurs in Winter (November through April) . AL-Haweja area is a part of the low folded zone of northern Iraq and it lies within the Hemrin – Makhul sub zone of unstable shelf area from nubia–Arabian platform[1]. Stratigraphically ,the studied area does not expose any outcrops of geological formations , but it is covered by quaternary sediments. The quaternary alluvium that consist of soil deposits. The soils of area are formed from material which belong to the fluviatil deposits during interpluvial phase of Pleistocene [2]. The course of AL-Haweja canal passes through recent flood sediments covers the entire area .The soil is alluvial , formed by periodic deposition and erosion during various stage of river flooding. Generally,itisclayey,silty and sandy,occasionally,it is sandy loam [3].

Sampling and Methodology:

Nine water samples were collected from different sites in AL-Haweja canal during October, 2005. The water samples were analysed in the laboratory North Fertilizers Company at Baiji city , using international methods as well as international standards. Determination of pH, electrical conductivity (E.C) , both major ions and heavy metals were determined in the laboratory using the analytical instruments shown in table(2)

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Table (2) :Analytical instruments used for determination of major ions and heavy metals in the study area.

Ions	Analytical instrument
Na^{+}, K^{+} ,Ca^{+2} , Mg^{+2} ,Mn, Zn, Cd , Fe	Atomic absorption spectrophotometer. type (Hitachi – 180 – 130)
SO_4^{-2} , HCO_3^{-2} ,Cl^{-}	Spectrophotometer Double beam .Type (UV –150 – O2)
E.C	Conductivity meter DS-8F , Japan
pH	pH meter (No. ser. 211) Europe

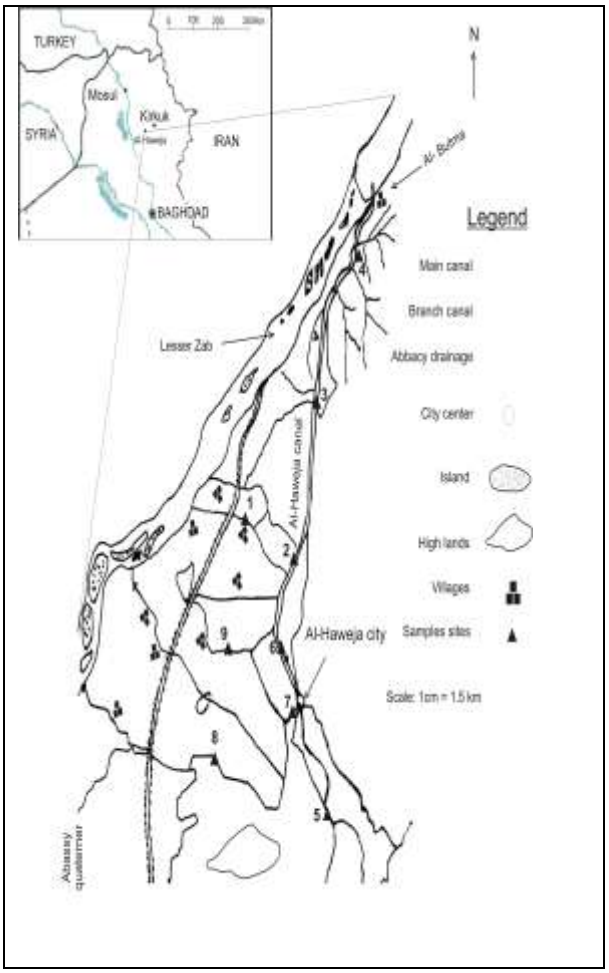

Figure (1) location map of the studied area with sample sites (From: Al-Haweja Irrigation office)

Results and Discussion:

Hydrochemistry:

The chemical and some physical properties of the water in AL-Haweja canal are shown in table (3). The pH value ranged between 7.35 to 8.51 (slightly alkaline) due to high concentration of Ca^{+2} ,Mg^{+2} and Na^{+} .The electrical conductivity (E.C) values ranged between 288-336 micro mohs /cm.The solute content, expressed as total dissolved solids (TDS) , is used to classify the water [4] . In the area of study the ranged of T.D.S was Classification of water depends on the principles of the IAH [6] , total equivalents of cations and anions were taken as 100 % and ions ,as more than 20 % (epm),were evaluated in the classification table (4) .

The water type of the study area is Mg –Ca –Na – HCO_3 –Cl-SO_4 at samples (1,2,3,5) ; the other types are Na- Mg- Ca –HCO_3 –SO_4- Cl and Mg –Na- Ca- HCO_3- Cl- SO_4 at samples (4,7,8,9) and sample (6) respectively table (4) . AL-Haweja canal is classified as fresh water according to T.D.S value (table 3) . The general water type is Mg-Na-Ca-HCO3-Cl-SO_4 according to the IAH [6] table 4 .

from 184 ppm to 215 ppm and the average is about 197 ppm .The concentration of Ca^{+2} ranged between 31 ppm to 90 ppm and the concentration of HCO_3^{-2} ranged between 147 ppm to 266 ppm (table 3).

The concentration of major ions of most rivers in the world have $Na^{+} > K^{+}$, $Ca^{+2} > Mg^{+2}$ and most have $SO_4^{-2} > Cl^{-}$ [5] .Therefore , in study area the dominant cation was Ca^{+2} and dominant anion was HCO_3^{2-} .

A preliminary characterization , carried out using the Schoeller semi- logarithmic diagram (figure 2) , it can be seen that all the fresh water samples show the same peak , which consists of levels of dissolved solids from chemical processes .

According to these results it is widely acceptable that fresh water can be supplied from Lasser Zab. When an area of accumulated solutes is reclaimed by irrigation [7] ,and increase water tends to leach away the solutes appears in the stream water [8] , therefore , these water have bicarbonates and magnesium concentration of more than 87.5 epm and 36.7 epm respectively (table4) .

Table (3) Chemical and physical properties in AL-Haweja canal water .
Concentration in (ppm) and ; (EC) electrical conductivity in micromohs / cm

Sa. No	pH	EC	TDS	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	HCO_3^{-2}	SO_4^{-2}	Cl^{-}
1	7.96	306	196	80	65	37	0.8	174	17	14
2	7.94	308	197	85	65	31	0.1	162	15	13
3	7.94	304	195	90	65	29	1.1	180	17	9
4	7.35	288	184	35	30	30	1.2	240	23	7
5	7.85	310	198	90	75	38	0.9	147	14	13
6	8.51	301	193	71	55	41	0.8	159	15	6
7	7.62	318	194	62	45	45	0.5	236	22	7
8	8.11	303	204	31	19	41	0.6	239	23	6
9	8.49	336	215	35	25	51	0.7	266	25	7
Av	7.97	308	197	64	49	38	0.74	200	19	9

Table (4) Classification of water in AL-Haweja canal depend on the IAH (1979) .
Concentration in (epm %)

Sa. No.	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	$HCO3^{-2}$	SO_4^{-2}	Cl^{-}	Water type IAH (1979)
1	**31.63**	**42.44**	**25.59**	**0.318**	**83.33**	**5.15**	**11.52**	**Mg-Ca-Na-HCO_3-Cl-SO_4**
2	**34.46**	**43.61**	**21.88**	**0.049**	**83.54**	**4.92**	**11.54**	**Mg-Ca-Na-HCO_3-Cl-SO_4**
3	**36.15**	**43.1**	**20.33**	**0.44**	**87.26**	**5.22**	**7.51**	**Mg-Ca-Na-HCO_3-Cl-SO_4**
4	**25.36**	**35.85**	**37.88**	**0.904**	**90.08**	**5.43**	**4.48**	**Na-Mg-Ca-HCO_3-SO_4-Cl**
5	**32.03**	**44.04**	**23.59**	**0.33**	**82.33**	**4.97**	**12.69**	**Mg-Ca-Na-HCO_3-Cl-SO_4**
6	**30.36**	**38.77**	**30.53**	**0.341**	**88.88**	**5.33**	**5.77**	**Mg-Na-Ca-HCO_3-Cl-SO_4**
7	**28.9**	**34.5**	**36.36**	**0.242**	**90.08**	**5.32**	**4.59**	**Na-Mg-Ca-HCO_3-SO_4-Cl**
8	**23.02**	**23.32**	**53.21**	**0.448**	**90.55**	**5.53**	**3.91**	**Na-Mg-Ca-HCO_3-SO_4-Cl**
9	**21.02**	**24.89**	**53.65**	**0.435**	**90.51**	**5.39**	**4.09**	**Na-Mg-Ca-HCO_3-SO_4-Cl**
Av	**29.21**	**36.72**	**33.67**	**0.39**	**87.4**	**5.25**	**7.34**	**Mg-Na-Ca-HCO_3-Cl-SO_4**

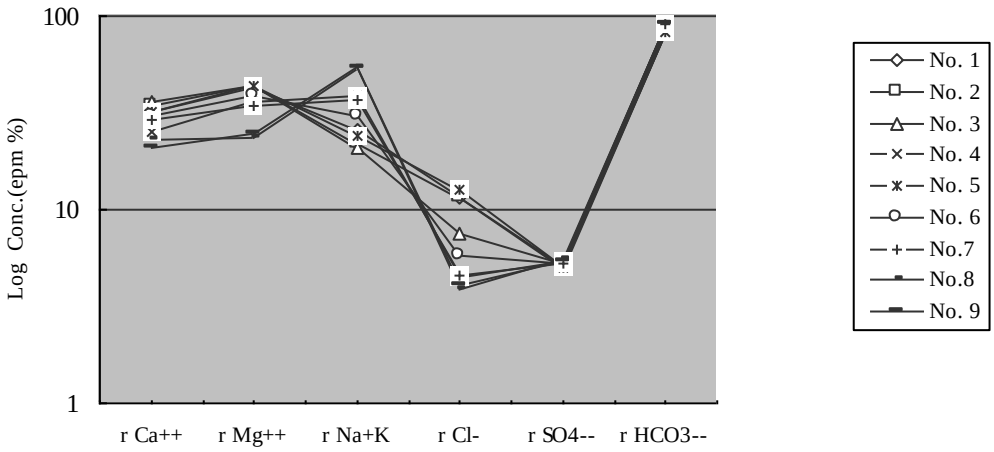

Figure (2) The plotting of the water of AL-Haweja canal on the Schoeller semi- logarithmic diagram.

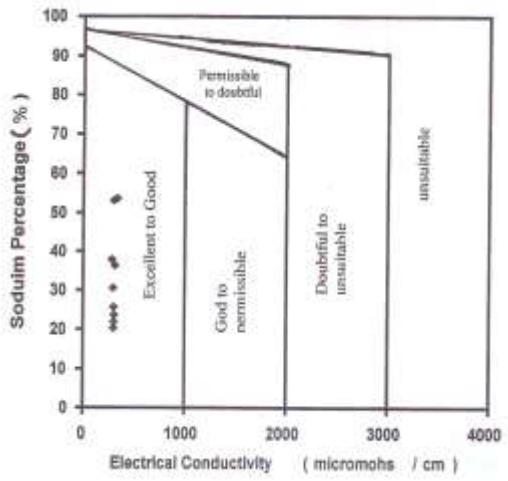

Figure (3) The ploting of the water of AL-Haweja canal on Wilcox diagram

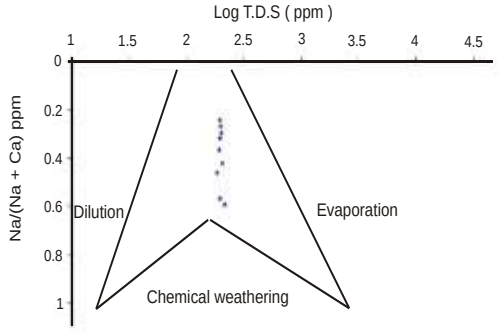

Figure (4) Classification of water in AL-Haweja canal according to Gibbs (1970)

The Wilcox diagram [9] is used for the classification of irrigation water .This graph is based on the electrical conductivity (EC) and the sodium percentage (Na %) .In AL-Haweja canal , the water is classified as " excellent to good " figure (3) therefore , this water has good quality for irrigation .T.D.S values and Na^+ / (Na^+ + Ca^{++}) ratios were used by GiIbbs [10] to classify the surface water.The Gibbs diagram is a graphical representation of the chemical composition of water in terms of two cations directly. Moreover, the Gibbs

diagram serves to classify water with genetic implication and presupposes the geochemical processes that affect waters in different parts of the boomerang [5] . Figure (4) explain the classification of canal water according to Gibbs [10] , the chemical composition of AL-Haweja canal is controlled by chemical weathering of sediments , on the other hand , the chemical composition of the water is varies because of chemical weathering of recent sediments which contains soluble minerals and may be the effect of human and agricultural activities .

Heavy metals:

Heavy metals analysis have been taken from AL-Haweja canal are shown in table (5).There are a number of sites (3,4,5,6,7,8 and 9) where heavy metals pollution have monitored in AL-Haweja canal .This data showed that Cd pollution was restricted to the sites and Mn was restricted to sites (3, 4 , 8 and 9). Cd and Mn values significantly exceed the EPA[11] standards .Wastewater discharge from agricultural farms which used fertilizers and pesticides and domestic wastes are seen along this canal , especially at middle part , probably caused the high level of Cd and Mn.

The inputs of the heavy metals from anthropogenic source exceed the contributions from natural source by several times [12 ,13]. A steady between 1.84 to 0.71 times increase in the concentrations of Cd and Mn respectively is observed in the study area , clearly showing the sensitivity of aquaticsystems to chemical weathering of sediments and may be human activity. These results show that AL-Haweja canal is being threatened by heavy metals pollution.

Conclusions and Recommendations:

The ecosystem is fresh water in AL-Haweja canal according to hydrochemical data.The measured pH of this canal is " slightly alkaline " and the average value of electrical conductivity is 288 micomohs / cm.

Table (5) Heavy metals concentrations of AL-Haweja canal .
(concentration in ppm)

Sa. No.	Cd	Zn	Mn	Fe
1	0.004	0.001	0.08	0.1
2	0.003	0.002	0.09	0.14
3	0.009	0.003	0.11	0.09
4	0.01	0.005	0.10	0.06
5	0.013	0.01	0.03	0.08
6	0.012	0.001	0.02	0.15
7	0.012	0.001	0.05	0.02
8	0.01	0.02	0.08	0.03
9	0.01	0.02	0.09	0.01
Av.	0.009	0.007	0.07	0.075
EPA	0.005	0.150	0.05	0.300

The dominant cation is Ca+2 and the dominant anion is HCO3-2 . The water type is Mg –Na-Ca-HCO3-2 –Cl-SO4 .On the Schoeller semi-logarithmic diagram, all the water samples gives similar signatures. According to the Wilcox diagram, all these samples are "excellent to good " and also suitable for irrigation . These analyses on canal water from the quaternary sediments suggest that this could be used as fresh water source according to the hydrochemistry data .The chemical weathering is dominant upon the dilution and evaporation in study area according to classification of Gibbs [10] because of contains solublemineral. The heavy metal contents of AL-Haweja canal exceed the EPA 2000 standards. In study area this includes especially, Cd and Mn., which clearly exceed the tolerance limits of EPA 2000 standards. From the hydrochemical practice and some heavy metals analyses, it is important to note that in near future this pollution will threaten this canal. Therefore, the following two points need to be addressed:

- The waste should not be released to AL-Haweja canaldirectly.
- Farmers must use fertilizers and pesticides conscientiously

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المظاهر الهايدروكيميائية وتقدير بعض العناصر الثقيلة في قناة الحويجه المائية /كركوك ،العراق

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الملخص:

تم جمع تسع عينات لمواقع مختلفة من قناة الحويجه المائية ،وأظهرت البيانات الهيدروكيميائية بان النظام البيئي لهذه المياه عائد إلى المياه العذبة. وان الكتيون والانيون السائدين فيها هما الكالسيوم والبيكاربونيت على التوالي، و نوعية المياه هي من نوع مغنيسيوم- صوديوم-كالسيوم-بيكاربونيت-كلوريد- كبريتات. في حين العملية الهايدروكيميائية السائدة في هذه المياه هي العملية الكيميائية للرواسب الحديثة والمعادن الثقيلة.كما ولوحظ في هذه القناة تلوثها بتراكيز عالية من العناصر الثقيلة وبخاصة عنصري الكادميوم والمنغنيز بسبب الفعاليات الكيميائية والنشاطات البشرية المنشأ.