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A Study the Concentration of Heavy Metals in Water of the Al-Massab Al-AamChannel (Middle Sector) in Iraq

Haider Abaid Salomy AL-Amar

Applied Geology Dept. College of science, Babylon University, Iraq

Abstract : This study was conducted on Al-Massab Al-Aam channel (middle sector) starting from Al-Hillah city up to AL-Nasiriyacity . In this study the heavy elements were specified and their impact on the quality of the of the Al-Massab Al-Aam channel (middle sector).The study covers the effect of the climate on the main outfall drain channel (Middle sector) which is represented by the quantity of rains falling over the area of study as well as the temperature all over the year at an annual rate straining from 1975 up to 2011, in addition to the evaporation during the above cited years.The heavy elements under this are Zinc "Zn" lead "Pb" copper "cu " Nickel "in" and cadmium . The study has revealed that the study area, namely the main outfall drain channel (Middle sector) is not polluted with the Zinc, nickel and cadmium elements. The concentrations of each element is 0 or Nil, while the concentration of lead was ranging from (0.04 - 0.086 ppm), with an average amounting at 0.051.These values show that the lead concentration in the Al-Massab Al-Aam channel (middle sector)is hazardous and poisoning.

The copper concentration rate was ranging from0 –0.06ppm) with an average amounting at 0.021.

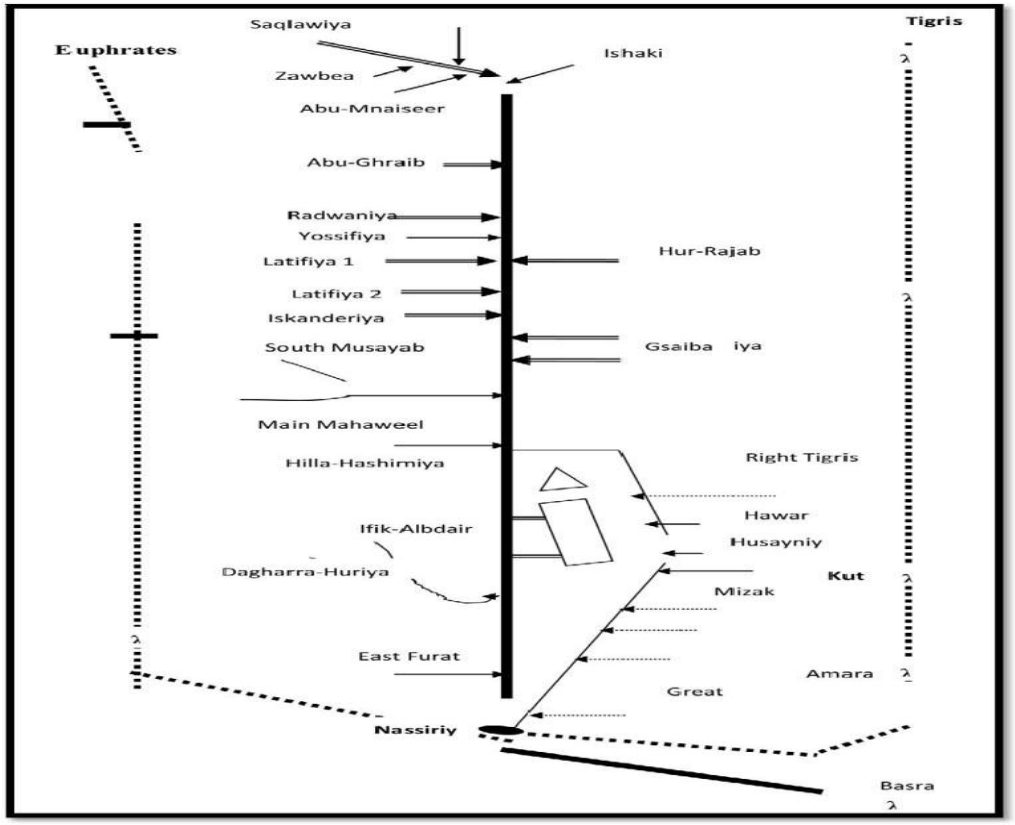
Through the above cited values it appears that the main outfall drain channel (Middle sector) is not polluted with the copper element.

Introduction

The main outfall drain or the "Third River" or main drain, was added as third great waterway to the two historic rivers, the Tigris and the Euphrates. The functions as the main outfall drain to reclaim new lands or to reduce water logging by collecting drainage water between the two main rivers Euphrates and Tigris for more than 1.5 million of agricultural and from north of Baghdad to the Gulf. The importance of this giant project is to collect drain water from agricultural land, improving the water quality of Tigris and Euphrates rivers, controlling the sand dunes movement in the area, creating new agricultural land using saline water in irrigation, wide plantation on both sides of river, improving fish and aquatic life in saline water, navigation, creation new settlements and villages, collecting shallow ground water in the area, creating new jobs for local farmers with hope that if there is additional water (some times in both rivers in future) a mixing might help to decrease the salinity of this saline water channel. It has a watercourse of 566 km, And a total discharge of 210 m^3/s. In 1995 an estimated 17 million tons of salt was said to have been transported to the Gulf through main outfall drain. The engineering schemes of the drainage systems in Iraq were designed to reduce salinities problems on millions of hectares of agricultural lands and to reclaim lands for food production. The largest single project, main outfall drain, was first suggested by British engineers in 1951 as a means of removing highly saline irrigation drainage water from 1.5 million hectares of agricultural land between the Tigris and Euphrates in central Iraq. Parts of main outfall drain were constructed in 1950 and more were completed in the 1960.The engineering work included the construction of the main outfall drain between the Tigris and Euphrates starting

from Main North Musayab Drain nearby Numaniya town and continues to West Shatra Drain fig.No(1-1). The later was discharged into Haur AL-Dalmaj. During the watercourse of main outfall drain. But the entire project was not completed until December 1993 engineering staff, (started on 25 May 1992 and finished on 7th Dec. 1993). The huge drain nearly 566 km in length, runs south from the end of Is'haki drain near Baghdad down the right side of Dalmaj marsh (it has in-and out-let link with the Dalmaj marsh). It continues down the right bank of the Shatt Al Gharraf and crosses the Euphrates via an inverted huge siphon beneath the riverbed just east of Nassiriya. It then skirts round the southwestern edge of Haur AL-Dalmaj, crosses the southeast corner of the AL-Dalmaj marsh (between raised embankments), and finally joins up with the Shatt Al Basra canal (man-made canal) which links the southeast corner of hour AL-Dalmaj to the head of the Gulf via Khawr Abdulla[6] period 1970 to 1990 many companies had been involved in design and construction of the new by

The typical design section of main outfall drain is 35m width at the surface and 23m wide at the bottom and the water level stand at 5.5m above the channel bottom and the discharge of the river is 88 m3/s from the beginning to the end of the channel as in fig. No(1-2)



Figure(1-1)showing the main outfall drain extension from Baghdad Governorate to Basra Governorate after ministry of water resources

The site investigation

Nine surface water samples were selected as random distribution in order to cover the study area along main outfall drain, also to use available data about the distribution and characters of main outfall drain. The locations of the selected water samples are shown in fig.(1-3).

Location of the Study Area

The study area occupies some of the central and southern parts of the Mesopotamian plain, along 199km ,it is located within Babylon , Al-Qadissiya, Wasit and Thi-Qar Governorates and bounded by Al-Shomaly district(Hilla-Waist road) from east and Al-Nasriya city from west ,the study area extends between longitudes (45° 06' - 46° 17') E and latitudes (31° 04' -32°26') N as in Fig.(1-3).

Figure (1-3) Location map of the study area in the southern part of Iraq from satellite image.

Aims of the Study

The study aims at water assessment of main outfall drain (middle sector) the study including chemical properties specially the heavy metals for the water of main outfall drain (middle sector) within certain stations, and suggesting remedial measures to ensure optimum investment of the water resources of the channel qualitatively and quantitatively.

Previous Studies

The Previous studies on main outfall drain channel Focused on different aspects, including topography ,geomorphology of the region and the economic significance of the river, changes in the quality of river water ,percentage of salts in soil with the study of sand dunes and the impact of wind erosion. Most of the previous studies did not pay attention to "the nature of the soil slopes of the river banks .

The following are the most important of these studies :

- Al-Muttalibi(1992)[9] Dealt in his study with topographic features in the alluvial plain and their impact on the path of main outfall drain channel, and the difference in levels between the opposite parts of the valley of the Tigris and the Euphrates rivers.
- Hamza and Shaibani (1992)[15] dealt with Geomorphology applications for the purposes of urban development on both sides of the river and proposed measures to exploit the region for the establishment of a modern housing complexes and stabilize the sand dunes.
- Hassan,(1992) [16]used landsat (TM)images for 1988 and 1990 to moinitor and estimate the sand dunes movement in the main outfall drain(the third river) area.
- Mohammed (1992)prepared study on the main outfall drain channel as development projects in the economic and social fields with its direct effects on agricultural activity to change the pattern of agricultural production in the region .
- Imran et al.,(1996)[20] Focused in their study on performing analytical study of the distribution of sediments in the northern sector with the analysis of soil and river bottom sediment concentration to calculate its total load , and the application of mathematical methods to calculate the sediment.
- Al-Bhadri(1997)[2] dealt with the changes in the quality of main outfall drain channel water and to determine water quality for irrigation purposes and determine the cations and anions and the value of electrical conductivity.
- Al-Husseini (1998)[5]refers to the behavior of the interference of surface water in main outfall drain channel with the groundwater adjacent to it in the area between Mahmudiya and Al-Suwaira, and the objective of the study was to identify the flow pattern and the quantities interfering between main outfall drain channel and the region adjacent to the river.
- Al-Jabariand Al-Nofel (2001)[6]dealt in their book marked by Al-Massab Al-Aam channel (middle sector)(miracle river) with detailed study that includes a historical overview of the river and its divisions , its main sections and the topographic phenomena and the performing engineering projects in addition to its strategic importance.

The most important engineering geological study about main outfall drainchannel was carried out by Al-Khatib(2002)[7] .

It was focused on slope failures of the river in its northern sector with detailed geotechnical properties of the banks deposits(physical ,chemical, and mechanical properties) .

- Hassan,(2010)[17] performed a desertification study of Al-Dalmaj marsh area in the Mesopotamian plain by using remote sensing techniques.
- Al-Ezerajawi,(2012)[3] carried out an environmental study of Dalmaj marsh area /Wasit Governorate/Iraq.
- Abdul Ameer,(2012)[1] carried out a geomorphological study of dune fields and their environmental effects at Al-Muthana Governorate-Iraq.(west of the study area)
- Al Amar Haider(2014) carried out a study & evaluations of slope stability of main outfall drain banks (middle sector) in Iraq.

Methodology:

The study passed through four different stages which could be useful for the intended restoration efforts. Analyzing and interpreting the chemistry of water can provide valuable insights into surface water interactions which include : -

The Data Collection Stage:

It represented the first step in this study, it involved collection of maps, reports, scientific papers and theses about the study area and studied all these data to get good idea about the nature of study area and scope of the previous work on it.

The Field Work Stage:

This stage included several field trips in order to select some field sites(stations)water was assessed, The number of sites assessment was(9)stations, water samples from the river were collected and the laboratory analyses were carried out for them.

The Laboratory Work Stage

After bringing the samples from the sites(stations), they were transferred to the laboratory.

Chemical tests included:

Chemical test of water includes the concentrations of the trace elements(Copper (Cu), Zinc(Zn), Lead (Pb), Cadmium (Cd)

Climate

The climate is one of the most important components of natural environment and has significant impact on the other environmental components, such as vegetation cover, soil, geomorphic features, precipitation and water quantity and quality also it is the cause of the substantive changes that take place within the local environment and it is linked to activities of living organism .

The study area lies within the dominantly prevailing arid and/or semi-arid desert climate characterized by very hot summer and limited seasonal rains, affected by global climatic change, as indicated by increase of the temperature, evaporation, and are blowing in Iraq and the middle east region doubled during 2008.[8] .Three station (Hilla, Diwaniya, and Nasriya) are record the climatic elements were used, such as rainfall , temperature, relative humidity, evaporation, wind speed , and evapo-transpiration, for the years 1975- 2011.These parameters are analyzed in three stations as in tables (3-1),(3-2)and(3-3), The main climatic elements affected the desertification phenomena in study area are:

Results and Discussion

Table (3-1):Means of monthly and annual values of climate elements for period (1975-2011) Iraqi meteorological organization –Al-Hillah station

Months	Temp ^{0}C	Sun Shine Hours	Evaporation Mm	RelativeHumidity`%	Rain Fall mm	Wind speed M/s
Oct	24.7	9	175	50.6	2.4	2.5
Nov	17.7	7	90	62.8	9.3	2.4
Dec	12.9	6.5	57	75	19.3	2.3
Jan	10.9	6	50	78.8	20.3	2.5
Feb	12.9	7.5	77	67.2	11.7	2.8
Mar	16.6	8.5	130	60.4	12.7	3.2
Apr	23.5	9	195	50.2	14.6	3.2
May	29.8	10.5	290	38	14.5	3.3
Jun	33.3	13	330	34.2	0.07	3.9
Jul	34.9	12	390	33.2	0	4.2
Aug	34.5	11.5	325	35.8	0	3.7
Sep	30.4	10.5	260	41.4	0.02	2.7
Mean annual rainfall (mm)					**104.89**	

Table (3-2):Means of monthly and annual values of climate elements for period (1975-2011) Iraqi meteorological organization –Al-Diwaniya station

Months	Temp ^{0}C	Sun Shine Hours	Evaporation Mm	Relative Humidity`%	Rain Fall Mm	Wind speed M/S
Oct	**24.4**	**9**	**237**	**40.6**	**2.63**	2.6
Nov	**16.2**	**7.5**	**121**	**57.8**	11.72	2.55
Dec	**11.0**	**7.0**	72	68	**20**	2.46
Jan	9.5	7.0	69.76	**74.4**	30.22	2.52
Feb	**12.1**	**7.0**	**101**	**65.2**	18.67	2.73
Mar	**16.0**	**8.0**	**180**	**57.4**	21.54	3.18
Apr	**22.9**	**9**	**263**	**47.2**	15.91	3.2
May	**28.9**	**9.5**	**385**	32.9	3.07	3.3
Jun	**32.7**	**12.0**	**501**	**25.2**	0.03	3.5
Jul	**35.1**	**12.0**	**560**	**24**	**0**	4.18
Aug	**34.3**	**11.5**	**501**	**25.8**	**0**	3.7
Sep	**30.5**	**10.5**	**366**	29.6	**0.01**	2.6
Mean annual rainfall(mm)					**103.77**	

Table (3-3) :Means of monthly and annual values of climate elements for period (1975-2011) Iraqi meteorological organization –Al-Nasiriya statio

Temp. ^{0}C	Month	Sun Shine Hours	Evaporation Mm	Relative humidity%	Rain-fall Mm	Wind speed m/sec
Oct.	27.05	**9**	**240**	35.6	4.79	2.63
Nov.	19.08	**7.5**	**122**	57.7	14.0	2.51
Dec.	13.3	**7.0**	74	65.6	14.08	2.47
Jan.	10.8	7.0	70	66.5	21.93	2.61
Feb.	13.57	**7.5**	**103**	57.81	15.31	3.12
Mar.	19.03	**8.5**	**180**	48.34	16.63	3.41
Apr.	24.8	**9**	**265**	39.14	8.55	3.6
May	31.27	**10**	**386**	28.19	4.0	3.59
Jun.	34.36	**12.5**	**515**	24.0	0	3.9
Jul.	36.14	**12.5**	**564**	21.2	0	5.22
Aug.	35.72	**11.5**	**512**	22.3	0	3.37
Sep.	32.56	**10.5**	**376**	28.5	0	2.97
Mean annual rainfall (mm):99.29						

Rainfall:

The mean monthly rainfall(mm) for the period (1975-2011)varies with the season ,being minimum (0 mm)in (Jul. and Aug.)inHilla, Diwaniya and in (Jun. , Jul. , Aug. and Sep.) in Nasriya. The maximum mean monthly rainfall values are in Jan. ,being (20.3mm in Hilla,30.22mm in Diwaniya and 21.93mm in Nasriya). Fig.(3-1).

From the tables(3-1),(3-2),(3-3) it appears that the mean annual rainfall values for the period (1975-2011) are (104.89mm)for Hilla, (103.77mm)for Diwaniya and(99.29mm)for Nasriya so that (1) the mean annual rainfall decreases from Hilla to Diwaniya to Nasriya consistently .(2) The mean annual rainfall value for all stations is low(around 100mm) ,this indicates arid to semiarid climate.

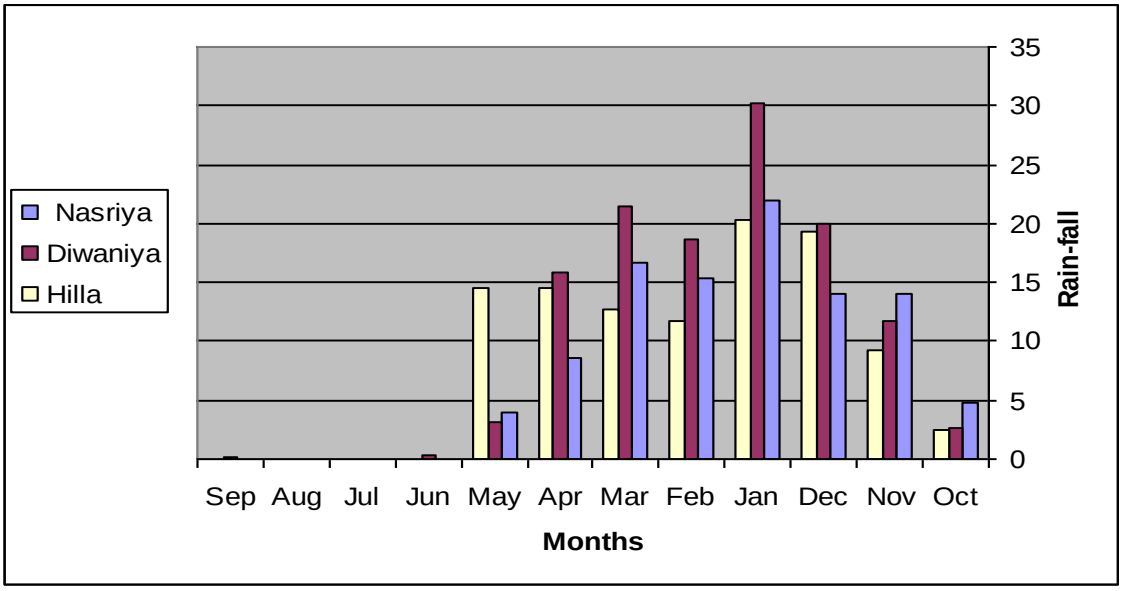


Figure (3-1) Means monthly Rain fall for years (1975-2011)

Heavy metals(Trace elements):

Trace elements defined as metallic elements with atomic weight great than (20).Trace elements occur naturally as a result of the weathering of the rocks [11].The occurrence of trace elements in groundwater was directly related to soil characteristics and they are causing the pollution of groundwater by three major sources [12].

The heavy metals enter the aquatic environment of southern Iraq from both natural and anthropogenic sources [8].Natural sources include dust storms, erosion or weathering, whereas the anthropogenic sources include sewage wastes, industrial effluent, automobile effluent, petroleum and fertilizer industry effluent [13]. Trace metals are also incorporated through the food chain of fish either from water via gills or from sediments and marine organisms via the gut track . The following trace elements were chosen for analyses in the main outfall drain (middle sectors): Copper (Cu), Zinc(Zn), Lead (Pb), Cadmium (Cd),as shown in table number(4-1) all samples by (ppm)unit.

Lead (Pb):

Lead exists in many type of rocks ,it exists in minerals of igneous rocks like Oliven ,Pyroxene, Amphiboles and AlKali-Feldspar ,[14] .The lead concentration is variable for a number of factors, including the conduct of the source water and the changing of the pH and specifications of the basin and the acidic conditions on the oxidizing environment[70].The high concentrations of lead causes the cancer , mind spoil to human and kidney infection. The Lead (Pb) concentration of the main outfall drain (middle sectors) as in table(4-1)ranges between the maximum value of 0.086 ppm in station No.9 and,the minimum value is 0.040 ppm in station No.7, and the average value is 0.051ppm .According to table (4-1), the lead concentration in water sample will be dangerous and toxic to human drinking water.

Copper (Cu):

The copper is one of the common elements in nature in the formof Sulfate and oxides, it increases with the increase of the temperature and acidic solution often resides in association with sulfur formed the copper Sulphate in most rocks, the concentrations of Copper (Cu) in water (1.5 ppm),if the concentrations exceed(2 ppm) then the water is considered to be toxic and causes many diseases which cause death to the Human[22-25] ,the little existed of Cu in the study area because of existing the clay menials and ores Illite which adsorbed the copper from aquatic environment causing decrease of its concentration[4].

The Copper(Cu)concentration of the main outfall drain (middle sectors) as in table(4-1) ranges between the maximum value of 0.061 ppm in station No.8 and , the minimum value of NILin stations No(2,3,6 and 9), and the average value is 0.021 ppm .According to table (4-1), the copper concentration in water sample is not dangerous or toxic tohuman drinking water.

Zinc(Zn)

Zinc 75 ppm in crustal rocks like Cu and Ni, thus it is fairly common ,minerals which contain Zn are Sphalerite , Smithsonite , Willemite and Hemimorphite**,** Another sources are the animal organic remains and the industrial activities,such as, metallurgy [18]. The zinc is one of the elements that enters within the structure of calcite and dolomite under low temperatures, as well as with clay minerals. Zinc does not show a difference in the presence of calcite and dolomite, or so it may be influenced by digenesis processes on the rocks.[10]

The Zinc concentrationof Al-Massab Al-Aam channel (middle sector)as in table(4-1) is NIL for all samples ,thus the zinc concentration in water samples will not be dangerous or toxic to human drinking water.

Nickel (Ni)

Ni is present in Carniorite, millerite, nicolite and pentlanditemineral,Nickel enters ground waters and surface water from erosion and dissolution of rocks and soils, as well as from biological cycles, industrial processes , and waste disposal . if the concentration of Ni exceed the permissive limit in drinking waters, it will be toxic to human .

The Nickel concentrationof Al-Massab Al-Aam channel (middle sector) as in table(4-1) is NIL for all samples ,thus the Nickel concentration in water samples will not be dangerous or toxic to human drinking water.

Cadmium (Cd):

The Cadmium(Cd) element is considered to be very toxic and not useful to human life. The Cadmium(Cd) accumulate in the human body along his life in his kidney and his liver and cause the kidney failure for humans this ill name (Itai-I). Weathering of Cd minerals ,Cadmoselite, Greenockite and Olarite ,and the rocks of the earth crust, such as, clay which contains (19)ppm adsorbed Cd ,liberate Cd to natural waters . Cd and Zn are similar in their geochemical characters ,but Cd is much less abundant in natural waters[18]. Excessive amount more than (10) ppm in drinking and irrigation waters will be toxic. The Cadmium concentration of main outfall drain (middle sectors) as in table(4-1) are NIL for all samples ,thus the Cadmium concentration in water samples will not be dangerous or toxic to human drinking water.

Table (4-1) Show heavy metals values in (ppm) Al-Massab Al-Aam channel (middle sector)

St.No	Cu	Pb	Cd	Zn	Ni
1	0.048	0.075	NIL	NIL	NIL
2	NIL	0.043	NIL	NIL	NIL
3	NIL	0.044	NIL	NIL	NIL
4	0.022	0.048	NIL	NIL	NIL
5	0.034	0.045	NIL	NIL	NIL
6	NIL	0.043	NIL	NIL	NIL
7	0.055	**0.040**	NIL	NIL	NIL
8	**0.061**	0.041	NIL	NIL	NIL
9	NIL	**0.086**	NIL	NIL	NIL

Conclusions

After studying some trace elements concentrations of Al-Massab Al-Aam channel (middle sector) the field observations find the following points:

The lead concentrations range between (0.04-0.086)ppm with average value of (0.051)ppm, copper concentrations range between (Nil-0.061)ppm with average value of(0.021)ppm, zinc,nickel and cadmium concentrations are Nil for all water sample.

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