International Journal of Mechanical Engineering

Utilization of a Drainage Water for Irrigation purposes: Case-Study, HAJI-ALI Drain, Babylon

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Abstract
The problem of scarcity of water supply is one of the most important problems currently facing Iraq, and because of the future deficit of Tigris and Euphrates rivers, it is necessary to consider other sources of water. This study aim to evaluate the quality of Haji-Ali drain water and its suitability for irrigation purposes after diluting it with Euphrates river water. Diluted water samples are subjected to the following analyses: PH, SOLUBLE cations and anions for different depths. The values of EC and SAR were increased with the increase of depth of root zone (avg. EC=7.34) and (avg. SAR=6.75) and after the comparison with the limits of FAO values, these values were acceptable for irrigation. The terms of the toxic effect with respected to CL with the concentration ranged (11 – 30) mg/L, and there forits suitable for irrigation. The use of diluted water increased the production level of the barley crop by 15%comparison with the neighboring areas of farmers in the region and its accepted for irrigating most tolerance field crops, however sensitive plants should be excluded.

Keywords: Irrigation watershortage, Drainage water Reuse, Irrigation water quality,Drainage water,Drainage water quality, Haji-Ali Drain.

1. Introduction

The abundance of water in the past meet the need for water and if its passed through sporadic drought times. Today water uses have varied in industry, agriculture, services and the result of population increase, which led to a scarcity of water, this is in addition to the presence of dams and hydraulic structures that were built on the Tigris and Euphrates rivers by neighboring countries , what required to regulate the use of water and reduce losses and finding other sources of water will help meet the need for water in our country.

The drainage water is considered one of the sources of water that can be maintained , water planning and dilution is used in the irrigation process, in some plantation that have resistance to salinity, like barley,maize citrus fruits.This is to provide an additional source that helps our country need for water.

The optimal use of water resources is carried out through quantitative water loading and evaluation to meet agricultural and industrial needs. In light of the acute shortage of water resources at the global level, the means have tended to reduce dependence on traditional sources of water and to pay attention to non-traditional saline water sources such as sewage, industrial and groundwater, and drainage water for use in some different industrial and agricultural fields by following an appropriate water management method(Alhadeethy 2013) and (Alhadeethy 2011].

Drainage water is defined as the process of withdrawing saline surface water in excess of the need for agricultural areas or streams through a drainage network to be drained into rivers or depressions in order to benefit from them and to keep the soil in a constant salt and moisture balance in which the accumulation of salts is prevented (Alhadeethy et.al 2009).

In many parts of the Middle Euphrates region, farmers use drainage water for irrigation,as a result of fresh water shortage in this area. In other hand, most Arab countries, drainage water constitutes the largest amount of non-conventional water, and it is necessary to take advantage of it to meet the country's need for water. About 15 billion cubic meters annually have reached in Egypt, discharged into the Nile River and the Mediterranean Sea. In Iraq, the drainage water from agricultural lands is estimated at about 6.6 billion cubic meters annually (Alhaidary and Fikrat 2005). The most important criteria for determining the quality of drainage water that must be studied, according to what the staff of the American Salinity Laboratory indicated(Alzurfy et.al 2005)

and (Alsaady and Ali 2006). It is the value of the electrical conductivity in units of measurement dS / m or µS / cm which is closely related to the total soluble solid material, the quantitative concentration of salts in a unit of measurement mg / liter (ppm) which includes the sum of the positive and negative ions dissolved in water (Na^{+}, Ca^{++}, Mg^{++}, Cl^{-}, HCO_3^{-}, $SO_4^{=}$), the sodium adsorption ratio, the boron concentration and other important determinants as the concentrationof Nitrates, bicarbonate and degree of reaction of water.

The salinity, the degree of sodium adsorption and toxicity are among the most important risks that cause the use of salt water for agricultural and industrial purposes, as the salinity of drainage water causes the inability of plant roots to absorb water and nutrients when using this water for irrigation(Department of State Council Affairs 2012).As for soda, it affects the rate of water infiltration in the soil, reduces the water conductivity, increases the hardening of the surface layer of the soil, and is evaluated by the degree of sodium adsorptionSodium Adsorption Ratio SAR [Zedan and Abdulkareem 2009).It is an indicator of a predictor of sodium hazard for irrigation water, and water is defined as having a high resilience when the SAR exceeds the value of 10(Salman 2006),(Taha 2003), and (Abdulabass 2012). As for toxicity, plants are poisoned due to the SAR in water exceeding 10, boron if it exceeds mg / l 5, nitrates if it exceeds30 mg/l, and bicarbonate if it exceeds520 mg/l.

Therefore, it is necessary to evaluate this water before its use to determine its quality and for what purpose it is used(Umran2012).

Many researches in the past had been studied on drainage water and its characteristics forusing in irrigation. (Alrazaq and Talib 2017) studied the attempt to exploit drainagewater of Karbala that is going vainly without benefit from them, the chemical analysis included TDS, EC, pH, cations (Ca^{++}, Mg^{++}, Na^{+}), chemical parameters (SO_4^{-2}, Cl^{-}, NO_3-N) and boron (Br). The values varied, and some were recorded within the permissible limits and some outside the permissible limits for irrigation water.(Hashem et.al 2014]developed a database for the quantity and quality water of northern and southern Kufa drainage system. The data indicated the electric conductivity (EC) of two Kufa drainage water during spring season was little value compared with other seasons due to dilution with rainwater, while increasing of electric conductivity during summer season was due to drainages proceeding and increased evaporation of heat temperatures during summer season. While in winter and autumn seasons were noted slight decreasing of EC was due to evaporation decreasing with high level of drainage water and limitation of drainage process agricultural land. In addition, results indicated high salinity in southern drainage water and it was moderate salinity according of classification system of USA salinity lab because there are treatment station named barakia drain its pollutant.(Salih, 2012)investigated the suitability of drainagewater in the area which is located at the north of Baghdad city (Al-Rashidiya and Al Husainiya areas) for irrigation of agricultural crops. The results indicated that the suitability of drainage water for irrigation of non-sensitive(high tolerant) crops , and the agricultural lands need to the drainage process when areusing this water , because of the high rate of salinity and chemical parameters (chloridesand magnesium).(Almaliki2013) selected Al-Hussainia main drain which is the middle sector of Al-Dalmaj irrigation project to be evaluated for its water suitability for irrigation. Chemical evaluation of drainage water to study the effect salinity indictors on crops production and comparing the test results of these indicators with their standards limitations. Leaching requirements computations to avoid salt accumulation in the soil and mixing for locations with high salt concentrations. The test results showed that there are no harmful effects from sodium indicators on crops production while there is a salinity problem. The leaching requirement of 0.25 for Wheat for all location while barley needs a leaching requirement of 0.15 for some locations and 0.17 for the others.

The present research aims toclose the gaps on the previous researches of the literature through prepare a database on the quality of the water quality of the Haji-Ali Drain water by Euphrates River for the province of Babylon by conducting chemical analyzes that include the total of positive and negative ions dissolved in water (Na^{+}, Ca^{++}, Mg^{++}, Cl^{-}, HCO_3^{-}, $SO_4^{=}$),and the percentage of sodium adsorption, boron concentration and heavy elements with the possibility of being recycled for different purposes.

The usage of drainage water in irrigation and after that indicated the best dilution for Haji-Ali water by Euphrates River water to obtain the suitable water to irrigate the crops ,and to get a reasonable relative yield.A comparison between the estimated values of the sodicity ,salinity ,and toxicity before and after dilution with stander values in order to choice the best value of dilution and in order to predict the development of salinity, toxicity and sodicity hazards in the root zone for the long use the drainage water, and also to improve crop yield and soil condition under good management practices.

2. Materials and Methods

The methodology of this research is represented by collecting samples of drainage waterfrom suggested locations along Haji-Alidrain and then tested to get raw data that necessary forthe analysis and getting the results.

2.1. Area of study

Haji-Ali Drain is one of the major drains in the Babylon Governorate and with shortage and scarcity of surface water, thinking started using tapped water for irrigation. Haji –Ali drain is tall about (55.9 km) serve region about (174317) donam; which receive

drainage water, and some of wastewater effluents from neighboring lands (Directorate of Water Resources in Babylon 2021) ,as shown in fig.1.

The climate in the area is sub-arid to arid with average yearly temperature of 23.1 C^0 with speed of 10 km/hr., precipitation of 1.2mm/hr (Iraqi meteorological organization and seismology 2019).Water consumption has been calculated for the crops has been irrigated by the drainage water dilution by using Blaney- Criddle method because it is easy to apply and it provides seasonal and monthly estimates of actual consumptive use (CU) in terms of two main climatic parameters; these are temperature and the number of sun shining hours. This was not specified so that the excessive use of water would not lead to the salinity problem in the soil.

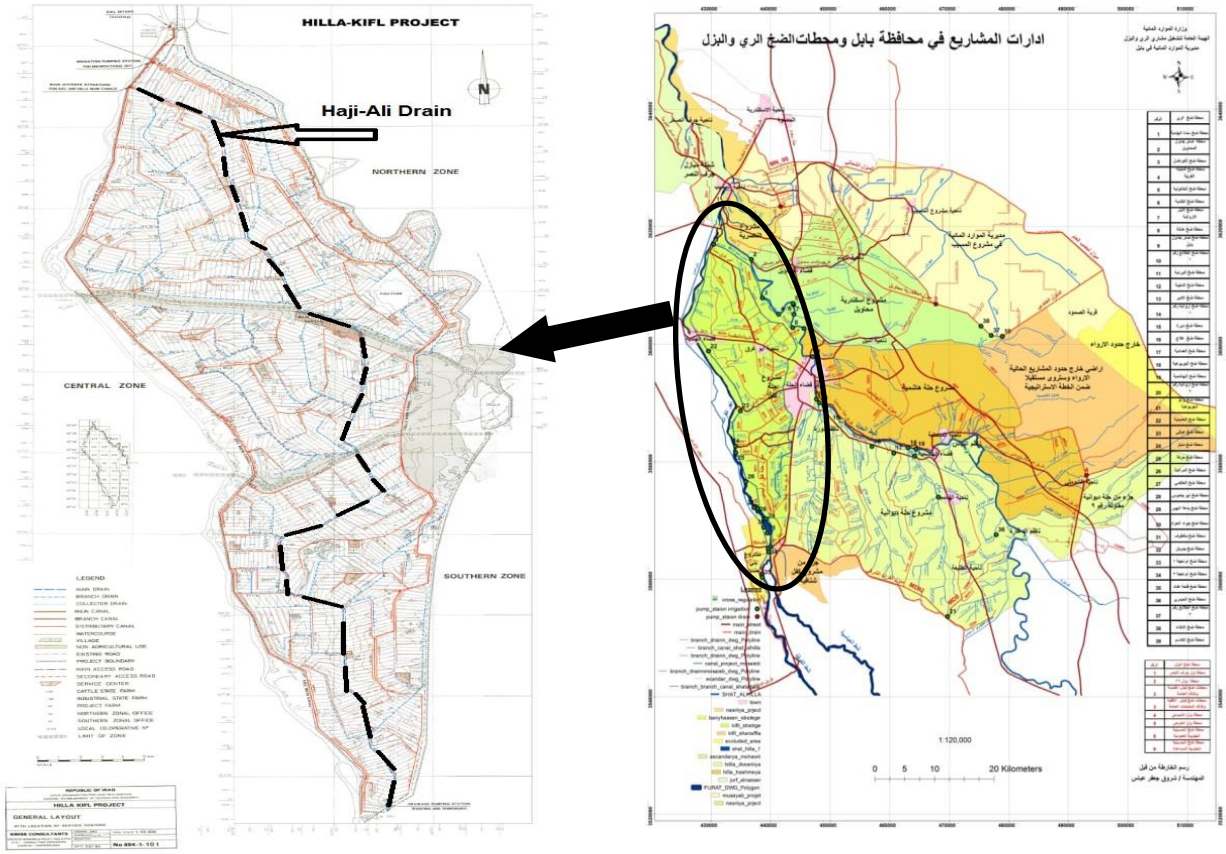

Figure 1: The location of Haji-Ali drain.

2.2 Experimental procedure

Water samples are frequently taken from Haji-Ali drain at the up- stream, middle and down-stream, also samples are taken from the root zone. The samples are collected monthly from drain and Euphrates River from 2018-2019 to cover all four seasons and only average values will be reported. These water samples are collected in the specific bottles and subjected to the following analyses: pH, Soluble cations and anions. The tests of water samples include chemical analyses which represent Electric conductivity (EC), Magnesium ion Mg^{++}, Sodium ione Na+, Chloride ion Cl^-, Sulfate (SO_4^{2-}), and bicarbonateHCO_3^-. These tests are conducted in the Laborites of Environmental engineering Department / Collage of Engineering / University of Babylon and Laborites of Ministry of Science and Technology;using the suitable device for each test: (EC, electrical conductivity meter), (pH, pH electrode), (Ca^{2+} and Mg^{2+}, Water Hardness Tester), (Cl^-, the Chloride sensor), (CO_3 and HCO_3, sensitive Raman spectroscopy), (SO_4, ion chromatography).

3. Results and Discussion

The average values of water samples are listed in Table.Water samples areconducted according to pH, soluble cations and anions.

Table 1: Chemical analysis of Euphrates raw water and drainage water

Water Resources	EC	Ca++	Mg++	Na+	Cl-	SO4-2	HCO3-
Euphrates Raw Water	1.20	4.10	3.42	3.23	3.83	4.35	2.47
Drainage Water	7.15	15.31	25.5	54.6	40.54	50.47	3.86

On the other hand, drain water was diluted with raw river water with many dilution ratios, the minimum dilution ratio that gives a suitable qualities is 50%. It is possible to use other ratios to give better results and by increasing the ratio of river water to the amount of drainage water but it's better to reduce the amount of river water used to reuse more of drain water. The chemical analysis of some parameters is listed in Table 2.

Table2: Chemical Analysis and EC for dilution drain water by (50%)

Concentration, mli.mol./L / Location	EC	Ca^{++}	Mg^{++}	Na^{+}	Cl^{-}	SO_4^{-2}	HCO_3^{-}
Babylon-Abi-Garag	6.3	6.32	7.46	13.65	11.1	13.25	2.0

Plant samples (Corn and Grain)are collected from soils irrigated by dilution drainage water and subjected to Chemical analysisare listed in Table 3.Figure2 shows a graphical representation for the chemicals analysis for the diluted water.

Table 3: Chemical Concentration in root zone using diluted water (50%).

Depth (m)	Ca++	Mg++	Na-	Cl-	CO3-	HCO3-	SO4-	SAR	PH	SUM CAT	Ca:Mg	EC	AVG,EC	AVG SAR
0.0	6.21	7.3	12.85	11.52	0.84	1.93	13.51	4.94	8.45	26.36	0.85	6.32		
0.25	9.75	10.6	18.0	15.22	0.79	3.96	18.76	5.64	7.88	38.35	0.91	6.48	7.34	6.75
0.50	14.4	14.9	25.32	22.5	0.70	5.85	26.44	6.61	7.89	54.62	0.96	7.51		
0.75	18.28	20.08	34.27	26.8	0.72	7.32	36.63	7.8	7.60	72.63	0.91	9.07		
1.0	19.54	25.7	39.6	29.8	0.70	7.94	44.58	8.76	7.33	89.84	0.84	9.55		
FAO Standards	0-20	0-5	0-40	0-30	0-1	0-10	0-20	3-9	6-8.5			0.7-3		

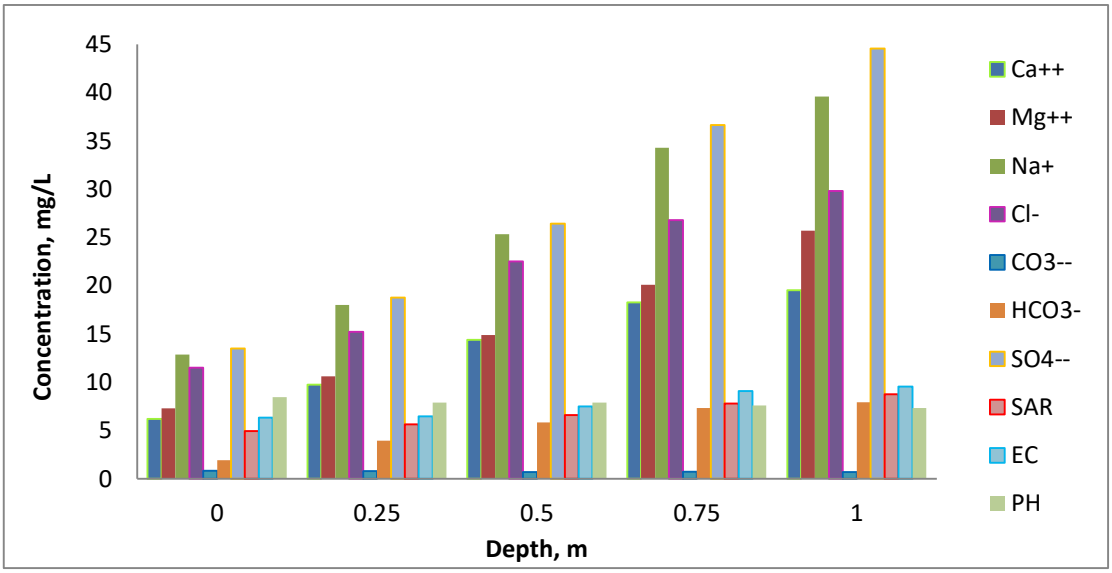

Figure 2: Graphical representation for the chemical analysis of diluted water

The value of pH of diluted water was varied and decreased with depth of the root zone because of the increment of electrical conductivity (EC) with depth; as shown in fig. 2. The estimated value of CA: Mg throw the root zone which is consideredas an indicter to the Calcium founder, the percentagein Table 3 areless than (1.0) which indicates the high concentration of Mg to the concentration of CA in the root zone and the possibility of a calcium-related nutritional problem(Rhoades and Mashali1992).The EC and SAR values of the diluted water arecompared with the permissible limits by FAO. Thesevalues are increased with the depth of the root zone and exceeded the permissible limits by FAO[Ayers and Westcott 1994].It is important to note that when sandy soils are irrigated with high SAR water , it is not easily depraved as compared to other type of soils .The high values of SAR in the root zone may not affect the soil permeability and do not reach to the possibility of the emergence of riskssodicity hazard and effect the plants growth(FAO 1989),because crops take most of the water (70%) from the consumptive use from the first and the second quarters of the root zone (FAO 1989). The average SAR was 6.75 ml.mol/L and is classified as a low sodium water(Kahtan 2012).The Salinity hazards areconsidered by incorporating data on electrical conductivity (EC).EC is one of the basic criteria in determining the salt concentration of water (Kahtan 2012); which ranged (6.32 – 9.55) ml.mol/L, this is classified according to USRS classification as a very high salinity water, and according to RC classification as acceptable (Kahtan 2012).The effect of the soil salinity on the yield of crops depends on (EC) and another element; and in the best condition; its effect has been taken on the upper layers of the root zone; and the average value of (EC) has been taken in the root zone and compared with the FAO standards. On the basis of the diagram of the USSL.S classification, shown in fig. 3, irrigation water is classified in to four type (C1, C2, C3, and C4) based on salinity hazard.

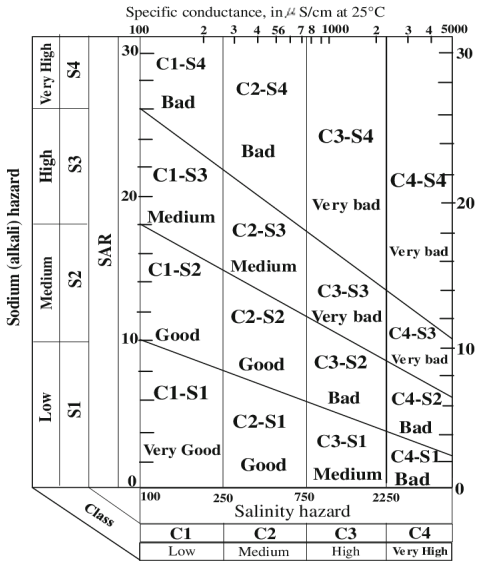

Figure 3: USSL-diagram for classification of irrigation waters.

As for the toxicity in irrigation water that expresses as the amount of chlorine concentration in diluted water; Table 3 shows that this value of the (CL=11.1M.LI.MOL./L), this is a small value and is suitable for all plants almost in terms of the toxic effect with respect to CL; like Grain ,Corn ,Tomato,and another's crops. At low concentrations, CL is an important element for plant's growth, chlorine does not adversely affect the properties of the soil, therefor there is no need to reclassify the quality of water in relation to chlorine concentration.The use of diluted water increased the production level of the barley crop by 15%comparison with the neighboring areas of farmers in the region by using different soils of texture and structure.

4. Conclusions

1- To reuse drain water safely in irrigation,its better be used in the winter season than in summer season .
2- EC, SAR values increasedwith the increasing of depth in root zone.
3- The quality of the diluted drainage water is accepted for irrigating most tolerance field crops, however sensitive plants should be excluded.
4- The diluted drainage water had lower salinity, lower Sodicity compared with drainage water and its suitable for irrigating of salt tolerant crops.
5- Experiment another ratios of dilution in order to get another type of water that can irrigate different type of plants.
6- Working on the maintenance of the drain from the animal and human influence, and open water river to entering in the drains in order to reduce salts concentration.

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