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Seasonal Assessment of Chemical and Physical Characterization of Khabur River, Zakho District, Kurdistan Region/Iraq -A Case Study

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ABSTRACT:

The river Khabur, the life line of more than 500 thousand of people, supplies water for the important requirements of life. In this work, a total of 192 samples of water were collected at Khabur River, Zakho District. The samples were collected monthly at four different seasons like spring, summer, autumn and winter from March, 2019 to February 2020. The samples of water were examined for total hardness (TH) , total alkalinity (TA), pH, Calcium(Ca^{2+}) , Electrical conductivity (EC), Nitrate (NO3-), total dissolved solids (TDS), Sulfate (SO_4^{2-}) , phosphate, magnesium (Mg^{2+}) BOD, and DO according to the standard methods . The results of the chemical and physical characteristics indicate the water river samples with the following parameters. The total mean values of temperature ranged from (14.461± 14.1469) ºC , pH varied from (7.831 ± 0.2842). Conductivity ranged from (560. 25 ±110. 805) µS/cm).Total alkalinity varied from (194.19 ± 69.591) mg/L. Total dissolved solids varied from (355.99 ±71.581) mg/L. Dissolved oxygen varied from (8.219 ± 0.7989) mg/L. Biochemical oxygen Demand (BOD) ranged from (9.857± 6.0760) mg/L. Total hardness varied from (535.02 ±78.014) mg/l. Calcium (Ca^{2+}) varied from (409.19 ± 46.875) mg/l. Magnesium (Mg^{2+}) ranged from (127.58 ± 46.875) mg/L. Chloride (CL-) varied from (26.938 ± 21.2133) mg/L. Nitrate (NO3-) ranged from (4.449 ± 2.0327) mg/L. Sulfate (SO_4^{2-}) varied from(43.24 ±22.479) mg/l. And phosphate ranged from (4.839 ± 1.9139) µg/L. Gradual increase in total alkalinity and hardness towards the downstream is, due to effluents in the Khabur River. Untreated from sewage discharge on river water it causes of high organic matter, phosphate and Nitrate, at high contents in Khabur River .TDS and EC were found moderate in all locations at Khabur River. The total hardness exceeded the permissible limit in all sites. The (Ca^{2+}) and (Mg^{2+}) were exceeded the permissible limit in all sites. In the present study an attempt had been made to determine the levels of wastewater that ultimately discharged into Khabor River without proper treatment.

KEYWORDS: Waste water, Khabur River, Physical and chemical parameters, Zakho city.

1. INTRODUCTION

The Khabur River rises about 100 km from the city of Zakho, the Khabur River that rises in Turkey and flows through Iraq to meet the Tigris at the tripoint of Iraq, Turkey, and Syria .The Khabur River originates in the Uludere region in turkey and involved a number of small Rivers, flowing off the bolkar mountain and flow southern of Hakkari. The River generally flows south crossing the Iraqi- Turkish border into Kurdistan of Iraq before meeting the Tigris River. Zakho is an important town along the Khabur River where crosses the delal bridge west of Zakho, the small Khabur is joined by its main tributary the Hizil River, which forms part of the border between Iraq and turkey. (Kamil ., 2016). Sources of waste water in the study area are hotels, laundries, industrial wastewater, hospitals, domestic wastewater and household activities. Wastewater is collected through sewage systems. The chemical, biological and physical parameters of Khabur River water are affected by pollutants and affect the quality of water and on water ecosystem. Sediment causes problems by preventing light penetration, covering water organisms, and filling water bodies (Ayoub, et al, 2015). Most of the villagers utilize the river water for domestic purposes. Owing to high values of contaminants like pesticides and toxic metals, the village community establishing on its edge is facing serious health problems. There are hundreds of people suffering from earnest ailments like stomach illness, cancer. The loading of Nitrate and Phosphate on fresh waters promote eutrophication, leading to raising algal blooms and growth of water weeds, due to agricultural seizes contributing nutrients to surface water. (Musher ., 2015) . Excess fertilization leads to variations in water clarity and phytoplankton biomass, which changes the water quality. There are numbers of rural situated on the edge of the Khabur River. The people from these rural utilize the water of Khabur river for livestock rearing and irrigation .This work aims is to evaluate the 13 chemical and physical characteristics of river water in the selected sites of Khabor Rive, Zakho District. And evaluate the effect discharge of wastewater of the Zakho town on chemical and physical, characteristics of Khabur River. And also assessed to determine its suitability for irrigation and drinking purposes

2. MATERIALS AND METHODS

2.1 Study area: The river Khabur supplies water for several purposes including domestic, drinking, agriculture, and industrial purpose to number of towns and villages .The untreated wastewater of these villages and cities is being discharged directly in the Khabur River. The studied area are located within Zakho District .The study area falls within Latitude: 37° 08' 55.36" N and Longitude: 42° 41' 9.28" E and lies about 55km north of Duhok Governorate .The climate of the study area is tropical summer with extreme temperatures ranging from 47.2 to 15°C during summer and winter. (Figure. 1) represents the location of the studied area and sampling sites

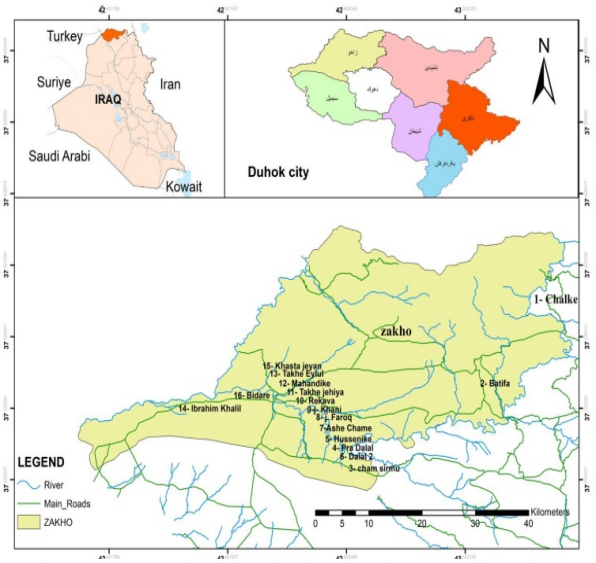

Figure 1: Map of Zakho district showing sampling sites, inflowing Khabur river water

2.2 Samples collection and analysis: Khabur River is located in the northern part of Iraq, for the monthly evaluation the quality of river water. A total of 192 samples of water are collected at Khabur River from various sites of the area study. In the present investigation. River samples are collected at sixteen locations were selected during the period March 2019 to December 2020. Two liters samples were collected in sterilized container, and immediately brought to the laboratory for the chemical and physical tests. The samples of water are tested for the parameters such as total Hardness (TH), (Cl) Chloride, (TA) Total Alkalinity, Biological Oxygen Demand (BOD), Dissolved Oxygen (DO), (EC), pH, Nitrate (NO_3^-), total Dissolved Solids (TDS), Sulfates (SO_4^{2-}) , Electrical Conductivity , (Mg^{2+}) and Ca^{2+}) and phosphates. According to standard methods (APHA., 2017).

Table 1: Monthly variation of Temperature (T°C) in sixteen locations

2.3 Statistical Analysis : Statistical analysis of the data was done by analysis of variance which was adopted to analysis the data and LSD0.05 was applied to determine significant differences between periods and hospital using a software program (SPSS version 19). All data were expressed as mean ± SE.

3. RESULTS AND DISCUSSION

Water Temperature T°C: The temperature of surface water has a direct effect on the biological and chemical processes of the river. It also affects the metabolies of living organisms and physiological processes in the water ecosystem. (MohdYawar et al., 2021). The temperature of Water usually depends on the geographic location, temperature of effluent entering the River and sampling time. (Saif., 2020). The mean value and standard error of mean values were ranged from (12.075 ± 3. 423) to (24.850 ± 4.361) ºC . (Table 15), The temperature of the collected water samples were in the range 7.2 °C to 18.9 °C, (Table 1) at all sampling locations in River water (Table1). The River water temperature varied depending on the seasonal variation of atmospheric temperature, it less in winter and higher in summer. The maximum level of sample temperature recorded at site Ashejam was 18.9°C in summer, the surface water is influenced by the intensity of the sunlight, while the minimum level was observed at site Jamsemo was 7.2°C in February, in winter. Decreasing the temperature of surface water due to the melting of snow of the mountain in the studies area **.** They have a significant variation at $p \leq 0.05$). The same results were observed by (Bishnu **.,** 2021**)**

Table 1: Monthly variation of Temperature (T°C) in sixteen locations

Months Sites	**Mar.**	**Apr.**	**May.**	**Jun.**	**Jul.**	**Aug.**	**Sept.**	**Oct**	**Nov**	**Dec**	**Jan.**	**Feb**	**Average**
1-Jalke	14.2 h	14.5 L	14.8k	15.2j	15.7k	16.3L	11.2n	10.7L	9.5L	8.4j	7.1k	7.3 m	12.0a
2-Batefa	14.1 i	14.3 m	14.9j	15.1k	15.9i	16.2m	11.4L	10.5m	9.4m	8.5i	7.7i	7.5 L	12.1a
3-Jamsemo	14.4 f	14.6 k	14.7L	15.2j	15.8j	16.3L	11.3m	10.7L	9.6 k	8.3k	7.9g	7.2 n	12.1a
4-Aelol Q	14.3 g	14.7 j	14.9j	15.1k	15.9i	16.3L	11.5k	10.9k	9.5 L	8.5i	7,6j	7.5 L	12.2a
5-Dalal 1	14,5 e	14.9 h	15.0i	15.3i	15.8j	16.4k	11.7j	11,3j	9.6k	8.7g	7.9g	7.8 j	11.1a
6-Dalal 2	14.6 d	14.8 i	15.2g	16.3g	16.9d	16,3L	11.9i	11.5i	9.8j	8.9e	7.7i	7.6 k	12.6a
7-Jean	14.7 c	14.9 h	15.1h	15.5h	16.8e	16.5j	11.9i	11.8g	10. i2	8.6h	7.8h	8.0 i	12.6a
8-Hasanke	14.5 e	15.1 f	15.3f	16.4f	15.9i	17.4f	12.0h	11.9f	10.6 h	8.8f	7.9g	8.2 g	14.1a
9-Rekafa	14.8 b	15.2 e	15.4e	16.7e	17.0c	17.5g	12.1g	12.2e	10.9 g	8.9e	8.1f	8.4 f	13.1a
10-Jeous Q	14.9 a	15.3 d	15.3f	1.6L	16.1h	17.6f	12.8e	12.6d	11.1f	9.1d	8.3e	8.6 d	11.9a
11-Muhand	14.8 b	15.2 e	15.5d	17.7c	17.1b	18.6d	12.9d	12.7c	11.4e	9.4a	8.9a	8.5 e	13.5a
12-Farok Br.	14.9 a	15.4 c	15.7b	17.9a	16.2g	18.8b	12.9d	12.9a	11.6d	9.3b	8.8b	8.7 c	13.5a
13-Khane Br.	14.8 b	15.3 d	15.6c	17.8b	16.1h	18.7c	13.0c	12.8b	11.7c	9.1d	8.7c	8.6 d	13.5a
14-Ashe jam	14.9	15.5 b	15.7b	17.9a	18.2a	18.9a	13.1b	12.9a	11.9a	9.2c	8.9a	8.8 b	13.8a
15-Bedara	14.8 a	15.6 a	15.8a	17.0d	16.4f	18.3e	13.3a	12.8b	11.8b	8.7g	8.8b	8.9 a	13.5a
16-Ibrhem Br.	14.4 f	15.0 g	15.2g	16.4f	15.8j	16.7i	12.2f	11.6h	10.9g	8.9e	8.6d	8.1 h	12.8a

EC) Electrical Conductivity µS/cm) : In this study. The mean value and standard error of mean values were ranged from (446.75 ± 36.544) to (675.00± 91.254) µS/cm), (Table 15) .The total mean value of (EC) (560.25 µS/cm) are within the safe level, according to (WHO., 2012) was 1000 µS/cm, for drinking uses . From the results shown in (Table 2), The value of Electrical Conductivity in this study showed a range of (441 µS/cm to 863 µS/cm).The value of conductivity was recorded lowest in Batefa site was 411 µS/cm in August, and the maximum conductivity were recorded in site bedara in February was 863 µS/cm . (EC) in all seasons was highest in winter. The high conductivity is likely due to extensive agricultural practices and geological conditions. The concentrations of all sampling sites were within the standard concentration of (WHO, 2012). The studied River water has significant variation in (EC) of the study times (Table- 15) . It has asignificant differences at p≤ 0.05) (Table2). In this paper are significantly minimum than those obtained by (Lilia .,.2020)

Table 2 Monthly variation of (EC) Electrical Conductivity (µS/cm)

Months Sites	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct	Nov	Dec	Jan.	Feb	Average
1-Jalke	417p	473 o	458 n	431n	417p	402p	429o	435L	429j	463p	469m	538 o	446e
2-Batefa	425o	485n	462 m	442L	426m	411o	449n	427o	418m	485n	458o	541 n	452 e
3-Jamsemo	438n	469p	449 o	463h	419o	426n	453m	429n	420k	488m	463n	529p	453 e

4-Aelol Q	457m	492m	463 L	459j	420n	448m	461L	433m	429j	479o	449p	569m	463 e
5-Dalal 1	466L	538L	458n	442L	462L	484L	489k	421p	431i	518L	470L	583L	480 e
6-Dalal 2	479k	553k	474 k	459j	577g	569i	513j	552i	429j	536k	479j	619k	519 d
7-Jean	481j	581j	481 j	437m	559i	511k	533i	549j	431i	594j	486i	636j	475 d
8-Hasanke	519i	629i	517 i	471f	513k	530j	559h	563h	419L	621i	473k	695i	585 d
9-Rekafa	537g	741d	531 h	449k	532j	596h	574f	772a	439h	643h	490h	717h	686c
10-Jeous Q	526h	694f	544 g	468g	586f	625g	563g	658f	462g	660f	510g	738g	639c
11-Muhand	684b	713e	593 f	460i	653c	651f	574f	663e	477f	729c	539f	816f	658b
12-Farok B	539f	686g	627 e	511e	670b	664e	612e	769b	486e	719d	557e	835e	675ab
13-Khane B	572e	742c	671 b	539d	694a	699b	639d	675d	497d	731b	593d	844c	658ab
14-Ashe jam	649d	761b	690 a	577c	618e	736a	661c	683c	514c	749a	611c	851b	675a
15-Bedara	661c	775a	649c	593b	633d	670d	683b	591g	522b	650g	627b	863a	659ab
16-Ibrhem B	693a	659h	638 d	610a	569h	683c	711a	527k	558a	669e	631a	841d	649ab

Total Dissolved Solid (TDS) in mg/L : Total dissolved solid in all water samples found majority in the form of potassium, calcium, sodium, carbonates , chlorides, magnesium, bicarbonates, sulfates and nitrates. They affect the corrosive and water hardness (MohdYawar et al., 2021). In the present investigation .The mean and standard error values were ranged from (285.42 ± 23.500) to (424.08 ± 66.432) mg/L. (Table 15), The total mean value of (TDS) (355.99 mg /L) is within the safe level, according to (WHO., 2012). The (TDS) ranged between 266 and 545 mg/l (Table 3).The high concentration of (TDS) found at site Farok Bridge in February was 545 mg/L, in the winter season .The presence of high concentration of (TDS) may be due to the influence of agricultural activities, domestic sewage, and solid waste dumping. The minimum range of TDS was seen at location of Jalke in March was 266 mg/L. in the spring season. The safe value of total dissolved solid for drinking water is 500 mg/l. TDS content in most samples were within the safe range of 500 mg/L, of (WHO, 2012) .The studied River water has significant variation in (TDS) along the study periods. They have a significant variation at $p \leq 0.05$). (Table15). This work are significantly higher than those obtained by (Bishnu., 2021). Because of geological formation in the study area**.**

Table 3 Monthly variation of (TDS) Total dissolved solids (mg /L) in sixteen locations

Months Sites	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Average
1-Jalke	266 o	302m	293m	275m	266n	257 n	274 o	278j	274 i	296o	300L	344 n	285 e
2-Batefa	272 n	310 L	295L	282k	272L	263m	287 n	273 m	267k	310m	293m	346 m	289 e
3-Jamsemo	280 m	300 n	287n	296h	268m	227o	289 m	274 L	268j	312L	496a	338 o	289 e
4-Aelol Q	292 L	314 k	296 k	293j	268m	286L	295L	277 k	274i	306n	287n	364 L	296e
5-Dalal 1	298 k	344 i	293m	282k	295k	309k	312k	269 n	257L	331j	300L	373 k	307e
6-Dalal 2	306 j	353 h	303j	293j	369g	364h	328j	353g	274i	343i	306j	396 j	332d
7-Jean	307 i	371 g	307i	279L	357h	327j	341i	351 h	275h	380h	311i	407 i	303 d
8-Hasanke	332 h	402 f	330h	301f	328j	339i	357h	360 f	268j	397f	302k	444 g	346 d
9-Rekafa	343 f	474 c	339g	319e	340i	381g	368e	494 a	280g	411e	313h	458 f	374 c
10-Jeous Q	336 g	444 e	348f	299g	375f	400f	360g	421 e	495a	422d	326g	427 h	375 bc
11-Muhand	437 a	458 d	397e	294i	417c	416e	367f	224 o	305f	466b	344f	522 e	387bc
12-Farok Br	344 e	339 j	401d	327d	428b	424d	391d	492b	311d	460c	356e	545 b	408 abc
13-Khane Br	366 d	474 c	429b	344c	444a	447b	408c	432d	306e	394g	379d	540 d	421 ab
14-Ashe jam	415 c	487 b	441a	361b	395e	488a	423b	337i	328c	479a	391c	544 c	432 a
15-Bedara	423 b	496 a	415c	379a	405d	428c	437a	478c	334b	316k	401b	552 a	421 a
16- IbrahemBr.	415c	474c	397e	327d	357f	381g	423b	338i	328c	314k	391c	540d	421ab

pH:(Table.4) explain the pH values at sixteen different locations of the Khabur River. It observed that pH concentration of water samples was ranged from 7.3 to 8.4, depending on the site. The high values of pH in the river water may be due to the discharge of wastewater, agriculture and industries in to the Khabur River, which increases the pH of river water. The mean value and standard error of mean values were ranged from (7. 517 ± 2167) to (8.142 ± o. 2065) (Table 15). The total mean concentrations of (pH) were in the safe limit (6.5–8.5).The standard concentration of pH for drinking water was (6.5-8.5). Set by (WHO , 2011). In this work, the maximum concentration was recorded in site Rekafa in January in winter was (8.4). The higher pH values are due to bicarbonate, carbon dioxide and carbonate. While the minimum value was recorded in Ashjame in August was (7.3). The studied River water has significant variation in (pH) at the study times. They have a significant Same results obtained by (O.I.Solana1et.al.,2020).

Table 4 Monthly variation of pH value in sixteen locations

Months Sites	Mar.	Apr.	May.	Jun	Jul.	Aug.	Sept.	Oct.	Nov.	Dec	Jan.	Feb	Average
1-Jalke	7.8 c	8.1b	7.9b	8.3c	8.0d	8.1c	8.2 a	7.8 d	8.0c	8.1b	8.3b	8.2b	8.0 ab
2-Batefa	7.9 b	8.2a	7.7d	8.5a	8.2b	8.3a	8.0 c	8.1 a	8.2a	8.2a	8.1d	8.3a	8.1 a
3-Jamsemo	7.8 c	8.0c	7.8c	8.1 d	8.1c	8.0d	8.1 b	7.9c	8.0c	8.0c	8.2c	8.2b	8.0 bc
4-Aelol Q	7.6 e	7.9d	7.9b	8.4 b	8.3a	8.2b	7.9 d	7.8 d	8.1b	8.2a	8.0e	8.1c	8.0 bc
5-Dalal 1	7.7 d	7.8e	8.1a	8.0 e	8.1c	8.0d	7.7 f	8.0b	7.8e	8.1b	8.3b	8.2b	7.9 bcd
6-Dalal 2	7.5 f	7.4i	7.7d	7.8 f	8.0d	8.2b	8.0 c	7.9c	8.0c	8.1b	8.2c	8.3a	7.9 cde
7-Jean	7.6 e	7.7f	7.9b	7.4 j	7.7g	7.6g	7,8 e	8.1a	7.7f	8.0c	8.3b	8.0d	7.8 efg
8-Hasanke	7.7 d	7.5h	7.8c	7.6 h	7.9e	7.7f	7.6 g	7.7e	7.9d	8.1b	8.1d	8.2b	7.8 efg
9-Rekafa	7.5 f	7.7f	7.5f	7.7 g	7.6h	7,5h	7.8 e	7.5f	7.6g	7.8e	8.4a	8.1c	7.7 ghi
10-Jeous Q	8.1 a	7.6g	7.6e	7.5 i	7.8f	7.7f	7.4 i	7.9c	7.8e	7.9d	8.1d	8.2b	7.8 fg
11-Muhand	7.4 g	7.4i	7.5f	7.4 j	7.7g	7.9e	7.7 f	7.5f	7.4h	7.7f	8.2c	8.0d	7.6 hi

12-Farok Br	7.7 d	7.6g	7.7d	7.5 i	7.9e	7.5h	7.4 i	7.8d	7.7f	7.9d	8.0e	8.2b	7.7gh
13-Khane Br	7.4 g	7.5h	7.6e	7.2 L	7.5i	7.7f	7.6 g	7.7e	7.6g	7.8e	8.1d	7.8e	7.6ij
14-Ashe jam	7.4 g	7.4i	7.3h	7.6 h	7.7g	7.3i	7.3 j	7.5f	7.3i	7.7f	7.9f	7.8e	7.5 k
15-Bedara	7.5 f	7.8e	7.4g	7.3 k	7.4j	7.7f	7.5 h	7.7e	7.1j	7.8e	7.6g	7.7f	7.5jk
16-Ibrhem Br	7.7 d	8.1b	7.8c	7.6 h	7.8f	8.0d	7.9 d	8.1a	7.7f	7.9d	8.0e	8.1c	7.8def

Dissolved oxygen (DO) in mg/L: The decomposition and oxidation of organic material reduce the solubility of oxygen in the water. DO is a major parameter of water quality evaluation and biological processes in river water (Saurabh et al ., 2021). The means value and standard error of mean values were ranged from (7.358 ± 0.6417) to (8.942 ± 0.5760) mg/L, (Table 15).The total mean value of (DO) were within the permissible limit. An ideal DO concentration of 5.0 mg/L is the standard for domestic water (Ackson ., 2020). In this work DO range from 6.6 mg/l to 9.9 mg/L, (Table 5). The minimum value recorded during summer at site Muhand in August was 6.6 mg/L, The lowest concentration of DO may be the cause of high temperature and addition of wastewater to Khabur River. Higher concentration of (DO) indicates good water life. The studied River water has significant variation in (DO) at the study times .They have a significant differences at $p \leq 0.05$). (Table2). This work are significantly maximum than those obtained by (NidhiGupta et al .,2017).

Table 5 Monthly variation of (DO) in sixteen locations

Months / Sites	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Average
1-Jalke	9.9 a	8.6e	9.7b	8.2c	8.7a	8.4c	8.0 b	8.5b	8.3d	9.5d	9.3b	9.7b	8.9ab
2-Batefa	9.4 b	8.9b	9.7b	8.5a	8.3d	8.7b	7.8 d	8.9a	8.9a	9.7b	9.0c	9.5d	8.9 a
3-Jamsemo	8.7 e	9.1a	9.4d	8.1d	8.6b	8.9a	7.4 g	8.3c	8.6c	9.9a	9.6a	9.8a	8.8 ab
4-Aelol Q	8.8 d	8.9b	9.6c	8.0e	8.4c	8.3d	8.1 a	8.5b	8.8b	9.6c	9.3b	9.6c	8.8 ab
5-Dalal 1	9.3 c	9.1a	9.8a	8.4b	8,1e	8.0f	7.9c	8.9a	8.3d	9.3e	9.0c	9.6c	8.8 ab
6-Dalal 2	9.3 c	8.8c	9.4d	8.1d	7.9g	8.3d	7.7 e	8.3c	8.0f	9.0f	8.9d	9.7b	8.6 b
7-Jean	8.5 f	8.6e	9.1f	7.8g	7.5h	8.1e	7.4g	8.1e	8.3d	8.8g	8.5g	8.9e	8.3 c
8-Hasanke	8.2 g	8.7d	9.3e	8.0e	7.9g	7.5h	7.8 d	7.9g	8.0f	8.5h	8.7f	8.6h	8.2 cd
9-Rekafa	8.0 h	8.2 f	8.5j	7.7h	6.8L	7.7g	7.3 h	8.2d	7.8g	8.1j	8.4h	8.8f	7.9 de
10-Jeous Q	8.5 f	7.9g	8.9g	7.5i	7.3i	7.0k	6.9 j	7.8h	8.2e	8.3i	8.7f	8.9e	7.9 de
11-Muhand	7.8 i	7.6j	8.3L	7.9f	6.6n	6.8i	7.2 i	7.5j	7.8g	8.0k	8.5g	8.6h	7.7 ef
12-Farok Br.	7.5 j	7.9g	8.5j	7.4j	6.9k	7.2i	7.5 f	8.0f	7.6i	7.9L	8.1j	8.8f	7.7ef
13-Khane Br.	7.2 L	7.8h	8.7h	6.9L	6.7m	6.7n	6.8 k	7.6i	7.4j	8.1j	8.3i	8.5i	7.5fg
14-Ashe jam	7.4k	7.7i	8.4k	7.2k	6.8L	7.1j	6.9 j	6.7k	7.7h	7.8m	8.1j	8.7g	7.5fg
15-Bedara	7.1 m	7.1k	8.1m	6.7m	7.2j	6.9L	7.4 g	6.6L	7.4j	6.9n	8.4h	8.5i	7.3g
16-Ibrhem Br.	7.8 i	8.2f	8.6i	7.8g	8.0f	7.0k	8.1 a	7.9g	7.8g	8.1j	8.8e	8.9e	8.0cd

(BOD5) Biochemical Oxygen Demand in mg/L . (BOD5) is an important parameter of water quality for it greatly affects the value of DO in the water body. In this work the mean value of (BOD) and standard error of mean values were ranged from (2.558 ± 0.9317) to (16.642 ± 2.9525) mg/L. (Table 15).The total mean value of (BOD) were increased the permissible limit. The permissible limit for BOD5 as per (WHO , 2011) is 5 mg/L. During the study area, Table 6, the lowest value of BOD was recorded in site Jalke in February in the winter season was 1.6 mg/L .The highest value was recorded in site Khane Bridge in August in the summer season was 19.9 mg/L .The high concentration of biochemical oxygen demand may be due to extensive uses of organic matter. The water samples from the sites Jalke, Btofa, Jamsemo, Aelol, Dalal, and jean site from the study area have BOD values less than the permissible limits. While the other samples were above the permissible limits . Increase in biochemical oxygen demand which is a reflection of bacterial oxygen demand leads to a decrease in DO and leads to hypoxia conditions. The studied River water has significant variation in (BOD5), at the study times. They have a significant difference at $p \leq 0.05$) (Table 15). This work are significantly minimum than those obtained by (Bilyaminu., 2020)

Table 6 Monthly variation of (BOD) Biochemical oxygen demand mg/L , in sixteen locations

Months / Sites	**Mar.**	**Apr.**	**May.**	**Jun.**	**Jul.**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb**	**Average**
1-Jalke	3.2 m	2.6 o	1.9 p	3.2 o	2.8p	3.1 o	1.7 o	2.1 n	1.7 o	2.0 p	4.8L	1.6 o	2.8 i
2-Batefa	3.7 k	2.9 n	4.1 L	3.1 p	3.5n	2.8 p	2.1 n	1.8 p	1.9 n	2.6 o	3.5n	4.0 m	3.0 hi
3-Jamsemo	4.1 j	3.5 L	4.0 m	4.5 m	2.9o	3.6 n	2.8 L	2.0 o	1.6 p	3.6 n	4.9k	3.8 n	3.4 ghi
4-Aelol Q	3.6 L	3.4 m	2.5 o	5.0 k	3.6m	4.9 k	2.4 m	2.7 m	2.0 m	4.7 k	4.3m	4.7k	3.6 gh
5-Dalal 1	3.2m	3.7 k	2.8 n	4.3 n	3.9L	4.4 m	3.3 k	2.9 L	2.6 L	3.9 m	5.0j	4.6L	3.7 gh
6-Dalal 2	4.1 j	5.0 j	4.9 k	4.7 L	4.4k	4.8 L	3.7 j	4.2 j	3.6 j	4.2 L	4.3m	4.8 j	4.3 g
7-Jean	4.8 i	7.3 h	5.5 j	8.1 i	5.9j	7.7 j	4.2 i	3.9 k	3.5 k	5.8 j	5.2i	5.8 i	5.6 f
8-Hasanke	6.2 h	8.2 g	7.4 i	6.8 j	14.6f	12.5 i	9.4 h	5.7 i	7.4 i	9.9 i	11.h3	9.9 h	9.1 e
9-Rekafa	8.6 g	6.9 i	8.3 h	9.4 h	12.9h	12.8 h	16.9 d	11.5 h	13.5 g	19.5 a	13.7e	14.7 e	13.4 d
10-Jeous Q	10.7 e	14.1 d	11.7 f	19.3 a	10.2i	13.6g	17.3 c	14.9 d	16.9 c	16.6 f	17.4b	19.5 a	14.3 b
11-Muhand	12.8 d	15.4 c	15.5 e	14.2 f	13.6g	15.1e	19.5 a	15.0 c	17.1b	17.9 d	14.1d	17.6 b	15.6 ab
12-Farok B	14.6 c	16.9 b	19.3 a	16.0 d	15.1e	22.7a	18.1 b	14.6 f	14.0f	17.1 e	11.8g	19.5 a	16.6 a

13-Khane B	12.8 d	14.1 d	18.2 c	14.7 e	17.3b	19.9c	15.0 e	19.1 a	15.8d	18.0 c	19.5a	11.9 g	16.3 a
14-Ashe jam	16,9 a	19.3 a	17.1 d	16.6 b	17.2c	18.6d	12.3 g	15.8 b	17.8a	14.1 h	15.2c	15.8 d	16.4 a
15-Bedara	15.9b	12.6 e	18.5 b	16.2 c	19.0a	13.8f	14.6 f	13.0 g	15.0e	19.4 b	14.1d	17.1 c	15.7 ab
16-Ibrhem B	9,5f	11.6 f	10.3 g	13.7 g	16.9d	21.0b	16.9 d	14.7 e	9.6h	15.3 g	13.6f	12.8 f	13.8 c

Total hardness as CaCO3 (TH) in (mg/L): The (TH) of the River water is dependent on the presence of (Mg^{2+}) (Ca^{2+}) and HCO3– ions in the water which cause the hard water. In this study the mean value of (TH) and standard error of mean values was (434.58 ± 11.843) to (636.08±54.199) mg/L. (Table 15), The mean value of (TH) were exceeded the permissible limit .The safe level of drinking water for hardness is 300 mg/L, set by (WHO ., 2012) . In this work the concentrations of (TH) at all sampling sites (Table 7), it ranged from (419 to 687) mg/L .The highest concentration was observed at site Bedara in July. The high value of total hardness of samples may be due to geological formation, while the minimum concentration was observed at site Jalke in May was 419 mg/L. The concentration of total hardness at all sites were exceeded the safe level (300 mg/L). And mostly exceeds the maximum permissible limits (500 mg/L). (WHO, 2011) .The studied River water has significant variation in (TH) at the study times .They have a significant difference at $p \leq 0.05$) (Table 15). In this work are significantly maximum than those obtained by (Saurabh et al., 2021).

Table 7 Monthly variation of Total Hardness (TH) mg/L in sixteen locations

Months Sites	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Avera ge
1-Jalke	427 o	432 o	419n	426p	434o	441o	428o	433o	427 n	436 n	449 o	463 o	434 k
2-Batefa	431 n	430 p	425m	429n	421p	438p	431n	431 p	425o	439 L	446 p	471 m	436 k
3-Jamsmo	444 m	451 n	431L	427o	436n	442n	452m	442 n	431 L	437m	451 n	469 n	449 k
4-Aelol Q	540 L	539 m	497k	469L	444m	449m	459L	451 m	429m	435 o	485 L	491 k	474 j
5-Dalal Br.	553k	561 L	518j	449m	451L	482L	478j	466 L	441 k	449 k	462m	487 L	483 ij
6-Solaf	568 j	589 k	563i	471k	466h	487k	471k	483j	453 j	461 i	489 k	519 j	497 hi
7-Jean	586 i	621 i	570h	483j	497j	505j	497i	478 k	461 i	459 j	511 j	538 i	557 gh
8-Hasanke	613 g	634 g	594d	499i	524i	531i	511h	488 i	475 h	466 h	533 i	544 h	534 fg
9-Rekafa	643 e	649 d	612c	589g	599g	578g	529g	491 h	499 g	513 g	546 g	563 g	567 e
10- Jeous Q	613 g	627 h	584g	595f	614f	611f	551f	525 g	511 f	526 e	552 f	574 f	573 de
11-Muhand	688 b	671 c	592e	610e	621e	623e	583d	537 f	531 e	519 f	563 e	579 e	591 cd
12-Farok Br.	642 f	639 f	570h	633d	642d	637d	579e	541 e	552 c	537 c	578 d	583 d	594 cd
13-Khane Br.	661 c	673 b	612c	639c	649c	651c	593a	544 c	539 d	539 b	591 c	611c	608 bc
14 Ashe jam	659 d	648 e	631b	641b	674b	659b	584c	563 b	561 b	542 a	613 b	638 b	619 ab
15 Bedara	692 a	701 a	674a	663a	687a	661a	591b	573 a	586 a	531 d	633 a	641a	636 a
16-Ibrahem Br.	596 h	611 j	589f	562h	577h	569h	551f	543 d	427 n	431 p	544 h	563 g	547 f

Calcium (Ca^{2+}) : in this work the mean value of (Ca^{2+}) and standard error of mean values were ranged from (321.00 ± 36.636) to (636.08 ± 54.199) mg/L. (Table 15), The mean value of (Ca^{2+}) were exceeded the permissible limit, The safe level of (Ca^{2+}) value for domestic purpose is 75 mg/L (WHO, 2011).(Table 8). The value of (Ca^{2+}) ranged between (278 to 493) mg/L , the highest value of calcium was recorded at site Bedara in February. The rapid urbanization and industrialization in the area lead to the high value of calcium. While the minimum value was observed at site Batefa was 278 mg/L in September. All the samples exceeded the permissible limit. The studied River water exhibit significant variation in ((Ca^{2+}) in the study area . They have a significant variation at ($p \leq 0.05$) (Table 15). In this work are significantly higher than those obtained by (NidhiGupta et al., 2017).

Table 8 Monthly variation of Calcium hardness (Ca^{2+}) in mg/L in sixteen locations

Months Sites	**Mar.**	**Apr.**	**May.**	**Jun.**	**Jul.**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Average**
1-Jalke	318n	321 n	338L	298m	331m	346 o	361m	382m	341 o	393m	386L	391L	350 g
2-Batefa	295o	341 L	295o	337L	371L	286 p	278n	362n	355 m	291o	279o	362n	290 h
3-Jamsemo	352 L	361 k	337m	351k	385k	391 k	375L	358o	349n	363n	361n	357o	361 f
4-Aelol Q	327m	340m	339k	363i	371L	382m	379k	383L	369L	394L	385m	391L	368 f
5-Dalal 1	386 k	291o	327n	362j	385k	373n	388j	396k	411j	407k	421i	418k	378 e
6-Dalal 2	395 j	417f	396j	386h	410j	396j	414h	227p	418i	431h	411j	427j	410 d
7-Jean	429 d	399i	418g	426f	419i	425g	439c	426i	419h	443e	421i	430i	424 c
8-Hasanke	417 e	426d	411h	430d	427f	431f	428f	434e	439d	451c	447f	445f	432 c
9-Rekafa	405 h	395j	436d	417g	426g	419i	433e	425j	437e	441f	428h	451d	426 c
10-Jeous Q	399 i	410h	422f	426f	431e	424h	428f	431f	420g	436g	441g	434h	425 c
11-Muhand	416f	421e	427e	429e	441d	438e	426g	428g	431f	427i	455d	441g	431 c
12-Farok Br	461 b	436c	445c	436c	455c	461c	439c	447d	451c	449d	462c	473c	451 b
13-Khane Br	467 a	459b	451b	464a	458b	476a	481a	479a	483a	471b	484a	491b	472 a
14-Ashe jam	386k	411g	396j	430d	427f	448d	435d	450c	439d	427i	451e	448e	429 c
15-Bedara	449c	463a	459a	462b	473a	469b	471b	466b	482b	473a	477b	493a	469 a
16-Ibrhem Br	413g	395j	410i	386h	425h	385L	411i	427h	379k	410j	395k	376m	401 d

Magnesium (Mg^{2+}) in mg/L : In this study the mean value of (Mg^{2+}) and standard error of mean values were (80.25± 15.915) to (188.75 ±55.464) mg/L. (Table 15), The mean value of (Mg^{2+}) .were exceeded the safe level, The acceptable limit of (Mg^{2+}). According to (WHO , 2012) is 30 mg/l and permissible limit is 100 mg/l (Table 9).The range of magnesium in River water samples was (30 to273) mg/l the highest concentration was observed at location ashejame and the lowest value was in site Dalal . (Table15) shows a significant variation in the (Mg^{2+}) among the studied River water. They have a significant difference at ($p \leq 0.05$). In this work are significantly higher than those obtained by (ackson et al ., 2020

Table 9 Monthly variation of Magnesium hardness (Mg^{2+}) in mg/l in sixteen locations

Months / Sites	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Average
1-Jalke	109 o	111 n	81 p	128 j	103i	95k	67m	51 o	86f	43j	63 n	72 o	84 h
2-Batefa	138 n	89 p	130 m	92 L	50o	152h	153b	69 h	70h	148a	167 a	159 c	144 def
3-Jamsemo	92 p	90 o	94 o	76 o	51n	51o	77L	84f	82g	74f	90 k	102 k	81 h
4-Aelol Q	213 f	199 L	158 k	106 k	73L	76n	80k	68i	60j	41L	100 j	100 L	106 fgh
5-Dalal 1	167 k	270 a	191 c	87 m	66m	109i	90i	70g	30p	42k	41 o	69 p	111 fgh
6-Dalal 2	153 m	172 m	167 g	85 n	36p	91L	57o	56L	35o	30m	78 m	92 n	87 gh
7-Jean	157 L	222 f	152 L	57 p	78k	86m	58n	52n	42m	16o	90 k	158 d	133 fgh
8-Hasanke	196g	208 j	183 d	190 d	97j	100j	83j	54m	36n	15p	86 L	99 m	152efg
9-Rekafa	238 d	254 b	176f	172 h	173h	109i	96h	66j	62i	72g	118 e	112 i	144cde
10-Jeous Q	214 e	217 g	162 i	169 i	183f	187c	123e	94e	91e	90d	111 g	140 f	148bc
11-Muhand	272 b	250 c	165 h	181 e	180g	185d	157a	109c	100d	92c	108 h	138 g	160bc
12-Farok Br.	181 j	203 k	125 n	197 c	187e	176f	140d	94e	101c	88e	116 f	110 j	142bcd
13-Khane Br.	194 h	214 i	161 j	175 g	191d	175g	112g	65k	56k	68h	107 i	120 h	136cde
14-Ashe jam	273 a	237e	235 a	211 a	247b	210a	149c	113b	122a	115b	162 b	191 a	190a
15-Bedara	243 c	238 d	215 b	201 b	214c	192b	120f	107d	104b	58i	156 c	148 e	167ab
16-Ibrhem Br.	183 i	216 h	179 e	176 f	252a	184e	140d	116a	48L	21n	149 d	187 b	146bc

Chloride (CL-) : This work the mean value of (CL-) and standard error of mean values was ranged from (21.825±2.2947) to (39.300 ± 47.3585) mg/L . (Table 15), The mean value of (CL-) obtained at Khabur River were within the safe concentration of chloride for safe drinking water according to (WHO.,2012) (250 mg/L). (Table 10).The highest value (39.8 mg/L) was recorded in Khane Bridge in the month of May , The higher content of (CL-), in Khabur River may be due to animal origins like sewage inflow and human faces, and the lowest value (18.3 mg/L) in location Batofa at November. (Table 15), observes a significant difference in the (CL-) at the studied River water (Table 2). They have a significant difference at ($p \leq 0.05$). This work are significantly minimum than those obtained by (Musher ., 2015).

Table 10 Monthly variation of Chloride (CL-) in mg/l in sixteen locations

Months / Sites	Mar.	Apr	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan	Feb	Average
1-Jalke	19.7k	20.1m	27.3f	19.1 n	21.9i	23.6f	20.9h	21.5m	21.0 L	22.8j	20.1k	23.9f	25.1h
2-Batefa	18,3o	19.5n	22.1j	18.6 o	20.8k	22.4g	18.4m	21.6L	19.6 n	23.7h	28.1b	21.4k	21.2h
3-Jamsemo	19.3L	21.4L	19.3n	22.6 i	25.1f	19.4k	18.8L	26.4f	21.9 k	28.5c	22.8g	26.0e	22.6fgh
4-Aelol Q	19,1m	18.4o	21.6k	19.6 L	27.3d	21.7h	19.6j	22.7k	24.1 j	23.2i	25.0e	22.6h	22.1gh
5-Dalal 1	18.4n	22.5k	28.3e	25.0 g	22.4h	28.1d	24.2f	30.0e	26.7h	29.3b	21.1j	18.5o	26.6def
6-Dalal 2	23.9h	26.3g	31.0d	28.4 c	29.4c	26.1e	18.9k	24.1h	31.0d	27.2e	27.9c	21.3L	25.5cd
7-Jean	29.5f	31.3c	25.2h	19.5m	18.8m	18.9L	18.4m	20.6n	27.5g	23.9g	21.6i	20.5n	24.8e-h
8-Hasanke	27.0g	29.5e	31.8c	25 .3f	21.6j	18,9L	20.5i	23.1j	19.6n	22.7k	34.1a	27.4c	26.9cde
9-Rekafa	32.8d	22.9j	18.4p	20.2k	18.8m	18.7m	19.6j	19.3o	20.1m	17.9n	22.5h	21.7j	21.1h
10-Jeous Q	37.0b	31.0d	26.4g	28.1d	23.6g	20.8j	27.9e	23.7i	24.4i	26.0f	27.1d	29.9a	27.1bc
11-Muhand	31.6e	27.6f	18.5o	20.7j	19.3L	22.4g	31.3d	35.2b	28.0f	32.5a	18.0m	23.4g	25.7cd
12-Farok Br.	22.7i	37.1a	22.5i	27.4e	18.7n	21.3i	21.8g	26.2g	33.7b	19.3m	15.1o	27.3d	24.4d-g
13-Khane Br.	39.3a	25.0h	19.4m	22.7h	29.7b	36.8c	39.5b	36.2a	28.5e	13.7o	17.3n	22.0i	27.5bc
14-Ashe jam	21.9j	32.6b	37.4 b	28.6b	25.9e	38.5a	33.6c	31.9d	32.6c	21.6L	18.9L	20.7m	32.1b
15-Bedara	35.2c	24.9i	39.1a	37.6a	31.9a	37.0b	39.8a	34.3c	38.4a	28.4d	23.8f	28.4b	33.2a
16-Ibrhem Br.	17.3p	16.1p	19.5 L	16.8p	13.0o	15.3n	10.6n	11.4p	13.6o	12.5p	14.0p	11.8p	14.3i

Total alkalinity (TA) in mg/L : In this work, (Table 15), the mean value of (TA) and standard error of mean values were ranged from (122.50 ±19.309) to (300.00 ± 44.239) mg/L. The total mean value of (TA) obtained in of Khabur River were within the safe level. According to (WHO ., 2012), the maximum permissible limit and desired limit for alkalinity in potable water is 200 and 600 mg/L. From the results shown in (Table 11) .Alkalinity concentrations in the analyzed River water samples were ranged from (81 to 349) mg/l. The maximum concentration was observed at site Ashjame in August, The high concentration of (TA) due to the presence of bicarbonates, hydroxides and carbonates in the river water. While the minimum concentration was observed at site Jalke in February . All sites showed value within maximum safe levels by (WHO, 2012). (Table 15), observed a significant difference in the (TA) at the studied River water. They have a significant difference at ($p \leq 0.05$). This work are significantly minimum than those obtained by (Riedh ., 2020).

Table 11 Monthly variation of Total alkalinity (TA) in mg/**L** in sixteen locations

Months Sites	Mar.	Apr	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Average
1- Jalke	139o	141o	116p	120p	127 o	135n	139m	141p	126p	110p	95p	81 p	122 j
2-Batefa	146n	127p	123o	129o	131 m	125o	131p	148n	133o	118o	105n	87 n	148 ij
3- Jamsmo	163j	173i	158n	135n	129 n	136m	136o	144o	137n	126n	99o	84 o	135 hij
4-Aelol Q.	147m	152m	173k	142m	136L	139L	138n	157L	140m	129m	116m	93 m	138g-j
5-Dalal Br.	158k	148n	168m	150k	141k	147k	140L	153m	142L	131L	121L	109 L	142f-i
6-Solaf	163j	17j1	182j	164j	149j	153j	147k	159k	147j	136k	127k	114k	151e-h
7- Jean	171h	18h9	169L	179j	163i	158i	149j	163j	144k	141j	129j	119 j	156efg
8-Hasnke	149L	162k	184i	188i	167h	174h	163i	170i	151i	149i	135i	123 i	159ef
9-Rekafa	164i	154L	188h	194h	173g	182g	172h	175h	159h	177g	151h	127h	168e
10- Jeous Q.	247f	268f	259f	310f	285e	254f	195g	211g	173g	169h	159g	131g	226d
11-Muhand	283b	311c	284d	326c	295d	281d	217f	231f	199f	221e	174f	139f	246bc
12-Farok B	281c	295d	311c	315e	319c	275e	242e	253e	206e	218f	191d	152e	254b
13Khane Br.	261e	293e	281e	317d	285e	311c	285b	277d	223c	253c	186e	163c	261b
14Ashe jam	272d	316b	327b	336b	323b	349a	281c	311b	263b	264b	205b	195b	286a
15-Bedara	296a	325a	331a	342a	331a	342b	315a	325a	277a	281a	224a	211a	300a
16-Ibrahem Br.	217g	222g	236g	261g	274f	281d	269d	284c	216d	233d	196c	158d	237cd

Nitrates (NO3-): In this study the mean value of (NO3-) and standard error of mean values were ranged from (1. 800 ±.7804) to (6.633 ± 1.4736**)** mg/L, (Table 15),. The mean value of (NO3-), were found within the safe level value of (WHO., 2011) which is 45 mg/L. (Table 15) shows a significant differences of the nitrates at the studied river samples (Table 12) shows the value of nitrate was observed in the range of (o.8 mg/l to 8.7) mg/L , the maximum concentration was observed at site Ashejame in January, The major sources of (NO3-), value in water might be anthropogenic or from the utilize of fertilizer on agricultural land. While the lower concentration was observed at site Jalke in September .They have a significant differences at ($p \leq 0.05$) (Table 15) **.** Same results obtained by (Yumin et al .2019

Table 12 Monthly Variation of Nitrates (NO3-) in mg/L in sixteen locations

Months Sites	Mar.	Apr	May.	Jun	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Average
1-Jalke	1.8 o	1.6 o	2.0n	1.9k	1.4L	1.1m	0.8 p	1.0p	1.6 p	2.8 n	3.6n	2.0p	1.8 i
2-Batefa	2.2 n	1.8 n	2.6m	1.4m	1.7j	1.0n	1.1 o	1.6n	1.9 o	2.5 o	3.5o	2.5o	1.9 ih
3-Jamsemo	2.9 m	1.6 o	3.2L	1.7L	1.2m	1.5L	1.7m	1.3o	2.3 n	3.7 L	3.9m	2.7n	2.3 ghi
4-Aelol Q	3.3 L	1.9 m	3.7k	1.9k	1.6k	1.7k	1.6n	1.9m	2.6 m	3.3 m	2.7p	3.3m	2.4gh
5-Dalal 1	4.0 j	2.6 L	3.9j	2.0j	1.9i	2.0j	1.9L	2.1L	2.9 L	2.8 n	4.2L	3.6L	2.8g
6-Dalal 2	4,4 i	3.7 j	4.2i	2.5i	2.2h	2.7i	2.0k	2.6k	3.5 k	4.3 k	5.1k	4.0k	3.4f
7-Jean	4.9 h	2.9 k	4.9g	2.9g	3.9e	4.9g	3.6j	2.9j	3.9 j	4.8 j	6.3j	5.8h	4.3e
8-Hasanke	5.1 g	3.8 i	5.0f	2.5i	4.6c	5.2f	4.3i	3.7h	4.3 i	5.3 i	6.8i	4.9j	4.6de
9-Rekafa	5.6 f	5.1 g	4.2i	3.1e	3.6f	6.0d	4.8g	3.3i	5.2 h	6.1 h	7.3g	5.3i	4.9d
10-Jeous Q	6.0 d	6.4 e	4.8h	3.5d	4.2f	6.8b	4.6h	4.4g	5.8 f	6.7 f	8.0e	6.2g	5.6bc
11-Muhand	6.5 b	5.9 f	5.3d	2.8h	3.9e	5.3e	5.7e	6.1f	5.3 g	6.9 e	8.2c	7.1e	5.7b
12-Farok Br.	5.8e	6.6 d	5.9c	3.9b	5.1a	6.6c	5.9d	6.8d	6.7 c	7.3 c	8.1d	7.7c	6.3a
13-Khane Br.	4.9 h	6.9 b	6.1a	4.0a	4.8b	7.2a	6.7b	7.3c	6.4 d	7.1 d	7.9f	8.3a	6.4a
14-Ashe jam	6.3c	7.3 a	5.9c	3.5d	3.9e	5.3e	6.4c	7.7b	7.0 b	8.0 a	8.7a	8.0b	6.5a
15-Bedara	6.9a	6.7 c	6.0b	3.0f	5.1a	6.0d	7.1a	8.1a	7.6 a	7.4 b	8.4b	7.3d	6.6a
16- Ibrahem Br.	6.7 c	6.6 c	6.5 b	2.7h	5.2a	6.6c	6.7b	7.8b	6.5d	7.2d	8.2c	8.2a	6.5a

Sulfate (SO_4^{2-}) : In this work the mean value of (SO_4^{2-}) and standard error of mean values was ranged from (16.00 ± 4.918) to (70.50 ± 12.881) mg/L (Table 15).The mean value of (SO_4^{2-}) were found within the permissible limit. The higher safe level of sulfate value in water is 400 mg/l according to (WHO ., 2011). (Table 13), the river water samples is varying from (9 to 95) mg/L. A higher concentration of sulfate was observed at site Bedara in January, the maximum value due to discharge from domestic waste and untreated sewage, while the minimum concentration of sulfate was recorded at site Jalke in September. The sulfate concentration of all locations lies within the safe levels according to (WHO ., 2012) (250 mg/L). (Table15), shows a significant variation in the (SO_4^{2-}) at the studied River water. They have a significant difference at ($p \leq 0.05$). Table 13 Monthly variation of Sulfate (SO_4^{2-}) in mg/L in sixteen location

Table 13 Monthly variation of Sulfate **(SO_4^{2-})** in mg/L in sixteen locations

Months Sites	Mar.	Apr	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Average
1-Jalke	19 m	17 n	21o	15n	13 o	11p	9 p	11 n	13 n	18p	26 o	19n	16 i
2-Batefa	13 o	14 p	26n	17m	11 p	15n	13 o	13 m	10 o	22o	31 m	26L	17 i
3-Jamsemo	19 m	16 o	33k	13o	15 n	13o	18 l	10 o	16 L	28m	28 n	21m	19 ih
4-Aelol Q	16 n	18 m	28m	18L	19 L	17m	14n	16 L	14m	25n	24 p	37j	20 ih

5-Dalal 1	21 L	19 L	38j	21j	17 m	19L	16 m	13 m	17k	37k	42 L	31k	22 gh
6-Dalal 2	22 k	20 k	31L	19k	21 k	26k	31 k	25 k	20j	31L	55 j	47i	29 g
7-Jean	32 g	25 j	46i	27h	25 j	37j	39 j	29 j	27i	39j	48 k	51h	35 f
8-Hasanke	39 e	28 i	38j	24i	31i	41i	44i	34 i	41h	52i	61 i	56g	40 e
9-Rekafa	41 d	33 h	52h	29g	39h	45h	53h	38 h	49g	58h	74 f	62f	47 d
10-Jeous Q	36f	39 g	61c	54d	52g	61g	59g	41 g	55e	62f	68 h	68e	54 c
11-Muhand	47 c	42 e	58d	69a	59e	68e	73d	47 f	52f	69d	84 d	77c	62 b
12-Farok Br	31 h	48 d	53g	51e	68d	71d	69e	52 e	59d	63e	71 g	81a	59 bc
13-Khane Br	48 b	51 c	62b	64b	73c	83b	78b	59 c	63c	74c	88 b	79b	68 a
14-Ashe jam	51 a	61 a	56e	57c	79b	94a	75c	66 b	69b	79b	85 c	74d	70 a
15- Bedara	47c	32h	38j	29g	31j	71d	78b	47f	56e	62f	74f	68e	71a
16- Ibrahem Br.	41d	39g	58d	65b	52g	41j	59j	41g	59d	62f	71g	62f	40e

Table 14 WQI values for Khabur River during studied period

Canadian WQI	Jalke	Batefa	Jamsemo	AelolQ.	Dalal Br	Solaf	Jean	Hasanake	Rekafa.	Jeousq.	Muhand.	FarokQ.	KaneB	AsheJam	Bedara	Brahembr
Drinking	Excellent	Excellent	Excellent	Good	Good	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor
Irrigation	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Good	Good	Good	Good	Good	Good	Good	Good	Excellent	Good

Table 15: Physical-chemical properties of Khabur River, data represented as mean± S.D, during studied period.

Sites	T °C	EC	TDS	pH	DO	BOD	TH	Ca2+	Mg2+	Cl	TA	NO3-	(SO_4^{2-})
Jalke	12.07±3.4 a	446.7±36.5c	285.4±23.5c	8.06±0.1ab	8.9±0.67 ab	2.55±O.9 i	434.5±11.8 k	350.5±331.8g	84.0±225.9 h	21.8±2.29h	122.8±19.3j	1.8±0.78 i	2.72±0.97i
Batefa	12.12±3.31a	452.4±37.1 e	289.1±0.23 e	8.1±0.205 a	8.94 ±0.95a	3.00 ±0.79hi	343.7±13.3 k	321.0 ±36.6 h	118.0±41.2 def	34.9±11.3h	125.2±16.5 ih	1.98±0.71ih	17.5±6.90i
Jamsem	12.1±3.3	453.8±31.9 e	302.9±41.51e	8.01±0.13bc	8.8±0.75 ab	3.44±0.91g hi	442.7±11.7 k	361.6±15.3 f	80.2±7.4 h	22.6±3.2 fgh	135.0±24.7 hij	2.30±0.93ghi	19.1±7.02ih
AlelolQ	17.9±4.31 a	463.2±28.9 e	296.0±25.0 e	8.0±0.22 b	8.7±0.58 ab	3.65±1.0 gh	474.0±37.3 j	368.5±22.1f	114.4±55.2 fgh	36.4±21.5gh	138.5±20.1 gj	2.45±0.78gh	20.5±6.82ih
Dala B	20.8±1.43 a	480.1±46.5 e	305.2±32.0 d	7.9±0.19 bc	8.7±0.62 ab	3.7±0.67 gh	484.0±30.6 ij	372.0±27.4e	111.0±22.5 fgh	24.5±4.0 def	142.3±16.0 fi	2.82±0.88g	24.2±3.9 gh
Solaf	24.8±2.1 a	519.9±56.6 d	332.3±36.4 d	7.92±0.65bcd	8.6±0.64 b	4.39±0.42 g	501.6±44.7 hi	410.5±14.5d	87.6±14.5gh	26.4±4.8 cd	151.0±18.9 eh	3.43±1.0 f	29.0±11.3g
Jean	12.6±3.3 a	523.2±63.3 d	334.4±40.6d	7.8±0.25 cde	8.3±0.53 c	5.64±1.4f	517.1±51.3 gh	424.5±11.1c	97.3±10.4fgh	22.9±4.4 g	156.1±20.5 efg	4.30±1.1 e	35.4±9.3 f
Hasanke	12.8±3.3 a	542±76.8	346.6±49.1c	7.8±0.22 efg	8.2±0.50 cd	9.1±2.6e	534.3±53.9 fg	432.1±11.8c	112.2±22.6 fg	39.3±11.4cde	159.5±19.1 ef	4.62±1.0 de	40.7±11.1e
Rekafa	13.1±3.4 a	586.0±111.6 d	376.6±68.5 bc	7.72±0.26 efg	7.9±0.54 de	12.3±3.6 d	567.7±53.4 e	426.0±15.5 c	137.3±54.8 cde	21.0±4.0 h	168.0±18.3 e	4.96±1.2 d	47.7±12.9 d
JeousQ	11.9±4.4 a	586.1±89.4 c	387.7±56.8 bc	7.8±0.25 ghi	6.9±0.70 de	15.1±3.17 b	573.5±39.9 de	425.1±11.5 c	148.4±46.7 bc	27.1±4.2 bc	221.7±56.5 d	5.6±1.3bc	54.6±10.8 c
Muhand	13.5±3.4 a	629.3±105.0 c	387.2±84.2 bc	7.6±0.26 fg	7.7±0.62 ef	15.6±1.98 ab	593.0±52.5 cd	431.6±10.5 c	161.4±57.3 bc	25.7±6.0 cd	246.7±58.4 bc	5.7±1.4b	62.0±13.2 b
Farok B	13.59±3.46 a	639.5±105.7 b	401.4±71.5 abc	7.7±0.2 hi	7.77±0.5 ef	16.6±2.9 a	594.4±41.5 cd	451.2±11.5 b	143.1±42.9 dcd	24.4±6.2 dg	254.8±54.0 b	6.3±61.1 a	59.7±13.5 bc
Khane B	13.5±3.4a	658.0±96.5b	413.5±62.1ab	7.6±0.2 hi	7.5±0.77 fg	16.3±2.6a	608.5±48.3 bc	472.0±12.3a	136.5±55.4 cde	27.5±8.8 bc	26182±47.8 b	66.3±1.3 a	68.5±12.6 a
Ashejam	13.8±3.6a	675.0±91.2a	424.0±66.4a	7.5±0.2g h	7.5±0.6 g	16.3±1.9 a	617.7±44.4 ab	429.0±21.4 c	188.7±55.4 ab	28.6±6.7 b	286.8±49.6 a	6.5±1.6a	70.5±12.9 a
Bedara	13.6±3.3a	659.7±88.1b	422.0±65.6a	7.5±0.2 ij	7.3±0.6 cd	15.7±2.3 ab	636.0±54.1a	469.7±11.4 a	166.3±59.7 bc	33.2±5.6 a	300.0±442a	6.6±1.4a	69.1±17.4 a
Ibrahem B	12.8±3.1a	649.0±83.0b	391.0±51.6b	7.8±0.1 jk	8.0±0.5 cd	13.8±3.4c	546.9±58.7 f	401.0±17.3 d	154.2±66.0 bc	14.3±2.7 i	237.2±38.2 cd	5.1±1.2cd	56.8±13.7 bc
Total	14.4±1.3a	560.2±110.8b	355.9±71.5ab	7.8±0.2 def	8.2±0.7cd	9.8±6.0c	536.0±780 f	409.1±46.8 d	127.5±62.8 bc	26.9±11.2 i	194.1±69.5 cd	4.4±2.0cd	43.2±22.4 bc

***Note*: Values in each rows with different letters are significantly different at P<0.05. Values in rows with same letters are not significantly different**

4. CONCLUSIONS

The present study has an attempt to evaluate the contamination impact on the river water related with the discharge of untreated wastewater from the "Zakho city" in Khabur River. This experiment confirmed that some chemical and physical parameters like pH, temperature and dissolved oxygen, chloride ,and total alkalinity met the standard acceptable limit according to (WHO., 2012).While Total hardness varied from (535.02 ±78.014) mg/l. Calcium (Ca 2+) varied from (409.19 ± 46.875) mg/l. Magnesium (Mg2+),were exceed the permissible limit compared to (WHO.,2014). The results suggested that the water quality of Khabur River is degraded to downstream and might be impacted by agriculture and domestic sewage water from Zakho city. There is need to ensure that wastewater is properly treated before discharge into the Khabur River.

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