

Study of Some Environmental and Reproductive Aspects of Some Fish Species in the Tigris River West of the City of Samarra, Salah Al-Din / Iraq

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Abstract: The study was conducted on the Tigris River in the Qalaa area, west of the city of Samarra, Salah al-Din/Iraq, for the period between October 2023 and March 2024, 117 fish were caught, with one catch per month. It has been observed that the higher sex ratio tends to favor females in *Carasobarbus luteus*, *Luciobarbus xanthopterus*, *Carassius auratus*, *Leuciscus vorax*, and *Cyprinus carpio* with ratios of 7.0:1, 5.0:1, 4.6:1, 3.5:1 and 3.0:1 respectively, while the lower percentage tends to favor females in *Acantho brama marmid*, *C. macrostomum* and *Chondrostoma regium* in the ratio of 1.8:1, 1.5:1 and 1.19:1, respectively. show the monthly changes in gonad (G.S.I) function for male and female fish (*Chondrostoma regium*, *Carassius auratus* and *Carasobarbus luteus*), (*Acantho brama marmid*, *Leuciscus vorax* and *Luciobarbus Xanthopterus*) and (*C. macrostomum* and *Cyprinus carpio*) respectively. The water temperature ranged between 10 and 22°C. The highest water temperature was in October and the lowest in February. The highest value of dissolved oxygen was 8.4 mg/L in March and the lowest value of dissolved oxygen was 6.5 mg/L in October. The highest turbidity value was 49 NTU 1 in December, and the lowest value 39.5 NTU was recorded in February.

Keywords: Sex ratio, G.S.I, Fish, Tigris River.

INTRODUCTION

Identifying the nature of reproduction of the fish species is one of the matters of successful and important fish management, and one of the important environmental factors is temperature and light in stimulating the maturation of the gonads and carrying out the reproductive process (Lagler, 1956). Fish are characterized by their high ability to reproduce, and most of their species produce thousands or millions of eggs every year, and many of these eggs are destroyed when exposed to unsuitable environmental conditions (Niklosky, 1963). Identifying fish reproduction is one of the important aspects of the fish's lifespan and its connection with other aspects such as the availability of food and oxygen and the presence and benefit in determining female fertility and the length and lifespan of the fish, which reaches maturity and fishing is regulated (Khalifa, 2017). Rasan *et al.*, (2016) stated that water temperature plays an important role on the activity, abundance, and presence of aquatic organisms and its impact on their vital activities, especially fish, in aspects of life such as nutrition, sexual maturity, growth, and reproduction in the Shatt al-Arab in the Shafi area. Yassin *et al.*, (2017) indicated the positive effect of water temperature on the abundance of fish species and aquatic organisms above salinity in the Shatt al-Arab River, Abu al-Khasib area, Basra. Hamad (2019) recorded in the Tigris River within Salah al-Din Governorate the gonad function of nine species of fish that were widely present within three stations to create a clear picture of the development of the gonad and the time of spawning. Shaker (2020) studied in the Tigris River north and south of the Samarra Dam the function of gonads for ten species of fish most abundant in my station and found a difference in the period of spawning and gonad development for the species studied. The current study aims to identify some reproductive aspects of some fish species caught near the city of Samarra and the effect of some environmental factors on gonad function.

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MATERIALS AND METHODS OF WORK

The study was conducted on the Tigris River in the Qalaa area, west of the city of Samarra, for the period between October 2023 and March 2024, 117 fish were caught, with one catch per month, the depth of the river ranges between 4-8 m, and the flow speed of the Tigris River is moderate. The worm net was used to catch fish. It was 20 meters long and 2 meters high, and the size of its holes ranged from (2 x 2) inches to (2.5 x 2.5 inches). The fishing net contained pieces of cork at the top and pieces of lead at the bottom. The fishing period extended between (2-3) hours and at a distance of 2 meters from the edge of the river in the fishing area. Classified according to the method used by Coad (2010). Equation layer sex ratio of the studied fish: Sex ratio = number of females ÷ number of males. The Gonado somatic index equation was used for males and females to determine the time of laying by West (1990): Gonad function(*G.S.I*) % = gonad weight (g) ÷ total body weight (g) x100. The data were analyzed according to the statistical program SAS (2001).

RESULTS AND DISCUSSION

1- Sex Ratio:

Table (1) and Figure (1) shows the sex ratio for a number of fish species in the Tigris River/Samarra. It has been observed that the higher sex ratio tends to favor females in *Carasobarbus luteus*, *Luciobarbus xanthopterus*, *Carassius auratus*, *Leuciscus vorax*, and *Cyprinus carpio* with ratios of 7.0:1, 5.0:1, 4.6:1, 3.5:1 and 3.0:1 respectively, while the lower percentage tends to favor females in *Acantho brama marmid*, *C. macrostomum* and *Chondrostoma regium* in the ratio of 1.8:1, 1.5:1 and 1.19:1, respectively, this is due to the fact that females precede males to breeding places.

The variation in the sex ratios of the mentioned species in the Tigris River near the city of Samarra may be attributed to the monthly fishing method for the fish species, or to their appearance at the time of reproduction or spawning, or to cases that occur to the fish, such as natural deaths or during fishing (Saxena *et al.*, 2016). Al-Ani (2016) found a sex ratio that favors *Carasobarbus luteus* males, 0.79:1 and 0.57:1 respectively in the Tigris River and the Eastern Basin, and this differs from the current study. Hamad (2019) obtained the sex ratio in *Carasobarbus luteus*, *Carassius auratus* and *Acantho brama marmid* at 1.33:1, 12.1:1, and 1.26:1, respectively, and it tends in favor of females in the Tigris River for different stations from Salah al-Din. Shaker (2020) stated that the sex ratio in *Carassius auratus* is 3.43:1 and tends to favor females in the Tigris River north and south of the Samarra Dam. Al-Faraji (2022) recorded the sex ratio in *Carassius auratus*, *Carasobarbus luteus*, *Chondrostoma regium*, *Leuciscus vorax*, *C. macrostomum*, *Luciobarbus Xanthopterus* and *Acantho brama marmid* 3.08:1, 1.83:1, 1.48:1, 1.5:1, 1.7:1, 1.3:1, and 1.2:1 respectively and tend in favor of females in the Rasasi and Asraj rivers of Salah al-Din, and this is consistent with the current study.

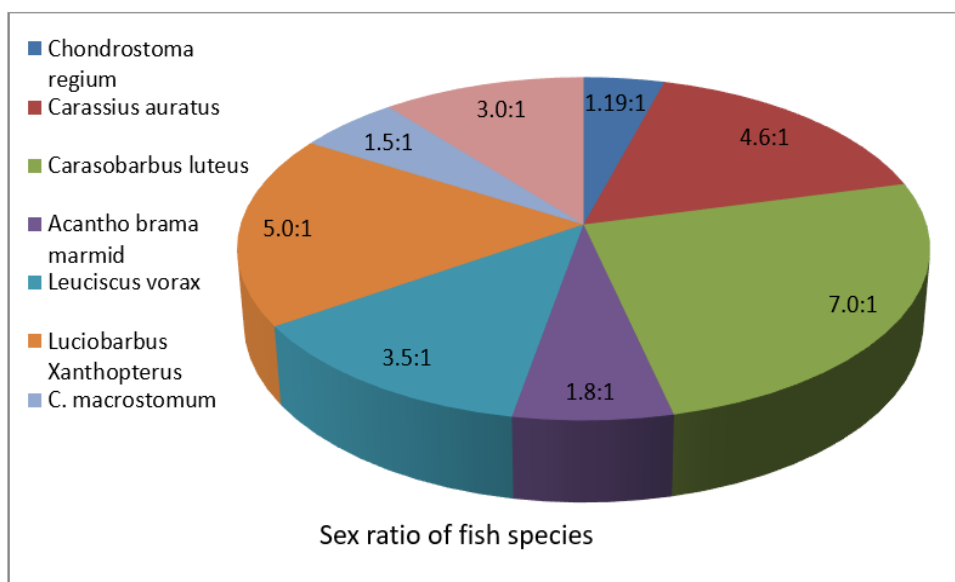


Figure 1: Sex ratio of fish species in the Tigris River near the city of Samarra

Table 1: Sex ratio of a number of fish species in the Tigris River near the city of Samarra

Species	Number Total	Number of males	Percentage of number %	Number of females	Percentage of number %	Sex ratio
<i>Chondrostoma regium</i>	35	16	45.71	19	54.29	1.19:1
<i>Carassius auratus</i>	28	5	17.86	23	82.14	4.6:1
<i>Carasobarbus luteus</i>	16	2	12.50	14	87.50	7.0:1
<i>Acantho brama marmid</i>	14	5	35.71	9	64.29	1.8:1

Species	Number Total	Number of males	Percentage of number %	Number of females	Percentage of number %	Sex ratio
<i>Leuciscus vorax</i>	9	2	22.22	7	77.78	3.5:1
<i>Luciobarbus Xanthopterus</i>	6	1	16.67	5	83.33	5.0:1
<i>C. macrostomum</i>	5	2	40.00	3	60.00	1.5:1
<i>Cyprinus carpio</i>	4	1	25.00	3	75.00	3.0:1

2-The function of the gonads (G.S.I):

Tables (2), (3) and (4) show the monthly changes in gonad function for male and female fish (*Chondrostoma regium*, *Carassius auratus* and *Carasobarbus luteus*), (*Acantho brama marmid*, *Leuciscus vorax* and *Luciobarbus Xanthopterus*) and (*C. macrostomum* and *Cyprinus carpio*) respectively Tigris River near Samarra. These fish are the most abundant in the Tigris River near the city of Samarra. It has been observed that the duration of spawning and the duration of gonad development differ in the species studied. The duration of spawning varies according to the species of fish and the characteristics of the aquatic ecosystem in which the fish lives, and these characteristics are determined by environmental factors such as temperature and food quality (Nikolsky, 1963). The highest value of gonad function in *Chondrostoma regium* females and males was 11.52 and 10.33 respectively in November and the lowest value for females and males was 7.18 and 2.65 respectively in January, while no gonad function was recorded in December and March due to its absence in the hunting sample, As shown in Table (2). Hamad (2019) found the highest gonad function for *Chondrostoma regium* for males 3.62 in March and 2.09 for females in February and the lowest gonad function for males 0.22 in May and 0.11 for females in July. He showed that the reproductive period extends during the months of February and March in the Tigris/Salah al-Din River. This did not agree with the current study. Shaker (2020) recorded the highest value for the gonad function *Chondrostoma regium* in males is 1.38 in April and in females is 4.36 in March, and its lowest value is 0.14 in males in November and 0.28 in females in September in the Tigris River north and south of the Samarra Dam, and this is not consistent with the current study.

Table 2: Monthly changes in gonad function G.S.I and standard deviation SD± for male and female fish *Chondrostoma regium*, *Carassius auratus* and *Carasobarbus luteus* in the Tigris River/Samarra

Month	Species																	
	<i>Chondrostoma regium</i>						<i>Carassius auratus</i>						<i>Carasobarbus luteus</i>					
	Males			Females			Males			Females			Males			Females		
	N	Gsl	SD±	N	Gsl	SD±	N	Gsl	SD±	N	Gsl	SD±	N	Gsl	SD±	N	Gsl	SD±
October 2023	4	7.02	2.70	2	7.19	0.60	2	10.75	0.77	5	256.45	544.67						
November	4	10.33	6.44	5	11.52	6.37										4	5.39	3.17
December										3	12.31	1.69	1	9.43		4	13.79	5.06
January 2024	6	2.65	1.02	5	7.18	1.98	2	5.91	4.50	5	15.96	7.23						
February	2	5.70	1.83	7	7.61	3.31	1	4.79		10	11.40	4.05						
March													1	3.91		6	12.03	2.15

The highest values for the gonad function *Carassius auratus* were recorded in males and females, 10.75 and 256.45 respectively in October, and the lowest values were recorded in males and females 4.79 and 11.40 respectively in February. Hamad (2019) explained that the two highest values of the *Carassius auratus* gonad function in males are 2.05 and 2.67 and in females 9.06 and 8.88 in March and may extend to June, especially females, and the lowest value for males is 0.26 in August and for females 1.03 in November in the Tigris/Salah al-Din River. This did not agree with the current study. Shaker (2020) indicated the highest value of the gonad function for *Carassius auratus* males and females 3.36 and 12.05 respectively in March, he noted an increase in the gonad function values for females in the months of February, March,

April and June and the lowest value for males and females 0.07 and 0.15 respectively in October at the station the first, the second station I find the highest value of the gonad function *Carassius auratus* for males 4.94 in females 9.95 and in Viram and the lowest value of the gonad function for males 0.91 in March and 0.03 in females in August in the Tigris River north of the release of the Samarra Dam, and this also was not completed in the current study.

The highest values of gonad function in *Carasobarbus luteus* in males and females were 9.43 and 13.79 respectively in December, and the lowest value of gonad function in males and females was 3.91 in March and 5.39 in females in November. Al-Rudaini and Al-Nasiri (2004) indicated that *Carasobarbus luteus* is characterized by its long spawning period producing individuals of different lengths during one year in one of the artificial lakes west of Baghdad. Bostanci *et al.*, (2007) showed that there are differences in the period of gonad development and offspring status in fish due to age length and when environmental conditions are appropriate. Al-Shawi and Wahab (2008a) explained that the spawning period of *Carasobarbus luteus* extends from June to August in the Tuz Gai River. Hamad (2015) found the value of the gonad function for the *Carasobarbus luteus* fish which starts from February to May and increases gradually, he noted that the reproductive period begins in March and continues until June in the Tigris River in Salah al-Din Governorate. Abdel Qader (2019) obtained the highest gonad function value for females and males of *Carasobarbus luteus* 7.080 and 4.202 respectively in May at the first station while she found an increase in the value of the gonad function for females and males of Al-Hamri 7.495 and 5.220 respectively in May at the second station in the River Tigris/Salah al-Din, and this did not agree with the current study.

The highest value of the gonad function was recorded for a fish *Acantho brama marmid* in males was 11.11 in March and in females it was 10.01 in December and the lowest value of the gonad function in males and females was 6.25 and 8.96 respectively in November as shown in Table (3). Unlu *et al.*, (1994) indicated that the gonad function of the *Acantho brama marmid* increased in May and decreased in June in the Tigris River in Turkey, and showed that some of the caught fish contained eggs in July. Saud (1998) found the highest value of the reproductive function for male and female *Acantho brama marmid* 2.31 and 11.59 respectively in March in the Karma Ali River. Wahab (2006) recorded the highest gonad function in *Acantho brama marmid* males and females 3.07 and 12.92 respectively in March, and the current study did not converge with previous studies.

Table 3: Monthly changes in gonad function G.S.I and standard deviation SD± for male and female fish *Acantho brama marmid*, *Leuciscus vorax* and *Luciobarbus Xanthopterus* in the Tigris River/Samarra

Month	Species																	
	<i>Acantho brama marmid</i>						<i>Leuciscus vorax</i>						<i>Luciobarbus Xanthopterus</i>					
	Males			Females			Males			Females			Males			Females		
	N	Gsl	SD±	N	Gsl	SD±	N	Gsl	SD±	N	Gsl	SD±	N	Gsl	SD±	N	Gsl	SD±
October 2023						2	1.39	0.32	1	81.25		1	2.46		2	10.31	4.08	
November	1	6.25		4	8.96	3.79												
December				2	10.01	2.68				2	4.40	1.21						
January 2024									2	4.22	0.86							
February																		
March	4	11.11	3.03	3	9.17	3.41			2	3.57	0.02				3	7.12	1.49	

The highest value of the gonad function of *Leuciscus vorax* in females was 81.25 in October and the lowest value of the gonad function in females was 3.57 in March while in October the value of the gonad function of males was found to be only 1.39 in the fishing sample. Hamad (2019) explained that the highest gonad function for *Leuciscus vorax* males and females was 6.58 and 10.07 respectively in January and sometimes continued into February, and the lowest gonad function for *Leuciscus vorax* males was 0.05 in July and 0.04 for females in April in the Tigris/Salah al-Din River, and this did not agree with the current study. Shaker (2020) obtained the highest value for the gonad function in *Leuciscus vorax* males 0.80 in May and 3.04 in females in November and its lowest value 0.27 in males in August and 0.24 in females in

September in the first station, and in the second station the highest value of the gonad function in males and females of *Leuciscus vorax* was 1.21 and 12.67 respectively in January and its lowest value was 0.15 in males in December and 0.16 in females in April in the Tigris River north and south of Samarra Dam, and this differs with the current study.

There was an increase in the value of gonad function in *Luciobarbus Xanthopterus* females 10.31 in October, and a decrease in the value of the gonad function to 7.12 in March, and was not recorded in the rest of the months of the study, while the value of the gonad function for males was recorded at 2.46 in October only because it appeared in the hunting sample. Abbas (2004) recorded the highest value for the gonad function for the fish *Luciobarbus Xanthopterus* in March for males it was 5.75 and for females it was 13.7 respectively, and the lowest value of the gonad function in August for males and females was 0.49 and 0.65 respectively in the Euphrates River near Musayyib. Shaker (2020) obtained the highest value for the gonad function *Luciobarbus Xanthopterus* In males it is 3.59 in March and in females it is 1.30 in May, and its lowest value in males and females is 0.31 and 0.09 respectively in August in the Tigris River north and south of Samarra Dam, and this is not consistent with the current study.

The highest value of the gonad function for *C. macrostomum* males and females was 15.91 and 9.68 respectively in December, and the lowest value of the gonad function for males and females was 6.59 and 2.39 respectively in March, No gonad function values appeared for the rest of the months in the hunting sample, as shown in Table (4). Metin and Akpınar (2000) obtained the highest reproductive index for male and female *C. macrostomum* 2.03 and 7.53 respectively in May in the Tigris River/Turkey.

Table 4: Monthly changes in gonad function G.S.I and standard deviation SD± for male and female fish C. macrostomum and Cyprinus carpio in the Tigris River/Samarra

Month	Species											
	<i>C. macrostomum</i>						<i>Cyprinus carpio</i>					
	Males			Females			Males			Females		
	N	Gsl	SD±	N	Gsl	SD±	N	Gsl	SD±	N	Gsl	SD±
October 2023												
November												
December	1	15.91		1	9.68		1	7.34		3	8.34	4.83
January 2024												
February												
March	1	6.59		2	2.39	0.01						

Wahab (2006) recorded an increase in the value of the gonad function for *C. macrostomum* males and females between 1.63 and 8.06 in April, and a decrease in the value of the gonad function for males and females 0.13 in August and 0.37 for females in September in the Tuz Gai River. The current study did not converge with the previous two studies.

The gonad function value for *Cyprinus carpio* males and females was found to be 7.34 and 8.34, respectively, in December, and the gonad function value was not obtained for the rest of the study months. Abbas (2004) showed that *Cyprinus carpio* spawns in February in the Euphrates River, and this does not apply to the current study. Wahhab (2006) indicated in the first station that there were two values for the gonad function in *Cyprinus carpio* males and females 1.94 and 5.37 respectively in October, at the second station he recorded values of the gonad function in males and females 8.39 and 11.64 respectively, in March in the Tuz Gai River. Shawwardi (2006) found an increase in the value of the gonad function of *Cyprinus carpio* females to 10.92 in the Tigris River in May, and noted that the optimal temperature for *Cyprinus carpio* fish for the egg-laying season ranges between 18-20°C. Al-Awadi (2007) obtained high values for the gonad function of *Cyprinus carpio* females in March 12.95 in the alhimar Hur. The gonad function of males and females in the current study was not close to previous studies.

3- Monthly Changes in the Values of Some Environmental Factors and Gonad Function for the Caught Fish Species
3-1- Water Temperature

The water temperature ranged between 10 and 22°C. The highest water temperature was in October and the lowest in February, as Table 5 shows, we did not notice a significant correlation between water temperature, dissolved oxygen, and turbidity (NTU), Differences in climatic conditions and air temperatures may be due to differences in water temperatures depending on the months, we also did not obtain significant differences between water temperature and gonad function for the fish studied, except for the presence of a significant correlation between the water temperature and the gonad function *Acantho brama marmid* 0.98 with a significance level of 0.05, while no studies have been obtained for the *Acantho brama marmid* fish to give a clear picture of the association of the gonad function with water temperature.

Table 5: Monthly changes in the values of some environmental factors and reproductive function for fish species caught from the Tigris River near the city of Samarra for the period from October 2023 to March 2024

Month	Environmental factor			Gonad function for fish species (Gsl)							
	Water temperature (°C)	Dissolved oxygen (mg/L)	Turbidity (NTU)	<i>Chondrostoma regium</i> (Gsl)	<i>Carassius auratus</i> (Gsl)	<i>Carasobarbus luteus</i> (Gsl)	<i>Acantho brama marmid</i> (Gsl)	<i>Leuciscus vorax</i> (Gsl)	<i>Luciobarbus Xanthopterus</i> (Gsl)	<i>C. macrostomum</i> (Gsl)	<i>Cyprinus carpio</i> (Gsl)
October 2023	22	6.5	42.4	7.08	186.3			28.01	7.69		
November	18	6.8	45.3	10.99		5.39	8.42				
December	12	7.0	49.1		12.31	12.92	10.01	4.41		12.79	8.09
January 2024	11	7.2	41.2	4.71	13.1			4.22			
February	10	7.5	39.5	7.19	10.8						
March	14	8.4	40.0			10.87	10.28	3.57	7.13	3.79	

Mahmoud *et al.*, (2018) found a water temperature increase of 24°C in June and a decrease of 8°C in January in the Tigris/Salah al-Din River, which did not agree with the current study. Hamad (2019) obtained the lowest water temperature of 12.5°C in the months of February and January and the highest water temperature of 28.5°C in August in the Tigris/Salah al-Din River. Shaker (2020) recorded the water temperature which ranged between 9-30 °C. The lowest water temperature was in the months of December, January, and February, and the highest in August in the Tigris River near the city of Samarra. The two previous studies converged with the current study at low water temperatures. Al-Faraji (2022) found the lowest water temperature was 13°C in January, and the highest water temperature was 22°C in October from the Al-Asraj and Al-Rasasi/Salah al-Din rivers, and this study agreed with the high water temperature in October and differed with the low water temperature. Hassan (2023) found the highest water temperature was 21°C in October, and the lowest water temperature was 9°C in January in one of the drains of Al-Alam District/Salah al-Din. This study converged with the current study regarding the rise in water temperature in October.

3-2- Dissolved oxygen

The highest value of dissolved oxygen was 8.4 mg/L in March and the lowest value of dissolved oxygen was 6.5 mg/L in October as Table 5 shows, we did not notice any significant differences between the environmental factors studied and dissolved oxygen, as well as with the gonad function of the fish studied. Al-Sarraj (2019) also explained that the reason for the decrease in dissolved oxygen values in the current study is the increase in air and water temperature and the abundance of fish, which led to a decrease in dissolved oxygen values, and it could be caused by living aquatic organisms that lead to an increase in the decomposition processes of organic materials that lead to Low dissolved oxygen. Hamad (2019) recorded the lowest dissolved oxygen value of 4.2 mg/L in July and the highest value of 10.52 mg/L in January. Shaker (2020) obtained the highest value for dissolved oxygen at 8.5 mg/L in December and the lowest value at 4.6 mg/L in August in the Tigris River north and south of the Samarra Dam. Al-Faraji (2022) mentioned that the low value of dissolved oxygen is 8.5 mg/L in October and the high value is 10 mg/L in January and February from the Asarji and Rasasi/Salah al-Din rivers. Hassan (2023) found an increase in the value of dissolved oxygen by 8.9 mg/L in December, and a decrease in the value of dissolved oxygen by 3.74 mg/L in October in a house in the Al-Alam district/Salah al-Din, this study converged with the current study regarding a decrease in the value of dissolved oxygen in October.

3-3- Turbidity (NTU)

The highest turbidity value was 49 NTU 1 in December, and the lowest value 39.5 NTU was recorded in February, the discrepancy in turbidity values in the study may be due to the nature of the aquatic environment and the presence of suspended materials in the water column, as Table 5 shows, no significant differences were recorded between the turbidity (NTU) and the environmental factors studied and the gonad function of the fish studied. Hussein (2018) showed the values of turbidity in the Tigris River in the Tigris River, which were the lowest value 1.8 NTU in February and the highest value 88.5 NTU in April. Mahmoud *et al.*, (2018) obtained high turbidity values of 192.5 NTU in May and low turbidity values of 3.55 NTU in March in the Tigris/Salah al-Din River. Hamad (2019) in the Tigris/Salah al-Din River found the highest value of turbidity 62.0 NTU in March and the lowest value 3.84 NTU in March. Shaker (2020) recorded the lowest turbidity value of 18 NTU in August and the highest value of 409 NTU in November in the Tigris River near Samarra, the current study did not agree with previous studies. Hassan (2023) indicated that there was an increase in the turbidity value by 17.6 NTU in December, and a decrease in its value by 3.25 NTU in November, this study converged with the current study in the NTU peak in December.

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