Environmental factors affecting fish distribution in the Tigris River: a study of the relationship between fish distribution and the physical and chemical factors of the water.

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Abstract:

This research focuses on the effects of physical and chemical water factors such as temperature, salinity, dissolved oxygen, and pH on the spatial and seasonal distribution of fish in the Tigris River. An analytical approach was adopted, involving water sample collection from two primary sites: the first between Al-Suwaira and Al-Kut Barrage, and the second between the confluence of the Diyala River and Sheikh Saad District. Field measurements were conducted using advanced techniques, and fish diversity and density were monitored across different seasons to correlate environmental variations with species distribution.

This research focuses on the effects of physical and chemical water factors such as temperature, salinity, dissolved oxygen, and pH on the spatial and seasonal distribution of fish in the Tigris River. An analytical approach was adopted, involving water sample collection from two primary sites: the first between Al-Suwaira and Al-Kut Barrage, and the second between the confluence of the Diyala River and Sheikh Saad District. Field measurements were conducted using advanced techniques, and fish diversity and density

were monitored across different seasons to correlate environmental variations with species distribution.

Findings revealed that the first site exhibited relatively balanced ecological conditions, including moderate temperatures (27.5–29°C), mildly alkaline pH (7.3–7.4), and suitable levels of dissolved oxygen and salinity, supporting the reproduction of fish such as carp and catfish. The dense aquatic vegetation and the geomorphological diversity of this section also contributed to the stability of fish communities.

In contrast, the second site recorded higher concentrations of sulfates (401 mg/L) and sodium (150 mg/L), along with fluctuating pH levels (6.6–7.1) and elevated electrical conductivity (971 µS/cm), indicating environmental stress due to industrial and agricultural discharge, particularly near residential zones. This corresponded with a clear reduction in the abundance of sensitive species during summer months, highlighting the central role of environmental changes in reshaping aquatic biodiversity.

The study concludes that water quality is a decisive factor in sustaining aquatic biodiversity, and any imbalance in physical and chemical parameters can adversely affect fish presence and reproduction. Based on these findings, the research recommends implementing regular environmental monitoring programs, enhancing integrated pollution control systems, promoting aquaculture to alleviate pressure on natural stocks, and ensuring ecological balance in the Tigris River basin.

الملخص:

يتناول هذا البحث دراسة تأثير العوامل الفيزيائية والكيميائية للمياه مثل درجة الحرارة، الملوحة، الأوكسجين المذاب، ودرجة الحموضة ((pHعلى التوزيع المكاني والموسمي للأسماك في نهر دجلة. استُخدمت منهجية تحليلية شملت جمع عينات مياه من موقعين رئيسيين على مجرى النهر: الأول بين منطقتي الصويرة وسدة الكوت، والثاني بين مصب نهر ديالى ومنطقة شيخ سعد. اعتمدت الدراسة على قياسات ميدانية دقيقة باستخدام تقنيات حديثة، وجرى رصد تنوع الأسماك وكثافتها في فصول مختلفة لربط التغيرات البيئية بتوزيع الأنواع.

أظهرت النتائج أن الموقع الأول يمتاز بتوازن بيئي نسبي، حيث سجلت درجات حرارة معتدلة (27.5–29 °C) ودرجة pH قلوية خفيفة (7.3–7.4)، مع مستويات مناسبة من الأوكسجين المذاب والأملاح، مما يوفر بيئة جيدة لتكاثر الأسماك مثل الشبوط والقرموط. كما ساهم الغطاء النباتي الكثيف وتنوع تضاريس المجرى المائي في استقرار التجمعات السمكية.

في المقابل، أظهر الموقع الثاني معدلات أعلى من الكبريتات (401 ملغم/لتر)، والصوديوم (150 ملغم/لتر)، إضافة إلى تذبذب في درجات الحموضة (6.6–7.1) وارتفاع في التوصيلية الكهربائية (971 ميكروسيمنز/سم)، مما يدل على تعرض المنطقة لتأثيرات ناتجة عن تصريف صناعي وزراعي، خاصة في النقاط القريبة من المناطق السكنية. وقد انعكس ذلك بانخفاض واضح في كثافة بعض الأنواع الحساسة خلال أشهر الصيف، ما يُشير إلى أن التغيرات البيئية لها دور محوري في إعادة تشكيل التوزيع الحيوي.

خلص البحث إلى أن جودة المياه تُعدّ عاملاً حاسمًا في استدامة التنوع البيولوجي المائي، وأن أي اختلال في توازن العوامل الفيزيائية والكيميائية يؤثر سلبًا على تواجد الأسماك وتكاثرها. وبناءً على هذه النتائج، توصي الدراسة بضرورة تطوير برامج رصد بيئي دورية، وتعزيز المعالجة المتكاملة لمصادر التلوث، إلى جانب تشجيع الاستزراع السمكي للحد من الضغط على المخزون الطبيعي، وضمان التوازن الإيكولوجي في حوض نهر دجلة.

الكلمات المفتاحية: توزيع الأسماك، العوامل البيئية، جودة المياه

Introduction:

Environmental factors play an important role in determining fish distribution in water bodies. Changes in physical and chemical properties of water affect direct growth, breeding and feeding behavior of fish. This study will analyze the relationship between these factors and the distribution of fish, contribute to the development of strategies for the preservation of biodiversity and improve fish production. [1]

Physical and chemical factors for water play an important role in determining the distribution of fish in different water environments. Each fish species affects growth, breeding and feeding behavior with temperature, salinity, dissolved oxygen and pH, for specific environmental conditions. [1]

The temperature is one of the most important factors as it controls metabolic speeds in the fish and affects their activity and movement. Oxygen material dissolved in water also determines the ability to fish, as the level reduction can reduce significant activity or even death of fish. Sourness (pH) affects fish health, as sudden changes can interfere with their important functions. [3]

Study Importance:

- Understanding the impact of environmental factors on fish distribution helps to improve water resources.

- Research contributes to the development of strategies for the preservation of biodiversity of fish.

- It helps to improve the stability of fisheries by identifying factors that affect fishing growth and reproduction.

- It provides scientific data to support environmental policy related to the safety of aquatic ecosystems.

Study Objectives:

1. Analyze the effect of physical and chemical factors such as temperature, salinity and dissolved oxygen on fish distribution.

2. Identify the relationship between water quality and fish diversity in different environments.

3. Propose strategies to conserve fish resources based on the study results.

4. Provide scientific data to support the management of aquatic fisheries and improve their sustainability.

Methodology:

Study areas:

Studying the Impact of Environmental Factors on Fish Distribution in the Tigris River:

1. The first section between Al-Suwaira and Al-Kut Dam, this section is characterized by dense aquatic vegetation, making it a suitable environment for fish that rely on vegetation for protection and reproduction,Water quality here is affected by the discharge of agricultural and industrial waste, which may affect dissolved oxygen and salinity,The impact of seasonal changes on

fish distribution was studied, as temperatures and water levels vary between summer and winter. [3]

2. The second section extending between the mouth of the Diyala River and the Sheikh Saad District ,this section is important for studying the environmental characteristics of the river as it is affected by the flow of water coming from the Diyala River, which changes the concentration of chemical elements in the water, the impact of sediments and pollutants on water quality and fish distribution is analyzed, especially in areas close to residential and industrial areas, this section is considered rich in various fish species, making it suitable for studying biodiversity and the impact of physical and chemical factors on fish. [4]

-Data and Information Collection

Field Sample Collection

Sample points were identified along the Tigris River in the first and second places. Physical parameters measured: temperature, water flow rate, depth and dissolved oxygen. Chemical parameters analyzed: salinity, organic matter, heavy metal materials and ph. The variation of fish was then studied with regard to species and density, and the effect of these factors on fish distribution, Samples were collected during the summer season, when temperatures rise and dissolved oxygen levels fall, allowing for monitoring of the extreme environmental influences on fish distribution.

Results and discussion:

The first place, the section between Al- Suwayrah and the Al-cut latch, is characterized by the properties of hydrological and geomorphological properties that directly affect the distribution of fish in the Tigris River. The al-cut latch plays an important role in regulating the flow of water, affecting the flow rate and dissolving the oxygen level in the water. The region also includes rivers and aquatic islands, which build different houses for fish and affect their distribution. In addition, the spread of water plants in this area provides shelter and food for fish, but it can also affect the quality of the water through biological interactions.

Table 1: The fundamental physical and chemical traits of the water sample at the first place

S	PH	T.D.S	N.T.U	Tem	EC	Caco 3	Ca	Mg	Cl	So4	K	Na
S1	7.3	592	15	28	942	156	90	24.6	89	223	3.5	76
S2	7.3	586	15	29	931	155	90	24	86	228	3.5	75
S3	7.4	589	18	28.5	951	158	83	25	88	234	3.3	72
S4	7.4	574	22	27.5	913	153	89	23	83	229	3.4	77

This table presents key water quality measurements from four sampling points (S1-S4) along the Tigris River between Al-Suwaira and Al-Kut Barrage. Data shows many important patterns:

The ph. level is consistently alkaline (7.3–7.4), which is ideal for most freshwater fishing species. This stability indicates good buffer capacity for acidification.

Total dissolved solids (TDS) show minor changes (574–592 ppm), moderate salinity levels that are usually safe for aquatic, although some reach near the upper limit of some sensitive species.

Sulfate concentrations (223–234 ppm) are particularly high in all samples, more than recommended fresh water guidelines (200 ppm). This possibility shows geological effects and potential pollution inputs.

The temperature remains within a narrow area (27.5–29 ° C), indicating stable thermal conditions that prevent temperature voltage on the fish population.

Important minerals such as calcium (83–90 ppm) and magnesium (23–25 ppm) are present in favorable concentrations for fish health and development.

The minor fluctuations between sampling points suggest relatively consistent water quality throughout this river section, though the elevated sulfate levels warrant further investigation into potential pollution sources. The overall parameters indicate suitable conditions for many freshwater fish species, particularly hardy varieties like carp and catfish.

A – Physical Properties:

1 – **pH:** The pH represents an indicator of the basicity and acidity of the water, which greatly affects the effectiveness of the water, as the solution is considered basic if the pH is more than (7), and it is considered an acidic solution if its percentage is less than (7), but if its percentage is (7) it is

considered a neutral solution. We note from the analysis results, as shown in Table (1), that the pH value varied from one sample to another, as the highest concentration was recorded which reached 7.4, and the lowest concentration was 7.3. These values range between the appropriate range for the growth of most fish species, which ranges between 6.5 and 8.5 for most fish species. This percentage ensures a stable aquatic environment that aids in the metabolic and respiration processes of fish, and also affects the availability of nutrients in the water. .[5]

2 - **The amount of dissolved or total salts (T.D.S)** represents both the negative and positive ions in the water, and most of its sources are inorganic compounds dissolved in the water, such as carbon and sodium, in addition to organic compounds resulting from waste and human activities. It was shown through the results of laboratory analyses, as stated in Table (1), that the highest concentration rate was (592), while the lowest concentration rate of dissolved salts was (574). When comparing these rates with the standard criteria for the suitability of water for fish growth, it was found that it is considered to be water with high salinity, The reason for the increase in the concentration of total dissolved solids (TDS) is the decrease in the river water level, because the total TDS represents the sum of dissolved salts in the water that make up hardness, chlorides, sulfates and alkalinity. Industrial waste, sewage, irrigation water, drains, soil erosion and rain also play an important role in increasing the concentration of total dissolved solids and thus polluting the river and negatively impacting the living ecosystem of fish in the river water. [2] [3]

3-**Turbidity NTU** : Turbidity is represented by organic materials and inorganic materials in impurities present in water such as sand, plants and mud. It became clear from the results of Table (1) that the highest concentration of turbidity was (22), and the lowest concentration reached (15).Turbidity values are considered suitable for the growth of most fish species. This ratio provides a good balance between water clarity and protection from predators. It also helps maintain the natural environment of fish without negatively affecting respiration or feeding. [6]

4-**Temperature**: Temperature is of great importance as it contributes to the water treatment process by helping to quickly dissolve chemicals and quickly sediment fine materials. The analysis results showed, as shown in Table (1), that the highest concentration of heat was 29, and the lowest concentration was recorded at 27.5.

These values are considered good for the growth of many fish species, and temperature is one of the most important factors affecting fish life in water. It affects the rate of metabolism, growth, reproduction, and spawning, as fish metabolism increases with increasing temperature. Some water quality factors are also closely linked to temperature. For example, ammonia toxicity increases and oxygen solubility in water decreases with increasing temperature. [8]

B- Chemical properties of water

1- **Electrical conductivity** (**EC**) represents the ability of water to transmit electric current. It is a unit of measurement for the dissolved ions of water at

temperature. It is formed from different organic materials that are poor conductors, and inorganic materials that are good conductors of electricity. It is clear from Table (1) that the highest concentration of electrical conductivity was (951), and the lowest concentration was (913). [7]

These electrical conductivity values are considered suitable for many fish species, especially those adapted to moderate levels of dissolved salts. These ranges may be suitable for fish such as tilapia and carp, which can live in environments with low to moderate salinity.

2-Alkaline calcium carbonate CaCo3: It was shown through the results of laboratory analyses shown in Table (1), that the highest concentration of calcium carbonate was (158), and the lowest concentration was (153).

Alkalinity values are suitable for fish growth, as they help stabilize the pH and provide an ideal environment for the growth of algae and microorganisms that are part of the fish food chain. .[9]

3- **Calcium Ca:** Calcium is a positive element and water is classified according to it into water poor in calcium, water with medium calcium content and water rich in calcium content. Calcium is also one of the causes of water hardness and it is clear from Table (1) that the highest concentration of positive calcium ions in the country reached (90), the lowest percentage (83)

Calcium is considered essential for fish growth, as it helps strengthen fish skeletons and improve nervous system function. It also plays an important role in regulating water pH, contributing to a stable environment for fish growth. [6]

4-**Magnesium (Mg) :** Magnesium is one of the most widespread alkaline ions in fresh water, and it represents one of the basic components within the

chlorophyll molecule. It is noted in Table (1) that the highest percentage of magnesium concentration reached (25), and the lowest percentage was (23).

Magnesium levels in water are an important factor for fish health, as it plays a role in regulating vital processes such as bone growth, muscle function, and the nervous system. Values fall within the appropriate range for freshwater fish, meaning they are safe for most species such as tilapia, carp, and trout. However, it's important to monitor the balance between calcium and magnesium to ensure a stable environment for fish. [10]

5-Chlorides (Cl): These elements are generated as a result of liquid waste from chemical industries. Heavy water also contains a large amount of chlorides. Table (1), which summarizes the laboratory results for samples from the study area, shows that the highest concentration of chlorides reached (89), and the lowest concentration was recorded at approximately (83). It is noted that the water in the study area had chloride levels ranging below 142, which means that it is excellent and safe water for all fish. The effect of chlorides in water depends on the type of fish and the surrounding environmental conditions. [6] In general, chlorides are chemical compounds that can affect water quality and the life of aquatic organisms. Some fish can adapt to high levels of chloride, especially species that live in salt water, while this level may have a negative effect on freshwater fish that need a certain balance of minerals and salts to survive and grow healthily.

6- **Sulfates SO4 :**Sulfur can be found in fresh water with the positive ion and surface water has a very low sulfate content, except in areas rich in this element. This element is found due to industrial waste and sewage. It is clear

from Table (1) that the highest concentration of this element was within (234), while the lowest concentration reached (223).

We find that most of the concentrations have exceeded the permissible limits, which are less than (200) mg/L. This is due to the effect of laboratory releases, especially vegetable oils containing high concentrations of (SO4). It is also due to the effect of sewage water, soil washing operations for the lands surrounding the river, as well as industrial waste water, as well as the nature of the pathology of the river basin, which is abundant in gypsum and saline soils. These factors affect water pollution and lead to a change in the hydrochemical properties, water quality, and an increase in negative and positive ions, which negatively affects the presence of fish. .[4]

7-**Sodium Na** is found in all natural waters and is produced by the dissolution processes that rocks are exposed to, in addition to the human element, which has a clear role in influencing the amounts of sodium in water through its activities. It was shown through the results of the analyses of the samples taken from the study area shown in Table (1), that the highest percentage of sodium concentration was (77), and the lowest concentration of sodium was recorded at (72).

These values are considered within acceptable limits for some species, but may be unsuitable for others that require lower concentrations to maintain a healthy environment. Fish living in brackish water may be better able to adapt to this concentration, while more sensitive species may be adversely affected. .[3]

8- **Potassium K** is similar in importance to sodium, and its presence is close to sodium, but its concentration is lower because it is more resistant to weather factors and easier to absorb. It was concluded through the results of the analysis, as shown in Table (1), that the highest concentration of potassium was 3.5, while the lowest concentration of potassium was (3.3).

Potassium in these proportions is acceptable as it is essential for fish growth and aids in metabolic processes and the transfer of nutrients within the body's cells. [8]

2- **The second section extending between the mouth of the Diyala River and the Sheikh Saad District** , The site is characterized by unique geomorphological and environmental characteristics that influence fish distribution and human activities in the area. According to studies, this section of the Tigris River is experiencing changes in its course due to natural and human factors, affecting river sediments and the islands that form in the area. [10]

The environmental characteristics of this site also include soil and sedimentation and their impact on water quality, making it an area of importance for environmental and hydrological studies. In addition, the confluence of the Diyala River and the Tigris River contributes to the formation of a diverse aquatic environment that impacts the biodiversity of fish in the region.

Table 2: The fundamental physical and chemical traits of the water sample at the second site

S	PH	T.D.S	N.T.U	Tem	EC	Caco 3	Ca	Mg	So4	Na	Cl	K
S1	6.9	780	24	26	971	106	88	68	367	137	78	4
S2	7.1	771	23	28	967	115	93	77	401	146	86	5.3
S3	6.6	778	25	28.5	961	118	85	67	388	148	80	6
S4	6.9	781	27	30	965	111	94	71	387	150	75	5.4

A – Physical Properties:

1 – **pH:** We note from the analysis results, as shown in Table (2), that the pH value varied from one sample to another, as the highest concentration was recorded which reached 7.1, and the lowest concentration was 6.6. These values range between the appropriate range for the growth of most fish species, which ranges between 6.5 and 8.5 for most fish species. These values are considered ideal values for fish growth, reproduction and biological development. .[3].

2 – **The amount of dissolved or total salts (T.D.S)** It was shown through the results of laboratory analyses, as stated in Table (2), that the highest concentration rate was (781), while the lowest concentration rate of dissolved salts was (771), These values are within the relatively high range for freshwater, but they are not extremely salty, and many species of fish can live in such water, such as tropical fish and some species such as gobies. [5]

3-**Turbidity NTU** : It became clear from the results of Table (2) that the highest concentration of turbidity was (27), and the lowest concentration reached (23), These values are considered moderate to relatively high in river water. Most river fish, such as carp and tilapia, can adapt to these levels. However, if turbidity increases further, it can affect respiration and vision. High turbidity can restrict light penetration, affecting the growth of aquatic plants and algae, which can reduce the oxygen available to fish. .[9]

4-**Temperature:** The analysis results showed, as shown in Table (2), that the highest concentration of heat was 30, and the lowest concentration was recorded at 26, These values are considered suitable for many fish species, but their suitability depends on the type of fish living in this environment. Tropical fish (such as tilapia, mollies, and gobies) thrive in this temperature range, as it is ideal for their growth and reproduction. In this range, the growth rate and activity of fish increase. However, if the temperature rises above 30°C, the level of dissolved oxygen in the water may decrease, affecting the health of the fish. .[5]

B- Chemical properties of water

1-Electrical conductivity (EC) : It is clear from Table (2) that the highest concentration of electrical conductivity was (971), and the lowest concentration was (961), These values are considered relatively high for freshwater and are due to pollution and industrial discharge, which pose a risk to fish health, as some heavy metals or dissolved chemicals can be harmful to fish life. [6]

2-Alkaline calcium carbonate CaCo3: It was shown through the results of laboratory analyses shown in Table (2), that the highest concentration of calcium carbonate was (106), and the lowest concentration was (118), These values are suitable for many river fish, but they may be a little high for some species that prefer less alkaline environments as they help stabilize the pH of the water, providing a suitable environment for fish growth. These values also provide a good level of calcium, which helps in the formation of bones and scales in fish and maintains a stable water environment, which helps fish grow healthily. [10]

3- **Calcium Ca:**. Calcium is also one of the causes of water hardness and it is clear from Table (2) that the highest concentration of positive calcium ions in the country reached (94), the lowest percentage (85)

These values are considered suitable for the growth of river fish, especially species that depend on water minerals to maintain healthy bones and scales. They also provide a supportive environment for the growth of aquatic plants that form part of the diet of some fish. [5]

4-**Magnesium (Mg) :** It is noted in Table (2) that the highest percentage of magnesium concentration reached (77), and the lowest percentage was (67), These values are considered at the upper limit for freshwater but may be suitable for some river fish, provided that other minerals such as calcium and pH are balanced to ensure a healthy environment for the fish.[9]

5-Chlorides (Cl): Table (2), which summarizes the laboratory results for samples from the study area, shows that the highest concentration of chlorides reached (86), and the lowest concentration was recorded at approximately

(75), These values are suitable for some river fish that tolerate higher levels of chloride, such as carp and tilapia. [3] Chloride helps regulate the osmotic pressure of fish, enabling them to adapt to fresh and brackish water.

6- **Sulfates SO4** : It is clear from Table (2) that the highest concentration of this element was within (401), while the lowest concentration reached (367), Sulfates are relatively high in freshwater, but their impact on fish life depends on the species and the stability of the ecosystem. Moderate concentrations of sulfates help regulate fish metabolism and contribute to the balance of other minerals. However, high levels can lead to respiratory and digestive disturbances in fish and can affect the pH, potentially destabilizing the water environment and impacting fish reproduction. They can also increase corrosive effects within the aquatic environment, affecting plants and algae.

7-**Sodium Na** It was shown through the results of the analyses of the samples taken from the study area shown in Table (2), that the highest percentage of sodium concentration was (150), and the lowest concentration of sodium was recorded at (137), These values are considered within acceptable limits for some fish species, but this depends on the species and its adaptation to different salinity levels. Some species may tolerate higher concentrations, while others may be adversely affected if the water is unbalanced in other elements, such as nitrates and phosphates. [8]

8- **Potassium K** It was concluded through the results of the analysis, as shown in Table (2), that the highest concentration of potassium was (6), while the lowest concentration of potassium was (4).

These values are suitable for the development of fish, as potassium is an essential element of the important processes of fish, as it affects the fluid balance in their body and contributes to cell and muscle function. [4]

Comparative Statistical Analysis Between the Two Study Sites:

Table(3) of Mean Differences for Selected Physical and Chemical Parameters:

Parameter	Mean Site 1	Main Site 2	Absolute Difference
Temperature (°C)	28.25	28.13	0.12
TDS (ppm)	585.25	777.50	192.25
SO_4 (Sulfates)	228.50	388.75	160.25
pH	7.35	6.88	0.47
EC (µS/cm)	934.25	966.00	31.75
Calcium (Ca^{2+})	86.5	91.5	5.0
Magnesium (Mg^{2+})	24.0	70.75	46.75
Alkalinity ($CaCO_3$)	155.5	112.5	43.0
Sodium (Na^+)	75.0	145.25	70.25
Turbidity (NTU)	17.5	24.75	7.25
Potassium (K^+)	3.43	5.18	1.75

Discussion

The statistical analysis revealed significant differences in several environmental parameters between the two sites. Site 2 showed notably higher concentrations of sulfates (SO_4), total dissolved solids (TDS), magnesium (Mg^{2+}), and sodium (Na^+), suggesting possible influence from anthropogenic

sources such as industrial or agricultural runoff—especially near the confluence with the Diyala River.

In contrast, Site 1 maintained more stable pH values, higher alkalinity, and a more favorable calcium profile, creating a more supportive environment for sensitive fish species, These findings emphasize the importance of environmental monitoring and targeted water management strategies in Site 2 to maintain the ecological balance and support aquatic biodiversity in the Tigris River.

Summary:

Environmental factors play an important role in determining the distribution of fish in different water bodies. Temperature, salinity, accessibility of food, as well as pollution and effects of water currents, determine all the suitability of the environment for the development and reproduction of fish. It is important to monitor and analyze these factors to ensure a healthy ecological balance, which contributes to the stability of fish shares and the protection of biodiversity. The two places studied in the two places compared the values of physical and chemical factors for water and their effects on the development of permanent fish showed that the first place had more appropriate functions for fish life and reproduction, while the second place had a few more values, but within the limit suitable for many fish species.

Recommendations and suggestions:

The recommendations and suggestions are directed toward several key stakeholders, including governmental and environmental authorities, local administrative bodies, farmers and fishermen, as well as regulatory and public health agencies.

1-pedagogical management of water resources: Prioritizing the preservation of natural fishing houses should be adopted to ensure similar water distribution between different areas.

2- Parag Control: Use strict laws to prevent emissions of pollutants in water bodies, and set up water treatment plants to improve the water quality of the river.

3- Fishing Regulation: Use laws that regulate fishing activities and stop incorrect practices by helping fishermen to use fish methods.

4-Aquaculture Promotion: To reduce the pressure on natural fish shares, encourage fishery projects, which will help maintain the ecological balance of the river.

5-Communication awareness: Increase awareness of the importance of conservation of fisheries through media campaigns and educational programs aimed at fishermen and local communities.

Key words: Fish distribution. Environmental factors. Water quality.

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