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An environmental study of some water characteristics of Al-Anaba desert lake in southern Libya

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A B S T R A C T

This study aimed to estimate the physical and chemical properties of Al-Anaba desert lake. The study found that the average temperature ranged between 8.15 and 15.3. The pH rates of the water surface of Annaba were close to the general average of 9.54. The dissolved oxygen ranged from 3.97 to 6.54 mg/l in both the west and south of the lake, respectively. There were no differences in the concentrations of total dissolved salts (TDS) with a general average of 49072 mg/l. The study showed differences in the sodium element concentration from 6.51 mg/l to 8.61 mg/l. There were clear differences in the concentration of the potassium element in the different directions of the lake water with a general average of 0.716 mg/l, which is higher than the concentration of the element in clean sea water (0.38) mg /l. The study showed clear differences in the concentrations of phosphate ions with a general average of 5.28 mg /l. Additionally, the lake is home to various animals such as birds, sea geese, insects like mosquitoes, and aquatic organisms such as brine shrimp. Human activities have affected the succession process in the lake, leading to the growth of the bottom and a reduction in the area of the lake.

1 Introduction

According to various sources, including the World Commission on Environment and Development, the Brandt Land Commission, and the Rio conference on development and the environment, sustainable development is seen as crucial to addressing environmental degradation and other developmental challenges facing the world. It is believed that meeting the needs and desires of humanity while protecting the environment is essential for successful and sustainable development. This is supported by research from Al-Saadi (2009) and the APHA, AWWA, and WPCF (1975) which indicates that a change in behavior towards the environment is necessary to ensure the continuity of the development process. Tourism planning is a crucial stage in the development process that can increase the benefits of tourism while avoiding its negative effects. Therefore, tourism planning is the best way to achieve sustainability in tourist destinations. Desert lakes can be seen in the south of Libya in hollow spaces between large sand dunes. Some of these lakes are usually dry and surrounded by dense vegetation that provides them with natural protection from sand encroachment. One of these lakes, known as "Grape," changes colors throughout the year, resembling the color changes of a grapefruit from birth to maturity. Unfortunately, many of the desert lakes in southern Libya are neglected, which decreases the quality of the desert tourism experience. However, Lake Grape has become a popular tourist destination visited by many groups. Tourism can have a direct impact on the quality of the lake's water and biodiversity. It is important to note that many people do not realize the importance of biodiversity in aquatic ecosystems, particularly in desert lakes. This paper aims to estimate some physical and chemical properties of Lake al-Anaba's water, compare them to neighboring desert water bodies, and analyze some qualitative and quantitative characteristics of the plants surrounding the lake's surface. The data gathered will form an initial database for Lake al-Anaba (Schelske, 1988).

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2 Previous Studies

Previous studies have focused on the ecosystems of lake waters, as stated by Abd al-Majid and al-Dardiri in 2001. One of these studies was conducted by Richadson and Gene in 1971, which revealed that environmental factors like temperature and humidity contribute to the distribution of vegetation cover and play a crucial role in accelerating the succession processes. Geyh and Thiedig in 2008, and Hatoua *et al*. in 1996, suggested that changes in non-living or living factors in a region can bring about a change in living communities. My father knows about succession, which is an organized development in environmental systems that leads to the establishment of a vital community in place of a previous one. A study by Schelske in 1971 indicated severe unwanted changes in the ecosystem of Lake Michigan. During the summer season, the proliferation of dominant phytoplankton, which require silica, is limited. Kim *et al*. in 2021 reported that hydrosea occurs in aquatic environments such as ponds, lakes, and swamps, where the succession goes through a series of stages. The study by Schelske (1988) examined the historical trends of silica concentrations in Lake Michigan, which indicates a decrease in silica impact due to increased deposition by diatoms, contributing to an increase of organic phosphorus. The study by Burdon and Gonfiantini (1991) focused on geology, hydrology, chemistry, and excess isotopes in the lakes of the Ubari Sand Sea in Fezzan. This study described the origin and formation of one of these lakes (Lake Mandara). In 2004, Manwar discussed in his study about Lake Byoua the factors that stimulate the improvement of food, which increase this process and accelerate the environmental succession process. In another study (Al-Mujahid, 1995), the stages of development of aquatic plants were divided from submerged plants to floating plants, reed swamps and meadows, then trees and climax communities. These are successive stages in the process of evolution, and each stage is characterized by certain types of dominant and distinctive plants.

A study (Jaing.S; *et al* 2004) indicated that the pH of Lake Momo recorded an average capacity of 10, i.e., The water of the lake is alkaline, and its average salinity ranges between 70 and 85 g/kg. As shown by (Mitsch, *et al* 2005). in a study of the qualitative change of water and the effect of this change in wet water systems, he indicated that succession works to change the water quality, and this, in turn, affects the growth of some aquatic plants. A study (Al-Sheikh., 2010). of Al-Asfar Lake in Al-Hasa in the Kingdom of Saudi Arabia indicated the properties of physalis. The chemical characteristics of the lake water indicate that the high concentration of permanent oxygen is associated with an increase in the effectiveness of phytoplankton in the photosynthesis process.

And a study showed (Vijayakumar, 2010) the chemical properties of the surface water of Lake Perumal in India, which showed the values of connectivity that ranged from 362 to 61800 s// cm µ and the PH between 7.2 and 8.1, while the TDS ranged between 254 and 17600 mg/liter, and the nutrients were measured and ranged between 0.829 and 1.942 mg/liter. As for phosphate, it recorded a concentration of 0.019 mg/liter.

(Al-Tani, *et al* 2013) evaluated the environmental succession of Lake Qabroun, and the results showed that the lake is distinguished by its transparency on the eastern side, while the western side is the least transparent, and its pH ranges between 9.25 and 10.31, meaning that the lake water is alkaline, and the conductivity of the lake reached (84320–237860 s/cm) with a high concentration of salts. A study (Al-Mutanan, 2016) showed that the ecosystem of Lake Umm al-Maa in the south of Libya is characterized by extreme chemical, natural, and biological characteristics for environmental and human reasons within its water surface and its vegetation surroundings, which lead to accelerating the processes of environmental succession and the disappearance of the lake. A study (Faraj 2018). on the environmental assessment of water quality and productivity in the northern lakes in Egypt indicated that they represent important points for biodiversity, as they are a haven for migratory birds in addition to thousands of animals, botanical inspirations, and microorganisms.

3 Materials and Methods

3.1 Study Area

Lake Al-Anaba is located Southern Libya in the Wadi Al-Shati area, and it is about 80 km away from it within the Ramlet Zalaf basin, between lines of length (26.944695) and width (12.977196) between the sand dunes, as shown in Figure No. 1. It was located within what was previously known as Lake The Great Fezzan, a giant lake with an area of about 150,000 km2, is a large lake that covers large areas of the Libyan desert, bordered by the Hamada al-Hamra plateau from the north, the Black Mountain and the black Harouge volcanic shield from the east and south, and the Acacus Mountains from the west (Al-Salman, *et al* 2007). Evidence has indicated that the Fezzan region contained sediment deposited from rivers and lakes during the period of the most humid environments. (Drake, *et al* 2008).

Figure (1): A picture of Lake Al-Anaba

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3.2 Sample Collection

The samples were collected from the study site (Lake Al-Anaba), where the sites were determined by taking samples from the lake according to the geographical directions (east-west-south-north). Where water samples were collected from these sites for the purpose of identifying the physical and chemical properties using (7) liter plastic bottles with (4) samples with three replicates represented by one sample for each geographical direction (east-west-south-north), botanical samples were taken from Each site was collected and classified according to its types and species, according to the classification found in the Libyan Flora book series. The samples were collected during a field visit to the lake on February 19, 2022, from 10:30 a.m. to 7:00 p.m.

3.3 Estimating the Physical and Chemical Properties of the Lake Water

A. **Temperature (T°C):** The temperature is measured directly during sampling using B. pH and thermometer together (a HQ40D multimeter with two channels).

B. **Electrical conductivity (EC):** The conductivity is measured directly after collecting samples using a laboratory conductivity meter. Model 4310.

1. **pH: (pH** is measured immediately after collecting samples using a pH-Meter) type PHILIPS and model (9421)

2. **Chloride (CL):** The calibration method mentioned in (Al-Sheikh. 2010 No. (408) is used. With a 0.0141N silver nitrate solution using a potassium chromate reagent

3. **Sodium and potassium: (Na, K)** A flask photometer is used to measure sodium and potassium in water according to the method mentioned in (Grasshoff 1976) No. 317,230.

4. **Phosphate: (Po_4)** Phosphate was measured in water samples using a colorimetric method. This method relies on the intensity of the color that forms after adding vanadate-molybdate, and the absorption is measured at a wavelength of 470nm using a UV-Vis Spectrophotometer.
5. **Total Dissolved Salts (TDS):** The total soluble salts of the samples were estimated through conductivity measurements using a previously mentioned device. It was calculated using the equation EC * 0.64 = TDS.

3.4 Estimate the Qualitative and Quantitative Characteristics of the Plants Around the Lake.

A. Measuring plant diversity: Diversity was measured using one of the indicators of relative diversity known as the Simpson index, which is one of the types of control indicators because it weighs the abundance of common species and gives the probability of any two individuals taken randomly from the community to which several species belong.

The Simpson Index states the following law: SDI = 1-D

$N(N-1)\ \sum D= n(n-1)$

Where n = the number of individuals in one species

N = the total number of individuals for each species

D = Diversity in general

means sum $=\sum$

SDI = Simpsons diversity index.

B. Estimation of plant density: The plant density was determined in one of the plant samples using the environmental square method (100 * 100 cm) in order to determine their types and prepare them to calculate their density per unit area (plant/mm squared) from the relationship: Vegetation cover density = a number of community members per unit area of the study area (1 m2). (Goldsmith, et.al. 2016) & (Zhuang, 2020)

C. Estimation of plant abundance: The abundance of plant species was estimated by taking plant samples using the environmental spatial square (100 * 100 cm) and counting the plants inside. The abundance of each plant species was calculated using the following mathematical relationship:

The percentage of abundance for each species is equal to the number of individuals of one species x the total number of species x 100, and by comparing these percentages with the environmentally approved percentages in calculating the abundance of species for the community shown in the following table mentioned in (Florence, *et al* 2012) & (Al-Salman, *et al* 2007).

Degree of abundance Percentage scientific term
Dominant type < 95% of the total
Type Abundant > 51-95%
Common type 10 - 50%
Frequent type 1 - 10%
The rare type is 0.5 – 1%
Very rare type 0.5 > %

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D. Frequency: Frequency is the number of times the plant appears in a number of sample frames of a similar area.

of it as a percentage. It depends on both density and distribution. Thus, changes in plant abundance and distribution can be measured.

Frequency calculation: the number of samples in which the type appeared Frequency x the total number of samples used x 100

3.5 Identify the Animal Species Present in the Study Area

3.5.1 Aquatic Animal Species: Water samples were taken from each site according to the division of the four sides, east, west, south, and north, in 7-liter bottles.

3.5.2 Non-aquatic Animal Species: Species were identified by eye observation, i.e., what was seen in the study place, and some species were photographed with a mobile phone camera.

3.5.3 The impact of Human Activities: the observance of funerals was recorded at the studied sites, and any effect of human activities on the lake environment was observed using the mobile phone camera.

4 Results

4.1 Physical and Chemical Properties of the Lake Water

4.1.1 Temperature: The results of the study showed It is shown in figure (2) that the average temperature fluctuated between 15.3 and 15.8 in both the south and west of the lake, respectively.

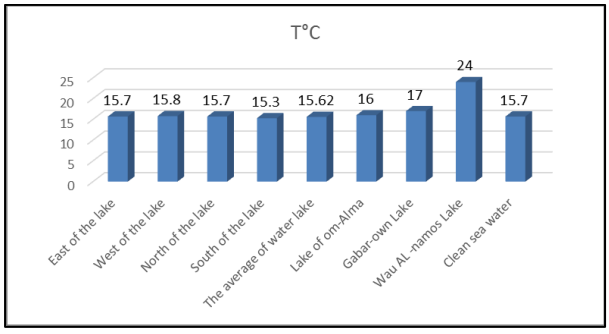

Figure (2): shows the temperature concentration in the study area.

4.1.2 pH: The results of the study showed, as shown in Figure (3), that the pH rates within the water surface of Anaba were close to a general average of (9.54).

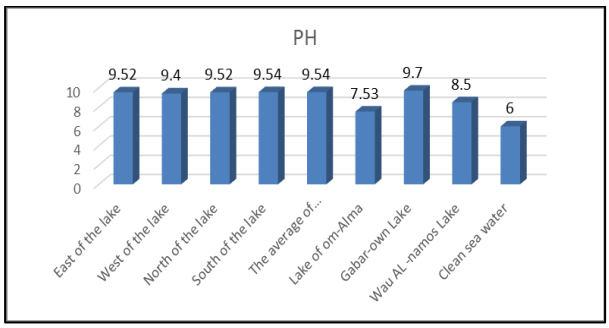

Figure (3): shows the pH concentration in the study area

4.1.3 Electrical Conductivity:the results of the study were recorded as shown in Figure (4). The general average of the conductivity values in Lake al-'Anaba reached 7682 ds/m^2, which

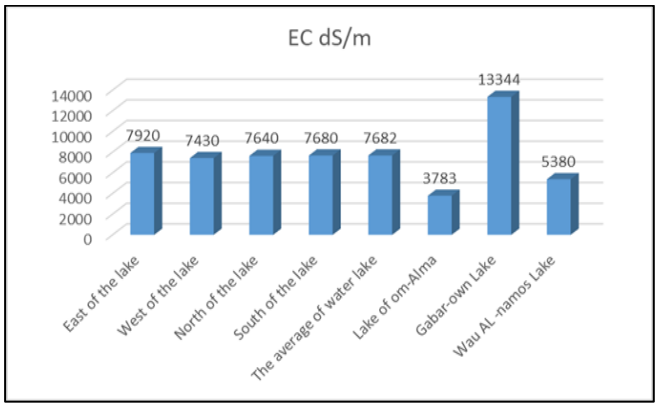

Figure (4): shows the concentration of electrical conductivity in the study area

4.1.4 Dissolved Oxygen: The results of the study, as shown in Figure (5), recorded a fluctuation in the dissolved oxygen values in the water of the lake from (3.97) to (6.54) mg/liter in both the west and south of the lake, respectively, with an average general (5.3) mg/liter,

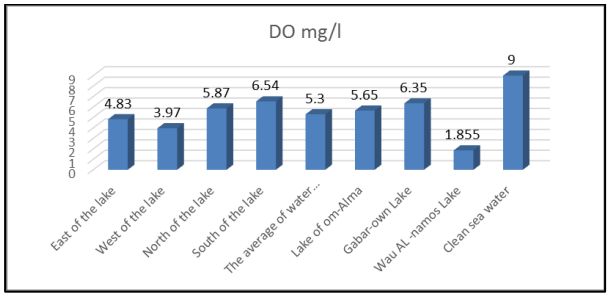

Figure (5): shows the concentration of dissolved oxygen in the study area

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4.1.5 Total Dissolved Salts: The results of the study were recorded as shown in Figure 6. The water surface of Anaba has a general average of 4907.2 mg/l.

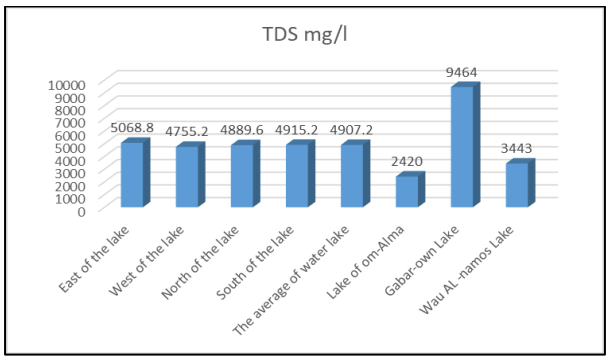

Figure (6): shows the concentration of total dissolved salts in the study area

4.1.6 Chloride: The results of the study are shown in Figure No. 7. Convergent values of chloride concentrations in various directions inside the lake with a general average of (29.5) mg/liter

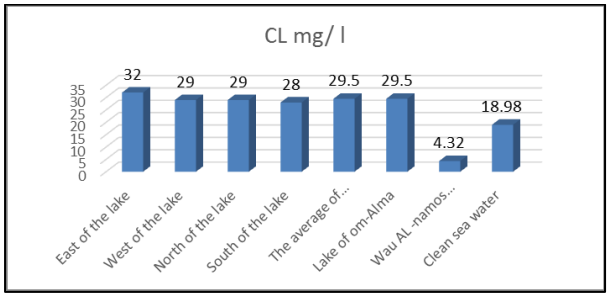

Figure (7): shows the concentration of chloride in the study area

4.1.7 Sodium: The results of the study are shown in Figure No. 8. Differences in the concentration of the sodium element from (6.51) mg/liter to (8.61) mg/liter in both the south and west of the lake, respectively, have a general average of (7.77) mg/liter,

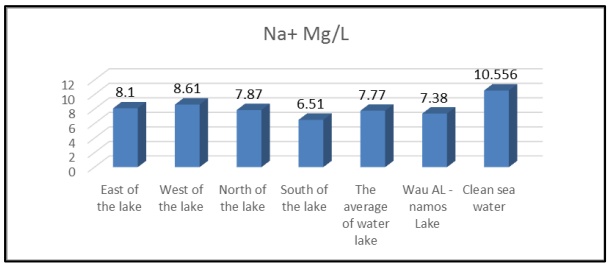

Figure (8): shows the sodium concentration in the study area

4.1.8 Potassium: Potassium in the different directions of the lake water in both the south and west of the lake is (0.545) and (0.841) mg/liter, respectively, with a general average of (0.716) mg/liter,

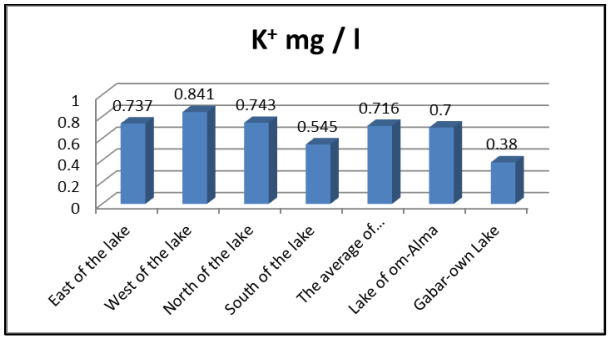

Figure (9): shows the concentration of potassium in the study area

4.1.9. Phosphates: The results of the study, as shown in Figure No. 10, showed clear variations and differences in the concentrations of phosphate ions in the water of Lake al-Anaba, where the water in the west of the lake recorded the lowest reading compared to the east of the lake (4.29) mg/liter and (7.35) mg/liter, respectively, with a general average of (5.28) mg/liter.

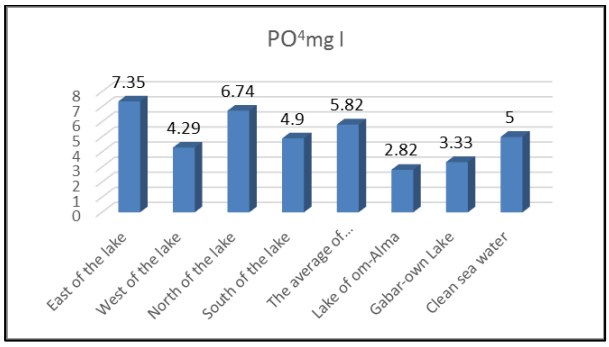

Figure (10): shows the concentration of phosphate in the study area

4.2 Specific Characteristics of Plants Around the Lake: Plant samples were taken from each site, collected, and classified according to their species, according to the classification found in the series of Libyan Flora books. The dominant plant on the study site is the reed plant. Along with this plant, there are other plants, some of which are densely distributed, some of which are mediumly distributed, and some of which are found in small numbers. The plants that are found on the study site are:

A- Cymbopogon Citratus plant: a perennial plant, the stem is an unbranched, smooth rhizome, with equal leaves, tapering at the tip, the inflorescence is compound, it has two unequal stems and the lower brachial is longer than the two stems. It blooms during summer and spring, and it is one of the semi-submersible plants belonging to the Poaceae family.

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This is distinguished The plant grows in shallow and moist areas.

B-Pinus halepensis is a large perennial tree, reaching a height of (11-16 meters), the stem is smooth, with a pale green or gray color, and the leaves are very small and serrated, with a sheath of (1.5-2 mm) long. Bleached pink, blooms from (8-11) months. This plant belongs to the Tamari cacao family. It is considered one of the plants that tolerate salinity and stabilize sand dunes.
C- A triplex halimus : plant: has a creeping or oblique rhizome stem, its length is (40-150 cm), devoid of hairs, i.e. the stem is smooth and covered at the base with a sheath leaf, the leaves are flat tapering with a ribbon blade and a dense peripheral inflorescence, the spike is semi-clustered, compound, the length of the spikes is (5-6).

D- Phoenix dactylifera: perennial trees with a stem that reaches a height of 40 meters. The old leaves are protective and located at the bottom of the tree. As for the leaves and flowers, they are found at the top, while the leaves at the top are smooth green in color, reaching a height of (30-50 cm), petiolate, feathery, and containing thorns. The fruits are a drupe that blooms during the months of 4 and 5. This plant belongs to the Plamceae family.

E Ziziphus Christi plant: a relatively small shrub with a length of 40 cm. It has very small leaves and stores water in large quantities. It has yellow flowers and very small seeds. Its roots are thin and not very deep.

F- Rhus ascendance plant: a juicy plant that stores water mainly in the leaves and in the stems that grow in the ground. (Ivanova, 2018) & (Ivanova, 2015).

4.3 Quantitative Characteristics of the Vegetation Around the Lake:

Vegetation density and diversity were calculated and determined and vegetation abundance and frequency were estimated for all species We find that the A triplex halimus plant is prevalent on the northern side of the lake and is the highest frequency, density, and abundance, than Phoenix dactylifera and Pinus halepensis, while we find that the Cymbopogon Citratus plant is prevalent in the southern side Followed by each of the A triplex halimus and Phoenix dactylifera and we find that the A triplex halimus plant is the only plant was dominating in the western side, and the study showed that the plant A triplex halimus, Cymbopogon Citratus plant and Pinus halepensis are the most frequent and dense in the eastern side as shown in figures (11) (12) (13) (14)

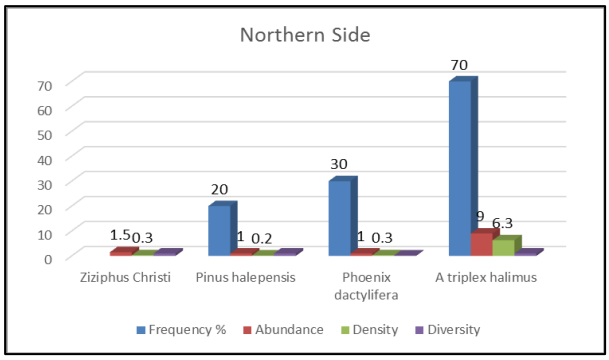

Figure (11): shows the Qualitative and quantitative characteristics of the plants of the northern side

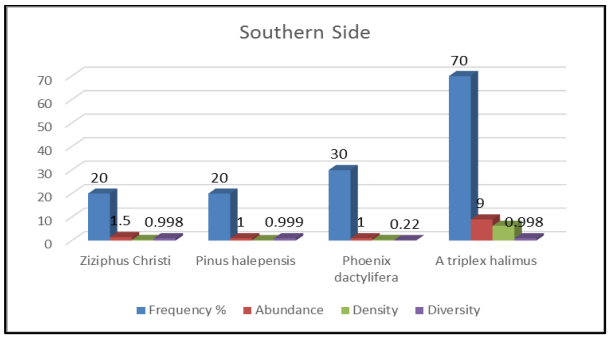

Figure (12): shows the Qualitative and quantitative characteristics of the plants of the southern side

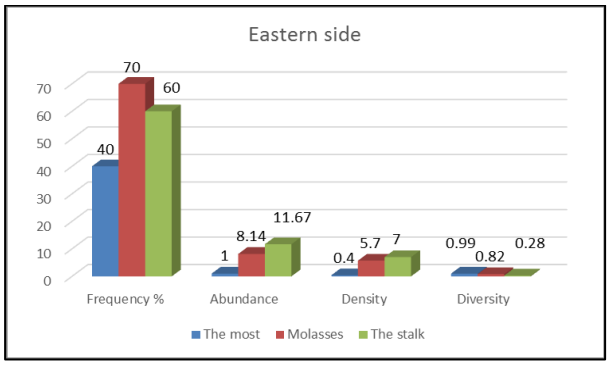

Figure (13): shows the Qualitative and quantitative characteristics of the plants of the eastern side

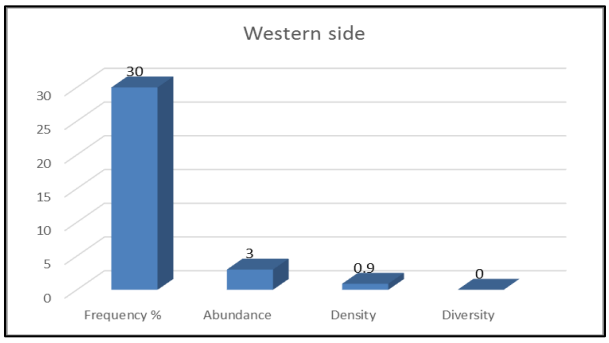

Figure (14): shows the Qualitative and quantitative characteristics of the plants of the western side.

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E. Species and aquatic and non-aquatic organisms around the lake:

The western and eastern sides of the water surface of Lake Al-Anaba recorded the presence of brine shrimp, a crustacean animal that lives in the salt water of the type Artema salina, which is a primitive gill-legged crustacean (Branchiopoda) without a shell, while the western side recorded the highest number density of brine shrimp, which amounted to (50 individuals / 5 Liter) and from the eastern side, (20 individuals / 5 liters) were recorded. As for the southern and northern sides, no individuals were recorded. The results showed the presence of some birds, sparrows, and sea geese, but in very few numbers, and the presence of mosquitoes in a large number.

4.4 Human Activities Around the Lake:

It was observed that there was waste dumped around the lake from the northern side, and this indicates that visitors stay on this side of the lake. From the lake, there are paths heading from the top to the inside of the lake, as well as the presence of car tires near the edge of the lake on the southern and western sides, which explains the reason for the decrease in vegetation cover in it.

5 Discussion

5.1 Physical and Chemical Properties of the Lake Water

Temperature: The water temperature is one of the specific environmental factors affecting the water environment. The temperature in the water is affected by the different depths and locations relative to the latitude circles. The change in temperature leads to changes in water masses and their circulation, which has a significant impact on aquatic life (Al-Saadi 2009). and compared to the general average temperature of other desert lakes, its rates were lower (15.6), especially Lake Waw al-Namos, which has a natural nature. The hot volcanic temperatures reached 24 degrees Celsius (Hatoua, *et al* 1996). and these results are consistent with the studies of (Al-Mukhtar, *et al* 2002) and (Nino Ambarak *et al* 2021). (17), (16), respectively.

The pH value is affected by many components, such as the bottom soil, the shape of the water basin, the temporary water content of gases and ions, and the presence of aquatic plants. Low and high pH values harm the growth rates and fertility of aquatic organisms. Fluctuations in the pH values are large and clear during the hours of the day. The pH suitable for living ranges from 5.5 to 10, and the most productive water is low-alkaline. (Mihir Pal, *et al* 2015) & (Al-Saadi 2009). meaning that the alkaline water is not much different from Lake Qabroun (9.7), and its rates are higher than Lake Waw an-Namos, Umm al-Maa, and Clean Sea Water (8.5), (7.5), and (6), respectively. These results agree with the studies of (Al-Mukhtar, *et al* 2002) & (Nino Ambarak *et al* 2021). (9.7) and (7.5), respectively

Electrical Conductivity Salinity is expressed by the amount of conductivity, which is the sensitivity and ability of water to electrical conductivity. It is characterized by the dissolved ionic concentrations in it and the quality of these ions. That is, the increase in the concentration of the percentage of these ions means an increase in their electrical conductivity. (Florence, *et al* 2012). The general average of the conductivity values in Lake al-'Anaba reached 76.72 ds/m^2, which is lower than the value recorded in Lake Qabroun (133.84 ds/m^2) and higher than the lakes of Waw an-Namos and Lake Umm al-Maa (53.8 ds/m^2) and (37.83 ds/m2), respectively. These results differ with the studies (Nino Ambarak *et al* 2021) & (Al-Saadi 2009). (133.8 ds/m^2) and (37.83 ds/m2), respectively.

Dissolved oxygen values are affected by several factors, including the abundance of aquatic plants, wind speed, and water currents, all of which lead to an increase in the solubility of oxygen in the water. There is an inverse relationship between dissolved oxygen and temperature(Al-Manhrawi, 1997). The values obtained are much higher than the value recorded in Lake Waw Al-Namous and much lower than the permanent oxygen in clean seawater (1.855) and (9) mg/L, respectively. These results are consistent with studies (Goldsmith, *et al*. 2016) & (Jaing.S; *et al* 2004). (6.35) and (5.65), respectively

Total dissolved Salts: Salinity is one of the environmental factors with large and important fluctuations affecting the distribution and spread of aquatic organisms and determining the size of the biological community. The types and numbers of organisms in the water differ according to the salinity. Salts enter the freshwater environment through groundwater from the erosion of rocks in the air and are transmitted by wind and rain (Drake, *et al* 2008) & (Ivanova, 2015). The concentration of salts in the water of Lake Anba is higher than the water of Lake Umm al-Ma and lower than the concentration of salts in Lake Qabroun (24.2) and (94.64) mg/L, respectively. These results differ from studies (Grasshoff 1976), (Nino Ambarak *e .al* 2021), and (Shen, *et al* 2017) (94.64 mg/L) and (24.2 mg/L), respectively.

Chloride It is an increase in the concentrations of elemental chloride in clean seawater and Lake Waw an-Namos (18.98) and (4.32) mg/l, respectively. These results agree with the study (Al-Mukhtar, *et al* 2002) & (Al-Salawi, 1989). (29.5 mg/th and in surface waters in the form of sodium chloride, potassium, and calcium Al-Matmani M.N (2010). and the results of the study

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are shown in Figure No. 7. Convergent values of chloride concentrations in various directions inside the lake with a general average of (29.5) mg/liter It is an increase in the concentrations of elemental chloride in clean seawater and Lake Waw an- Namos (18.98) and (4.32) mg/l, respectively. These results agree with the study (Al-Mukhtar, *et al* 2002) & (Al-Salawi, 1989). (29.5 mg/L), and differ from the study Al-Matmani M.N (2010). (4.32 mg/L).

Sodium The concentration of sodium in the water of Lake Anba is slightly higher than the concentration of sodium in Lake Waw Al-Namous (7.38) mg/L and less than the concentration of the element in clean sea water (10.556) mg/L. These results are consistent with the study of Al-Matmani M.N. (2010) and (Al-Saadi 2009) (7.38) mg/L.

potassium is found in lower concentrations than sodium in water (Ivanova, 2018) & (Ivanova, 2015).The concentration of potassium in the water of Lake Anba does not differ from the concentration in Lake Waw Al-Namous (0.700) mg/L and an increase in the concentration of the element in clean sea water (0.38) mg/L. These results are consistent with studies (Al-Mathani 2010) and (Al-Mukhtar *et al*. 2002) 0.716 mg/L and 0.7 mg/L, respectively.

Phosphate slightly soluble in water. Phosphate derivatives are used in the form of phosphate fertilizers. (Mara'I, 2003).Phosphate concentrations are high compared to clean sea water, Lake Qabroun and Umm El Maa (5) (3.33) and (2.28) mg/L, respectively. These results are consistent with studies (Al-Mukhtar *et al.* 2002) and Embarek *et al*. 2021) (3.33) mg/L and (2.82) mg/L, respectively.

5.2 Specific and Quantitative Characteristics of the Vegetation and the Lake

There is a diversity of vegetation, namely (reeds, palm trees, tamarisk, damran, and marsa). The reed plant was the most widespread and abundant due to its competitive ability and resistance to environmental conditions and the characteristics of the roots that enabled it to crawl towards the lake waters, in addition to the fact that the environmental conditions are considered more suitable for this plant. (Faraj 2018)

6 Discussion

Species and aquatic and non-aquatic organisms around the lake:

The presence of animals that live in and around the lake, namely birds, is an indication of their high resilience and resistance to harsh environmental extremes. (Faraj 2018) In addition to the presence of Artemia, studies have indicated that Artemia is found in salty water bodies and its presence is considered a vital indicator of the presence of bacteria and phytoplankton as its preferred food, and this is consistent with (Ivanova 2018).

6 Conclusions and Recommendations

6.1 Conclusions

Through a study of Lake al-Anaba, the following conclusions can be drawn:

- The ecosystem in Lake al-'Anaba is characterized by special chemical, physical, and biological characteristics and is exposed to many changes for environmental and human reasons in its water surface, vegetation, and terrestrial surroundings.

The characteristics of the water in the lake indicate that it has high conductivity, which indicates high salinity due to the high concentrations of total dissolved salts (TDS), accompanied by the presence of concentrations of nutrients such as phosphates, which contribute to nutritional enrichment and accelerate environmental succession processes, as well as the effect of dissolved oxygen and its role on organisms. Aquatic living.

- The high rates of sodium and potassium in the water are evidence that the water contains these elements, resulting from the geology of the rocks under the lake and their impact on the life of living organisms and their life cycle.

- The pH was high, evidence of the alkalinity of the lake water, which provides a suitable environment for the living organisms and algae that live in it. The lake was called the grape because of its different color during the seasons of the year, as is the case in the color of grapefruits from birth to maturity, which may be due to the quality of algae and the biodiversity within the water. the lake

- The vegetation cover was characterized by a limited diversity, where the existing species were (reeds, dais, palm trees, tamarisk, damran, and anchoring).

- The vegetation extends around the lake (20 m) and the reed plant was the most dominant due to its competitive potential and rhizome characteristics that enabled it to crawl towards the lake water.

- It also found living animal organisms, and this ecosystem was characterized by the presence of animal species, the most important of which are birds. During the study, the presence of artemia was observed, and

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this gives an indication of the effect of nutrients and dissolved oxygen, which is considered to have a specific role in its life cycle and its adaptation mechanism.

- There are many negative effects of human activities around the lake, represented in the pollution of the lake's surroundings with waste and the destruction of vegetation cover, all of which contribute to accelerating the occurrence of the succession process, which in turn contributes to the disappearance of the lake with what it represents as an environmental, cultural, and touristic landmark.

6.2 Recommendations

Continue to study the physical and chemical properties of the water in the southern lakes on a regular and continuous basis.

Carrying out an extensive study of the environmental community of the benthic lake because of its important role in preserving and reducing the growth of the benthic lake. Tightening and activating measures to protect the lake from all manifestations of encroachment on it, such as practices of deliberate burning of vegetation cover and other manifestations of vandalism.

Develop a scientific plan to stop the encroachment of plants and weeds into the lake.Making suitable paths for going down to the lake water, including the lack of movement of sand towards the lake water studying the climatic environmental factors and establishing a meteorological station around the lake to track climate changes in the lake because climate changes greatly affect the continuation of the lake and the preservation of its presence.

Conflict of Interest: The authors declare that there are no conflicts of interest.

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