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Bathymetric survey of the bottom of Al-Khasa Dam Lake - northeast of Kirkuk, Iraq

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Abstract
Water is the backbone of human, animal, and plant life, and its presence in certain quantities is a necessity required by economic and population growth. Ancient civilizations were concentrated in areas where water is present, such as springs and rivers.
A problem that exists in many dams in Iraq, especially in the northern regions (Al-Mamoori *et al*., 2019) [2], has been studied by Iraqi researchers. This problem is that some of the water evaporates or seeps into the soil, affecting the amount of water remaining in the lake (Jassim & Goff, 2006) [8].
Al_khasa dam lake, located northeast of Kirkuk city, is an important water collection site in this region. The dam was built to store rainwater and control floods, as well as to provide water for agriculture and other uses.
It aims to study and measure the depths of various water bodies, such as lakes, rivers, seas, and oceans. This type of survey provides a comprehensive understanding of the topography of the water body's bottom and helps create accurate three-dimensional topographic maps of submerged areas (Philip *et al*., 1992) [10].
The current study examines the bathymetry of a particular lake and surveys the lakebed within the lake at depths of 15-30 microns. It found that the depths in the southeastern part are greater than those in the western part of the lake.
This which indicates that this area represents the main course of the river valley before the construction of the dam. Also, the close proximity of the isobath lines on the eastern side indicates the presence of a steep bank, while the plans on the western side represent a more gentle gradual slope. This geomorphological contrast reflects a difference in the rock composition and geological structure of the layers composing the two sides of the valley (Werdy, 1997). The northeastern bank shows characteristics that are less resistant to erosion and weathering factors, compared to the southwestern bank. Contrasting between the two banks of the lake.

Keywords: Bathymetric, Geometric, Lake, Geology, Dam- survey

1. Introduction
1.1 Preface
Water is the backbone of human, animal, and plant life, and its presence in certain quantities is a necessity required by economic and population growth. Ancient civilizations were concentrated in areas where water is present, such as springs and rivers.
A problem that exists in many dams in Iraq, especially in the northern regions (Al-Mamoori *et al*., 2019) [2], has been studied by Iraqi researchers. This problem is that some of the water evaporates or seeps into the soil, affecting the amount of water remaining in the lake (Jassim & Goff, 2006) [8].
Al_khasa dam lake, located northeast of Kirkuk city, is an important water collection site in this region. The dam was built to store rainwater and control floods, as well as to provide water for agriculture and other uses. The aim of constructing the dam is to enhance the groundwater in the region and to improve the environment in this region in terms of attracting tourists and developing fish wealth and to secure drinking water for the northeastern part of the city of Kirkuk to cover the needs of (50) thousand people as well as to protect the city of Kirkuk from the dangers of floods and to add a storage annex to the reservoir of the Great Dam to release it when needed.

1-2 The aim of the study
The aim of the study is to conduct a geometric analysis of the lakebed to determine the shape of the lake using a bathymetric survey. This study is the first to calculate the lake's geometry.

2. Study Area and Methodology
2.1 Location of the study area for the Al_khasa lake dam
The study area is located northeast of Kirkuk Governorate, with coordinates of latitude (35°33′30″N) and longitude (44°28′30). It occupies an area of approximately 420 km². The study area is approximately (21) km from the center of Kirkuk city.

The study area is bordered to the north and northeast by the northern Jamjamal Fold, to the northwest by the Shwan Sub-Basin, and to the west by the Khasah Dam (Al-Ghuburi, 2020) [1].

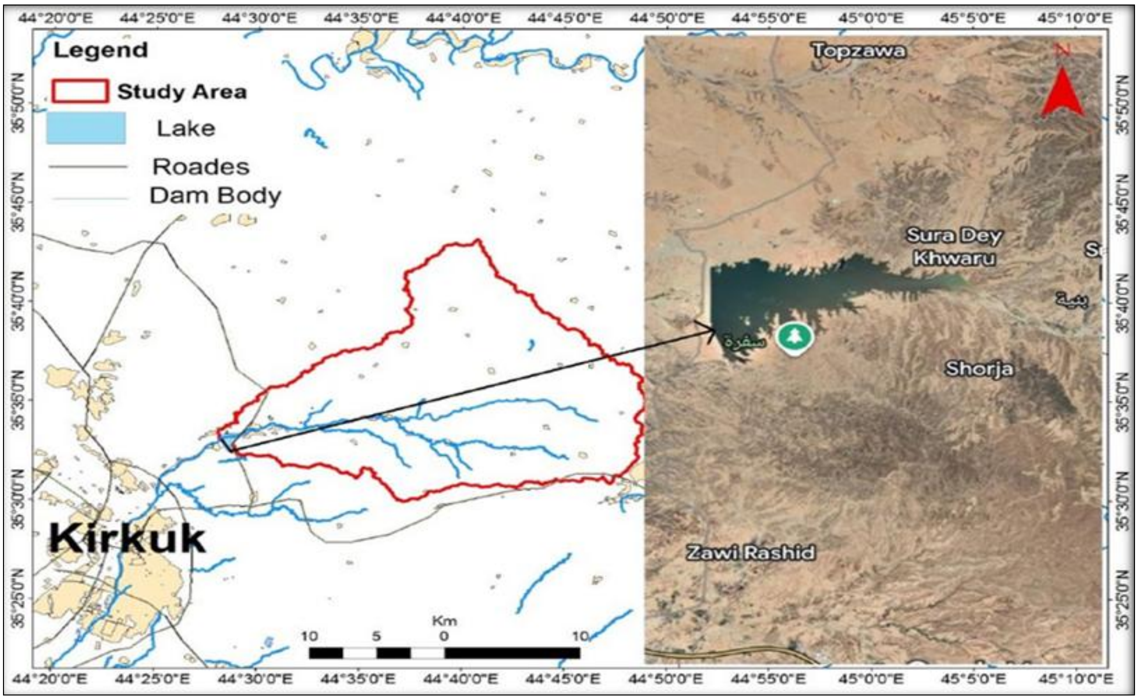

Fig 1: A map showing the location of the lake and the dam in relation to Kirkuk Governorate.

2.2 Geology of the study area
Many geological formations are prominent within the study area, covering the region within a different topographic and geomorphological range. All of these formations belong to the Tertiary and Quaternary periods, which extend from the Miocene to the Pleistocene - Holocene. In general, the oldest rocks appear on the edges of the basin in which the study area is located, while modern sediments covered the middle of the basin.

2.3 Stratigraphy of the study area
The study area consists of several geological formations and the following is a description of these formations (Sissakian, V.k, 1992).

2.3.1 Injane Formation (Late Miocene)
The Injana Formation (Upper Fas) is part of the Tertiary geological age, and its stratigraphic location indicates an Upper Miocene age (Al-Naqib, 1959). It consists of mudstone, siltstone, and sandstone in the study area (Sissakian & Al-Jiburi, 2012) [12]. However, according to (Sissakian *et al*., 2017) [12], the thickness of the formation is 398 meters. According to (Kassab and Jassim, 1980) [9], the Injana Formation contains less information than the Muqaddadiya Formation. The Injana Formation comprises 0.94 square kilometers (0.223%) of the study area.

2.3.2 Muqdadiya Formation (Late Miocene-Pliocene)
The Muqdadiya Formation (Lower Bakhtiari) is considered to have formed during the Tertiary geological period. Using the stratigraphic location, deposits of pebbly sandstone, siltstone, and mudstone were found in the study area (Jassim *et al*. 1984) [7] (Al-Rawi *et al*. 1992) [4]. The thickness of the formation is 456 meters (Sissakian *et al*., 2017) [12]. The Muqdadiya Formation covers an area of 30.59 square kilometers (7.26%) of the study area.

2.3.3 Bai Hassan Formation (Pliocene-Pleistocene)
Using stratigraphic location, the Bai Hassan Formation (Upper Bakhtiari) was identified as belonging to the Pliocene-Pleistocene, a Tertiary geological epoch (Jassim *et al*. 1984) [7] and (Al-Rawi *et al*. 1992) [4]. The Bai Hassan Formation consists of sediments that include sandstone and mudstone found in the study area (Jassim *et al*. 1984 and (Al-Rawi *et al*. 1992) [7, 4]. The thickness of the formation is (790) mm, and the study area comprises (354.74) square kilometers (84.46%) of the Bai Hassan Formation.

2.3.4 Quaternary (Middle Holocene)
This period is represented by the Quaternary sediments found in the research area. It is characterized by slope deposits containing fine clastic rock fragments, multiple deposits containing silty clay soils, and river terrace deposits with sandstone and mudstone. Quaternary sediments constitute 10% of the research area, equivalent to 12,272 square meters (Sissakian, 1992) [11].

2.4 Tectonic and structural study area
According to the classification made by (Buday and Jassim 1987) [6], in which the area was separated into a high folded

zone and a foothill zone, the research is located within the unstable platform on which tectonics continues in the area. (Bolton, 1958) was the first to propose a foothill zone by virtue of (Doski and Ahmad, 2016).

2.5 Geomorphology of the Study Area
Rainfall is the sole source of water in the study area, falling annually during the winter and spring seasons. The area is characterized by a dendritic drainage system, named after the Greek word for "dendritic pattern" (dendron). The drainage pattern often tapers from the highlands toward the main river, or from the north and northeast to the western part of the study area. Weathering and erosion are also widespread in this area, significantly affecting the region. Sheet erosion affects almost all flat areas covered with various sediments. The degree of weathering varies depending on the rock types, and due to the diverse rock types present within the area, all degrees of weathering are present (Sissakian, 1992) [11].

2.6 Topography of the Study Area
The study area contains several small valleys that flow into the main stream. Part of the surface water flows from the higher elevations in the north to the western part of the area, while the other part flows from the northeast of the study area to the western part, where the two sections of the valley meet at coordinates (3936202 East, 464719 North) near the dam.

3. Bathymetric survey of the lake bottom
Bathymetric surveying is one of the most important scientific techniques used in water sciences and hydrology. It aims to study and measure the depths of various water bodies, such as lakes, rivers, seas, and oceans. This type of survey provides a comprehensive understanding of the topography of the water body's bottom and helps create accurate three-dimensional topographic maps of submerged areas (Philip *et al*., 1992) [10]. The topographic sections were derived from the digital elevation model of the proposed reservoir at an elevation of (497-442) m above sea level, since the section at this level can give an image of the rest of the elevations in the same geographical location. The map shows an inhomogeneous distribution of elevations, which reflects the geomorphological complexity of the original water basin. While we find that the depths of the lake range between (5-35) m, and the deep areas are concentrated in the eastern part of the dam with a sharp gradient towards the west, which indicates that this area represents the main course of the river valley before the construction of the dam. Also, the close proximity of the isobath lines on the eastern side indicates the presence of a steep bank, while the plans on the western side represent a more gentle gradual slope. This geomorphological contrast reflects a difference in the rock composition and geological structure of the layers composing the two sides of the valley (Werdy, 1997). The northeastern bank shows characteristics that are less resistant to erosion and weathering factors, compared to the southwestern bank. Contrasting between the two banks of the lake.

This process was conducted using a (HONDEX) (EchoSounder). A (GPS) was also used to determine the coordinates of the start and end points of each path. It was also used to determine additional coordinates, which were later used with other data, including depths, to draw cross-sections and longitudinal sections and a contour map of the Al_Khasa dam lake. To conduct the survey of the reservoir bottom, a boat was used, traveling at a constant speed. Modern satellite imagery was also used to determine the paths to be followed during the survey. (7) paths were identified, the purpose of which was to cover the private dam lake almost completely. After the paths were identified, the survey was conducted. Several programs were used, including Grapher v8.0 for drawing only graphical figures, such as cumulative frequency curves, and Global Mapper v13.0 for plotting locations on the map. By identifying landmark points on the sides of the lake, Figure (1) shows various points and the names of survey lines. Cross and longitudinal sections were then drawn. The cross and longitudinal topographic sections of the reservoir bottom are very important in studying the geometric characteristics of the reservoir. The cross sections provide an idea of the reservoir's width and the variations in its depths relative to the banks. The longitudinal section, on the other hand, provides an idea of the variations in depth between the upstream and the dam.

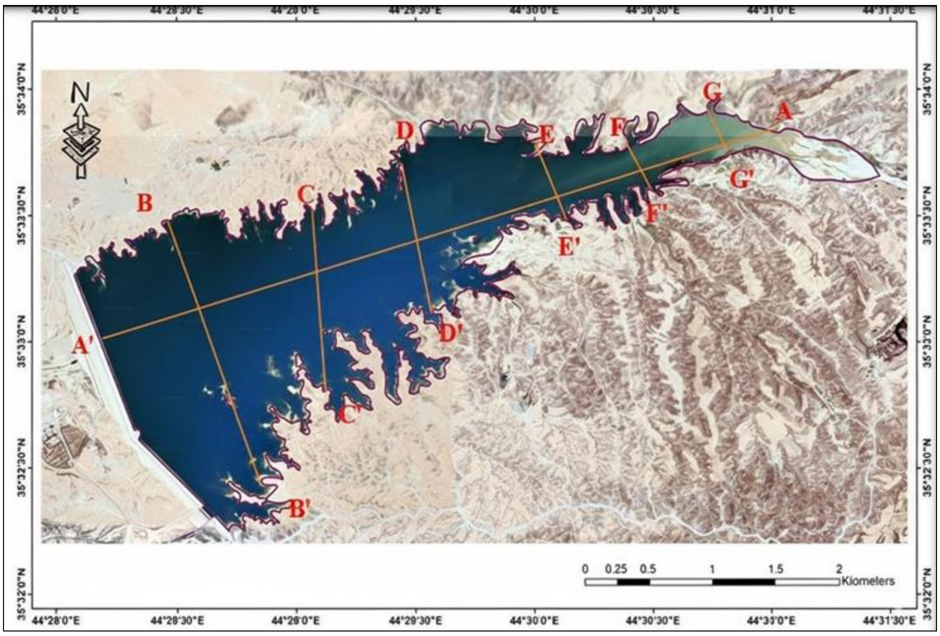

Fig 2: Locations of the seven sections on the lake map

4. Results and Discussion

The topographic sections indicate a fluctuation in the depth of the reservoir from one location to another, and that the depth on the northern bank is less than on the southern bank along the main part of the reservoir. This can be seen in Figure (2) and the three-dimensional figure (3), which were drawn based on bathometric survey data for the bottom of the lake reservoir.

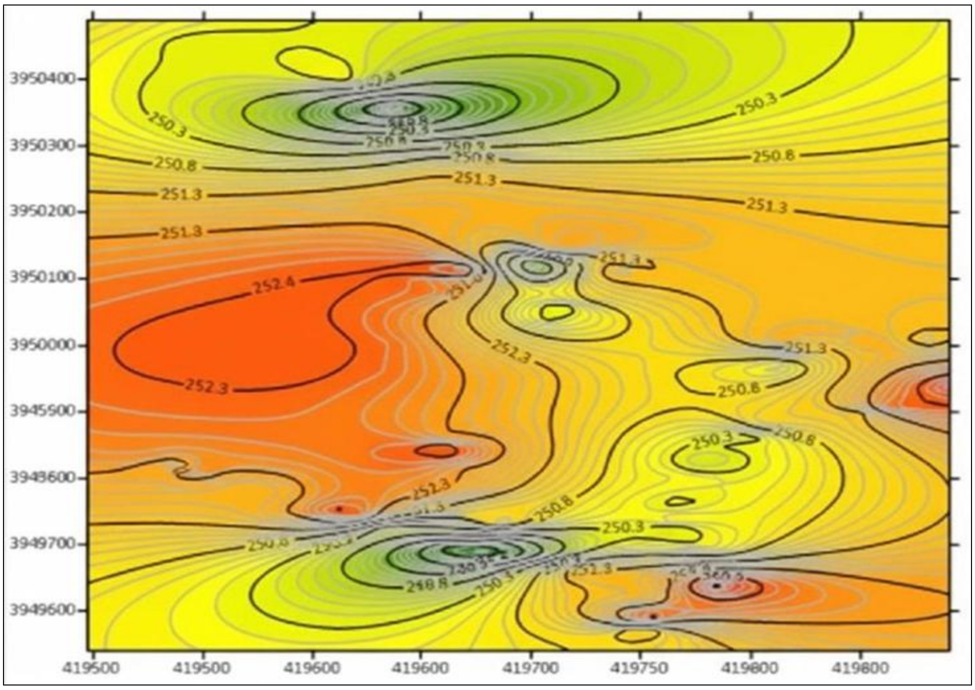

Fig 3: Equal-depth map of the bottom of the reservoir of the Special Dam using the SURFRE program

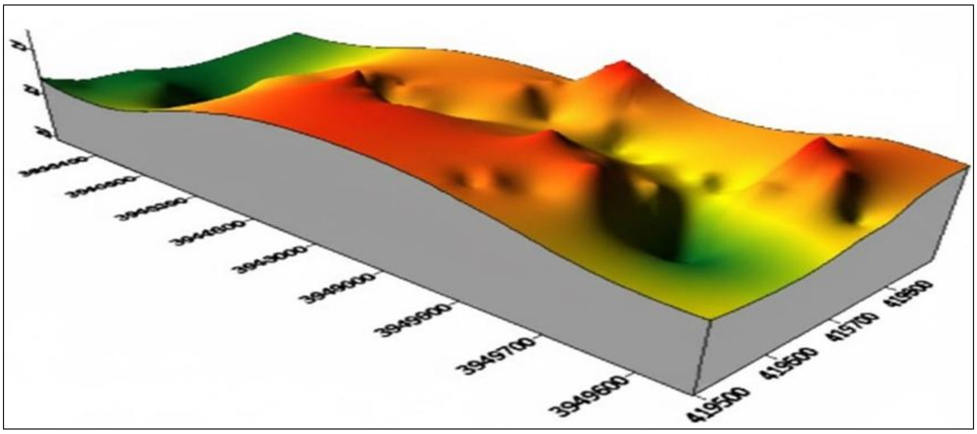

Fig 4: A three-dimensional model of the bottom of a special dam reservoir using the SURFRE program.

The slope of the river bed along this distance is evident in the first longitudinal section (A-A) in Figure (4). The length of the section is 90 meters, and the depth of the water at the deepest point reaches 35 meters on the eastern side of the reservoir. Then the depth begins to fluctuate between (5-30) meters at a distance of 50 meters from the eastern bank of the reservoir. Then the fluctuation decreases and is between (3-20) meters at a distance of (50-10) meters. Then the depth increases to 30 meters on the western bank. The fluctuation in depth at this section is due to the topography of the study area.

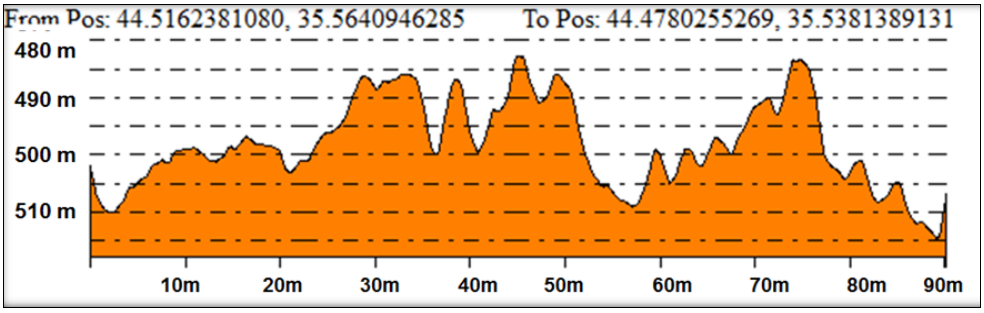

Fig 5: Longitudinal section (Á-A) based on the Gloppal Mapper program

As for the second section(B-B'), Figure (5), which is (1) km away from the dam body, and in the widest area of the lake's width, the length of the section reaches (60) m. It is noted that the depth is small at the edges, but it is deep on the northern bank, as it gradually increases to reach (35) m, which is the greatest depth at a distance of (15) m from the southern bank of the reservoir.

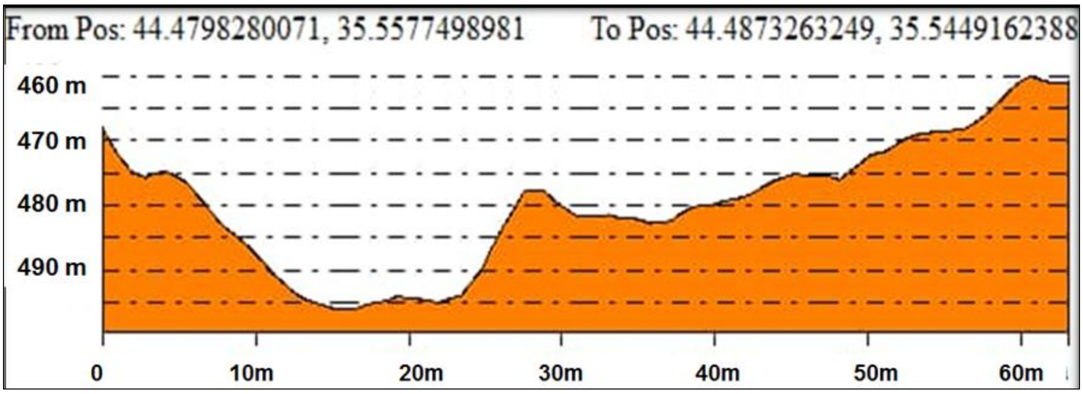

Fig 6: The second cross section (B-B'), based on the Gloppal Mapper program

The third cross-section (C-C), Figure (6), reaches a length of 50 m, and is similar to the cross-section (B-B'), but the northern bank is less deep than the southern bank, as the depth gradually increases to reach (28) m, which is the greatest depth at a distance of (20) m from the northern bank of the reservoir.

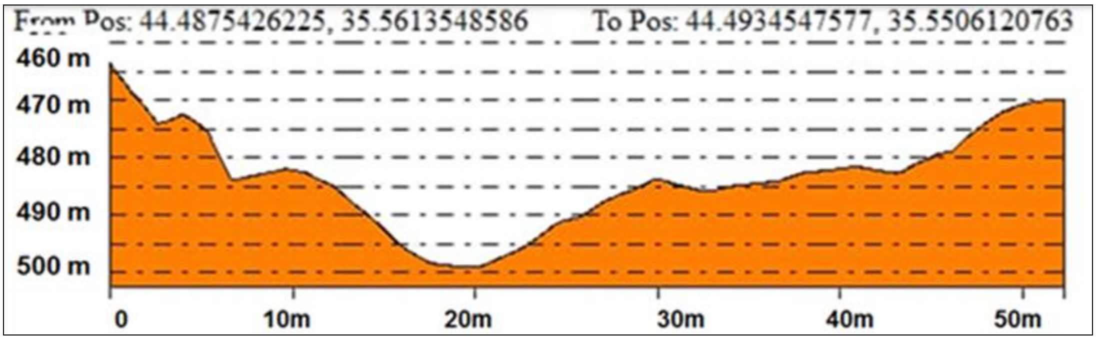

Fig 7: The third cross section (C-C) based on the Global Mapper program

In the fourth cross-section (D-D) Figure (7), the length of the section is (60) m, the depths are low at the edges of the cross-section, and the depth increases gradually to reach (35) m at the deepest point, which is closer to the southern bank of the lake reservoir.

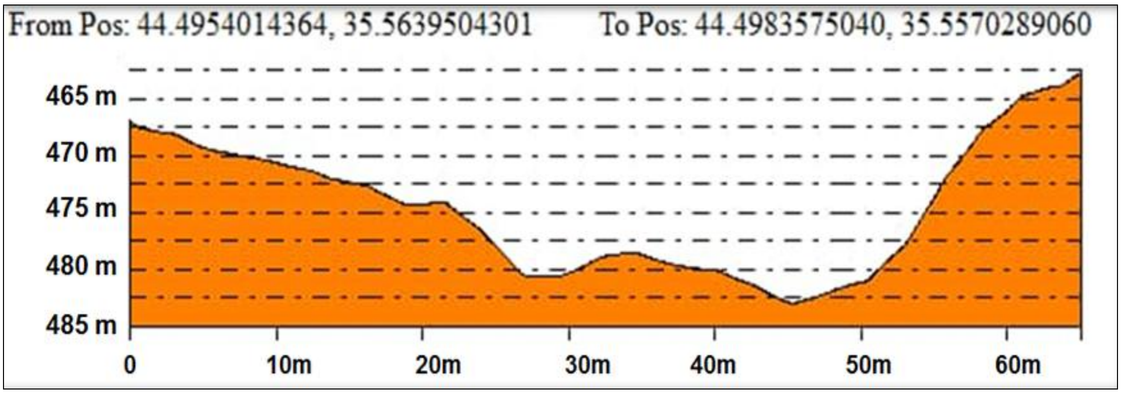

Fig 8: The fourth cross section (D-D) based on the Global Mapper program

As for the fifth cross-section (E-E) Figure (8), the length of the section reaches (80) m, and it continues to deepen in the middle compared to the edges of the lake reservoir, and the deepest point reaches (25) m, and also the southern bank is less deep than the northern bank of the lake.

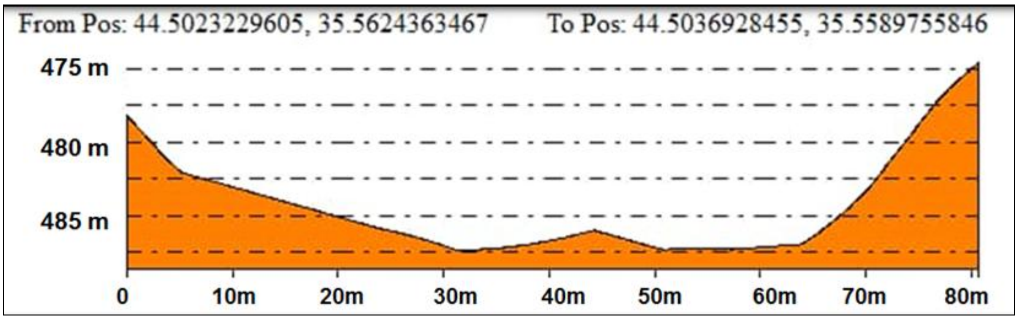

Fig 9: The fifth cross section (E-E) based on the Global Mapper program

As for the sixth cross-section (F-F) Figure (9), which represents the narrow areas of the lake reservoir, the shape of the lake bottom continues to deepen in the middle of the section, while the edges are less deep, and the deepest point reaches (30) m, and in this section the southern bank is still less deep than the northern bank of the lake reservoir.

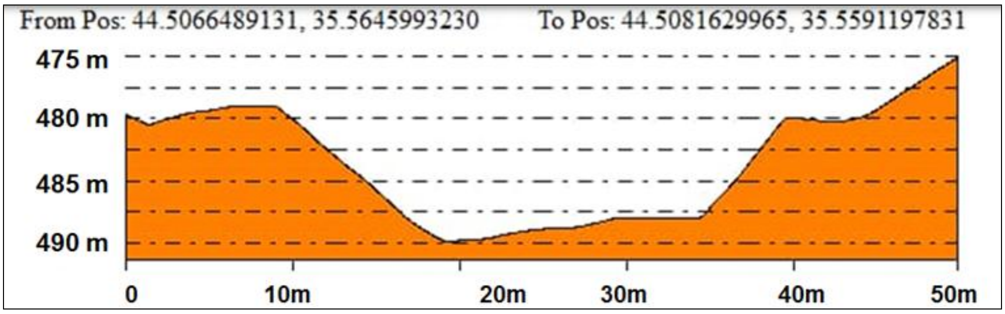

Fig 10: The sixth cross-section based on the Global Mapper program

While the seventh section (G-G) reflects Figure (10), the length of the section reaches (60) m, and here it is noted that the depths of the reservoir decrease to reach (16.5) m at the deepest point, in addition to the fact that the southern bank becomes less deep than the northern bank.

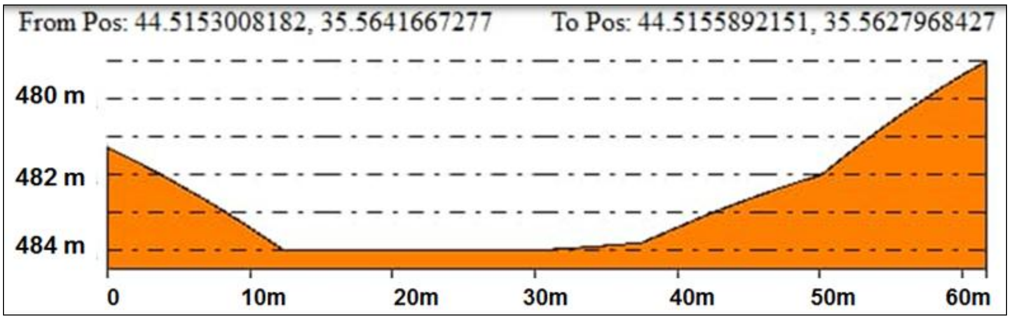

Fig 11: The seventh longitudinal section (G-G) based on the Global Mapper program

5. Conclusions and recommendations

Through a geometric study, it was concluded that the lake's size and levels are not significantly different, and the depth on the eastern side of the lake is essential for the western side. This is due to the water velocity, where fine sediments accumulate at the bottom of the lake on the eastern side. Through a study of the lake's basic geometric characteristics, it was determined that the lake is a special, branched, and elongated artificial dam lake with its own circulation. Through this study of its dam lake, and based on the information discussed and the indicators provided by these studies on the geology of the lake's water, the requirements were formulated, enabling us to gain confidence in the importance of the new relationships between the reservoir and the lake's superstructure. It is necessary to conduct a precise triangular thalweg survey using an Eco Sounder device, and we learned about the change in the lake's commercial capacity.

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References

1. Al-Ghuburi MRG. Groundwater vulnerability and risk assessment of upstream Al-Khassa Dam Sub-basin, Kirkuk/NE Iraq [Master's thesis]. Kirkuk: College of Science, University of Kirkuk; 2020.
2. Al-Mamoori SK, Abdulrahman SH, Ali NS. Sedimentation problems in dams in Iraq. Iraqi Journal of Civil Engineering. 2019;13(2):44-55.
3. Al-Naqib KM. Geology of southern area of Kirkuk Liwa, Iraq. Tech. Publ., Iraqi Petroleum Company Ltd. 1959;50 p.
4. Al-Rawi YT, Sayyab AS, Al-Jassim JA, Tamar-Agha M, Al-Sammarai AHI, Karim SA, Hagopian D. New names for some of the Middle Miocene-Pliocene formations of Iraq (Fatha, Injana, Mukdadiya, and Bai Hassan formations). Iraqi Geological Journal. 1992;25(1):1-7.
5. Bolton C. Geological map, Kurdistan series, sheet 4 (Rania). Site Investigation Company. 1958;(276).
6. Buday T, Jassim SZ. The regional geology of Iraq: Tectonism, magmatism and metamorphism. Vol. 2. Geological Survey and Mineral Investigation, Baghdad; 1987. 352 p.
7. Jassim SZ, Karim SA, Basi MA, Al-Mubarak M, Munir J. Final report on the regional geological survey of Iraq. Vol. 3: Stratigraphy. GEOSURV Internal Report. 1984;(1447).
8. Jassim SZ, Goff JC. Geology of Iraq. Ministry of the Czech Republic and Heritage Oil Company; 2006. 345 p.
9. Kassab IIM, Jassim SZ. The Regional Geology of Iraq. Baghdad: General Directorate for Geological Survey and Mineral; 1980.
10. Philip G, Eweida E, Al-Gamal S. Quantitative geomorphology of some watersheds in Wadi Qena in relation to basin hydrogeology. In: Proceedings of [unspecified publication]; 1992. p.159-164.
11. Sissakian VK. The Geology of Kirkuk Quadrangle Sheet NI-38-2, scale 1:250000. Baghdad: GEOSURV; 1992.
12. Sissakian VK, Al-Jibouri BS. Stratigraphy of the low folded zone. Iraqi Bulletin of Geology and Mining. 2012;(5):63-132.
13. Werdi SN, Allah NS. Hydrological and sedimentary study of Lake Habbaniyah [Master's thesis]. Baghdad: University of Baghdad; 1997. 117 p.

Appendices

Below is the data for the seven tracks surveyed by the lake bottom bathymetric survey.

First track			
Depth	**Depth from sea level**	**Y**	**X**
1.5	252	3549831	449522
1.9	251.6	3549820	449537
1.4	252.1	3549811	449548
1.8	251.7	3549800	449561
2	251.5	3549786	449577
1.8	251.7	3549768	449593
1.2	252.3	3549754	449607
1.2	252.3	3549740	449622
3.5	250	3549728	449634
3.6	249.9	3549713	449649
5.5	248	3549697	449664
5.3	248.2	3549685	449686
4	249.5	3549675	449702
2	251.5	3549662	449721
2	251.5	3549651	449735
2.1	251.4	3549637	449750
1.5	252	3549624	449768
1.3	252.2	3549620	449800

Second track			
Depth	**Depth from sea level**	**Y**	**X**
2.6	250.9	3549543	449742
2.8	250.7	3549566	449750
3	250.5	3549576	449752
1.2	252.3	3549585	449752
1.1	252.4	3549595	449753
1.5	252	3549606	449751
2.1	251.4	3549612	449752
1.7	251.8	3549617	449760
1.8	251.7	3549622	449760
1	252.5	3549632	449777
0.6	252.9	3549640	449784
3.1	250.4	3549691	449782
3.3	250.2	3549719	449768
3.3	250.2	3549729	449768

2.7	250.8	3549735	449769
3.3	250.2	3549759	449767
3	250.5	3549805	449772
3.3	250.2	3549815	449775
3.4	250.1	3549827	449778
3.3	250.2	3549839	449788
3.1	250.4	3549848	449794
3.4	250.1	3549859	449797
3.2	250.3	3549869	449798
2.5	251	3549880	449804
2.4	251.1	3549888	449810
2.2	251.3	3549899	449853
1.3	252.2	3549905	449861
1.2	252.3	3549918	449877
1.1	252.4	3549927	449885
0.8	252.7	3549937	449889

Third Track			
Depth	**Depth from sea level**	**Y**	**X**
1.9	251.6	3550006	449811
2.4	251.1	3550008	449877
2.1	251.4	3550008	449866
1.9	251.6	3550006	449859
1.9	251.6	3550003	449848
2.2	251.3	3550001	449837
3.1	250.4	3549967	449813
2	251.5	3549958	449697
1.4	252.1	3549958	449642
1.3	252.2	3549961	449633

Fourth Track			
Depth	**Depth from sea level**	**Y**	**X**
1.3	252.2	3550002	449636
3.4	250.1	3550045	449708
3.1	250.4	3550048	449711
3.4	250.1	3550053	449713
3.5	250	3550057	449716
2.9	250.6	3550061	449721
2.6	250.9	3550071	449725
2.5	251	3550092	449726
2.3	251.2	3550101	449727
2.3	251.2	3550110	449727
2.1	251.4	3550114	449735
2	251.5	3550119	449742
2.6	250.9	3550124	449747
2.1	251.4	3550130	449753

Fifth Track			
Depth	**Depth from sea level**	**Y**	**X**
1.7	251.8	3550147	449715
1.6	251.9	3550144	449711
3.6	249.9	3550135	449703
3.8	249.7	3550122	449693
0.7	252.8	3550113	449672

Sixth Track			
Depth	**Depth from sea level**	**Y**	**X**
2.7	250.8	3950490	449498
3.3	250.2	3950455	449545
3.1	250.4	3950398	449614
5.8	247.7	3950358	449633
2.4	251.1	3550275	449656
1.9	251.6	3550219	449661
2.1	251.4	3550167	449680
4.2	249.3	3550112	449704
1.5	252	3550098	449657
1.8	251.7	3550094	449658

1.4	252.1	3550089	449658
1.3	252.2	3550084	449659
1.2	252.3	3550070	449561
1.7	251.8	3549860	449662

Seventh Track			
Depth	**Depth from sea level**	**Y**	**X**
1	252.5	3549847	449663
1.3	252.2	3549828	449665
1.7	251.8	3549815	449668
1.8	251.7	3549786	449674
2	251.5	3549774	449676
2.4	251.1	3549767	449679
2.6	250.9	3549745	449685
2.3	251.2	3549735	449687
2.8	250.7	3549724	449687
4.3	249.2	3549710	449689
4.7	248.8	3549700	449692
4.9	248.6	3549684	449694
3.1	250.4	3549666	449699