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Geomorphology of Sabkha Al-Qasab, Using Geographical Information Systems and Remote Sensing

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Abstract:

Sabkha Al-Qasab is one of the wasted natural and salt resources, which did not receive enough attention like other natural resources, so what is meant by reed Sabkha? The reed Sabkha is salt surfaces in areas of highly saline lakes. The salt surfaces are usually based on clay, silt, and sand, often covered with saline crusts, and the Sabkha form when the underground water level approaches the earth's surface. The importance of the research lies in explaining the importance of applying remote sensing techniques and geographic information systems in creating a digital database for Sabkha and determining the volumetric, morphological, and mineralogical characteristics of Sabkha sediments and their origin, intending to know the deposition environments and the stages they have gone through. The study relied on satellite visualizations, topographical maps, and field studies. The team used the objective, analytical, and historical method for conducting the survey in the Riyadh region in the Kingdom of Saudi Arabia. The study concluded by encouraging industries based on salt extraction, following up distributing the product to consumers, and emphasizing the necessity of implementing environmental laws by not throwing any waste so that the groundwater is not polluted.

Keywords: *Geomorphology, sabkha Al-Qasab, information systems, remote sensing*.

I. Introduction

The Sabkha is considered salt surfaces in areas of highly saline ponds. Salt surfaces are usually based on formations of clay, silt, and sand, often covered with saline crusts, and marshes form when the subsurface water level approaches the earth **[1]**. The sabkhat is an open system that combines a multi-source water system with a continental, flood, and antenna system. It represents a suitable environment for some microorganisms **[2].**

1.1 Significance of the study:

The study of reed sabkha came due to the lack of research using geographic information systems technology and remote sensing to study sabkhats, especially creating a digital database.

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The importance of sabkha deposits and their sedimentation environments, as their studies contribute to identifying the application aspects and different marshlands' different uses.

-The importance of applying REMOTE SENSING TECHNIQUES and geographic information systems in creating a digital database for Sabkha.

- Monitoring the reed sabkha's morphological changes by applying remote sensing technology and geographic information systems and determining the reed sabkha's spectral signature during the different years of study in different years (1987-2002-2018) and the effect of this change on the applied side sabkha.

-Determining the volumetric, morphological, and mineral characteristics of sabkha sediments and their source, to know the deposition environments and the stages they have gone through.

Study the hazards resulting from human intervention to find suitable solutions for it and determine future potentials to maintain the ecological balance because of its economic dimensions for the reed's local residence.

1.2 The Study Objectives:

• Drawing the geomorphological map of the reed sabkha, studying each unit's morphometric characteristics, and completing the shortage through satellite visualizations in addition to the field study.

• Study of the topographical features of the Sabkha.

• give insight into the sabkha environment's geomorphological change, using remote sensing techniques and geographic information systems.

• recognizing the developmental processes of Sabkha and its water source, and the factors affecting its roots.

• build up a model that illustrates the relationship between human activity and the sabbath systems to study the impact of economic activity.

• The field study aimed at determining the extent of the influence of the extension of the marshland properties on urban development.

II. Materials and Methods

2.1. The study sources:

1- Satellite Visuals:

The study relied on several different satellite visualizations in the original (satellite type) and accuracy of different spatial and spectral accuracy to reach the objectives of the study mentioned above, as follows:

Table (1) the satellite visualizations used to study Sabkha Al-Qasab

Visuals number		Date of Filming	Visuals name	Platform	Visuals
Path	Row				
166	43	1987/11/10	LT05_L1TP_166043_19871110_20171214_01_T1_B4.TIF	Landsat5	Scanner (MSS)
166	43	2002/3/18	LT05_L1TP_166043_20020714_20180616_01_T1_B1.TIF	Landsat7	scanner (ETM+)
166	43	2018/11/15	LC08_L1TP_164042_20181101_20181115_01_T1_B1.TIF	Landsat8	Scanner (OLI)
166	43	2014/9/23	SRTM1N25E045V3	SRTM	Digital height model

Source: http//earthexplorer.usgs.gov.

2- Topographic Maps:

The study leans on a group of maps, as follows:

• Topographic maps scale 1: 500,000 drawing for Riyadh published by the Ministry of Petroleum and Mineral Resources, Air Survey Department, published in 1409 AH, Riyadh, Kingdom of Saudi Arabia.

• Topographic maps scale 1: 50,000 drawing for Riyadh, published by the Ministry of Petroleum and Mineral Resources, Department of Air Survey, published in 1401 AH, Raghba - (Al-Qasab (al-washm) - Qasur Umm Al-Jadawel - Shaqra (Northeast) - Shaqra (Southeast), Kingdom of Saudi Arabia Saudi.

• Geological Maps scale 1:250,000 for Shaqra Region published by the Geological Survey Authority in 1988, Kingdom of Saudi Arabia.

2.2. Field study:

The field study of the Redlands was divided into two phases, as follows:

• An exploratory visit on 3/23/2019 AD, which included exploring the salt basins in the Sabkha until we reach into Nafood Al-Areeq in the West and taking some photographs of the surface shapes of Sabkha.

• The second visit on 12/28/2019 to the natural sabkha area to record observations and field measurements of the subtle phenomena associated with Sabkha and collecting samples of sabkha sediments.

4- The used programs: software package ARCGIS10.4.1 -ERDAS 15 -11Global Mapper - AutoCAD Map 2019, in addition to Microsoft Office programs.

2.3. Study curricula and methods:

The objective approach depends on Sabkha's study as a geomorphological phenomenon in terms of the factors that led to its emergence and its phenomena.

Analytical method: It was employed to deal with the geology of the Sabkha, recording field observations, and analyzing some morphometric measurements of the subtle phenomena on the surface of the Sabkha.

Historical approach: It was employed to identify the developments and changes that occurred in the Sabkha and the extent of the human factor's interference in the occurrence of these changes through data, maps, and satellite visuals for different dates (1986-2002-2018)

2.4. Study methods:

The quantitative method: through which the Sabkha's morphometric and morphometric properties were studied, with the data resulted from those measurements being tabulated using ArcGIS software.

- **Statistical analytical method:** by analyzing digital models and linking them statistically to Excel to obtain the results of the measurements in addition to the morphometry of geomorphological phenomena.

Laboratory method: It was employed to analyze samples mechanically and chemically in the laboratory.

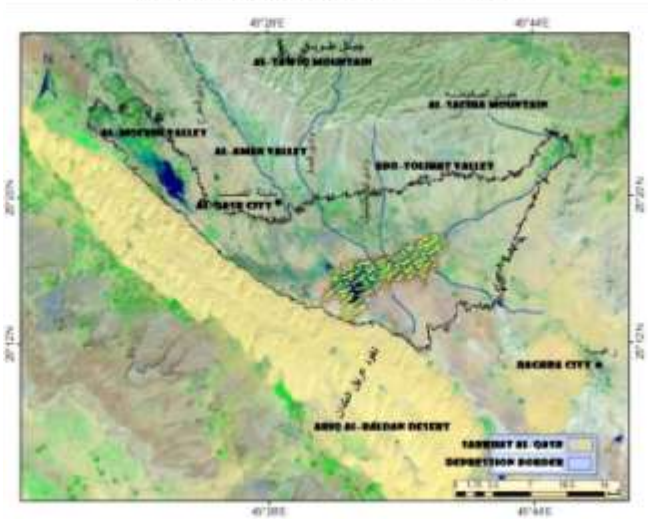
III. Results and Discussions

3.1. The location and topography of sabkha al-reed

3.1.1. Location and extension.

- Sabkhat al-Qasab located in the southeast of Shaqra governorate, about 30 km between two circles of width 25 ′13 43 and 25 18 ″ 23 north, longitudes 45 ′32 ″ 49 and 45 40 31 east, with an area of about 45.6 km2, and a width ranging Between 1 and 5.8 km and a length of 14.3 km. Figure (1), the Sabkha is located within a basin depression surrounded by a contour of 660 meters above sea level, with an area of 426.7 km2. The sabkha depression levels vary from 625 to 673 meters, and the reed sabkha begins at the level of 634 meters, and its deepest point is located in the far West at a level of 625 meters. There is a high way connects it with Riyadh through the Harimela Governorate, about 160 km away from it, approximately 21.5 km from the city of Raghba to the southeast, and about 13 km from the town of Al-Qasab from the West, and it is considered within the northern agate of Najd, known in the past as (Batn Al-Atak). Now known as (Batn Al-Atesh).

Figure (1) Sabkhat al-Qasab site



Source: The work of the two researchers, based on the digital elevation model, using Arc GIS software.

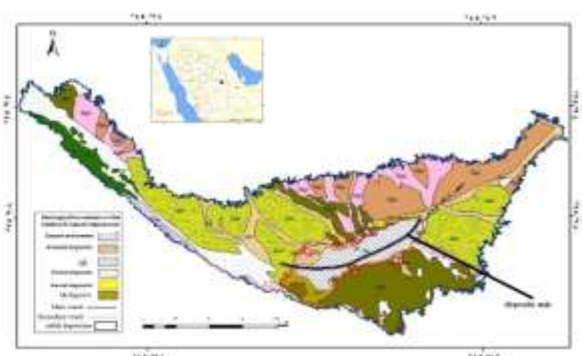
3.2. The natural factors affecting the emergence and development of Al- Qasb sabkha .

Four main factors responsible for the formation of Al- Qasb sabkha can be identified:

3.2.1.Geological characteristics.

The sabkha area consists of a stratigraphic sequence of the middle Jurassic rocks to the south, Figure (2), made of limestone, with the clay shale alternating with it to the fourth geological time with gravel brushes.

Figure (2) the geological formations in the Sabkhat Al Qaseb Depression.



Source: The work of the two researchers, based on the geological map of Shaqra area, scale of1: 250,000.

It is evident from the geological map analysis: the existence of a descending basin area to the west of Jabal Tuwaiq directly and parallel to it from north to south.

Table (2) Area of surface geological formations in the Sebkha Al Qaseb Depression.

Time	**Configs**		**Code**	**The area in km2**	**Percentage%**
Middle Jurassic	**Darma**		Jdi	**13.8**	**3.2**
Lower Jurassic	**marrat**		jdm	**81.5**	**19.1**
Fourth time	**Limescale**		Qdc	**4.2**	**1**
	Aerial deposits	**Active**	Qdz	**10.3**	**2.4**
		Not Active	Qdy	**0.2**	**0.05**
	Overflow deposits		Qax	**107.6**	**25.2**
	Qk sediment		Qk	**74.6**	**17.5**
	Alluvial deposits		Qtz	**36.5**	**8.6**
	Gravel deposits	**Not Active**	Qgx	**0.3**	**0.07**
		Not Active	Qgy	**59.4**	**13.9**
		Active	Qgz	**38.3**	**8.98**
Total				**426.7**	**100**

Source: The Geological Map of Shaqra Region, Figure (2).

Pebble sediments (Qgz): They are composed of limestone or quartzite, and they cover separate parts in northern Sabkha al-Qasab.

Alluvial deposits (Qtz): These sediments spread over the northwestern parts of Sabkha Al Qasab.

- Experiences deposits QK: It consists of alluvial clay (clay) bonded to some evaporites in its basin areas.

- Flood sediments: dating back to the fourth geological time, which was brought about by wadis descending from the Tuwaiq Mountains to the north and east, which spread their flood fans

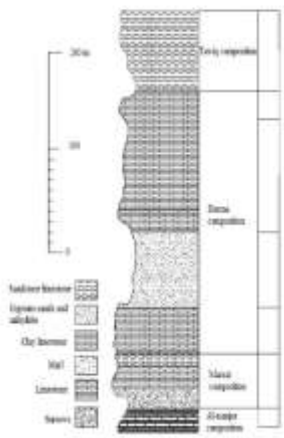
Aerial deposits:

It consists of dunes, hills, flat, and sand veins, and it is in the sabkha area.

Image (1) Auryq Nufud Al-buldan, looking towards the West.

Source: The two researchers photographed through the field study.

Figure (3) Geological section of the sequence of geological layers in the study area.



Source: citing Joudeh Al-Turkmani, 1994.

3.2.1.1 The climate:

Climate is one of the most important factors affecting the geomorphology of sabkha al-reed. The presence of gypsum and anhydrite in sabkha deposits has an impact on climatic conditions.

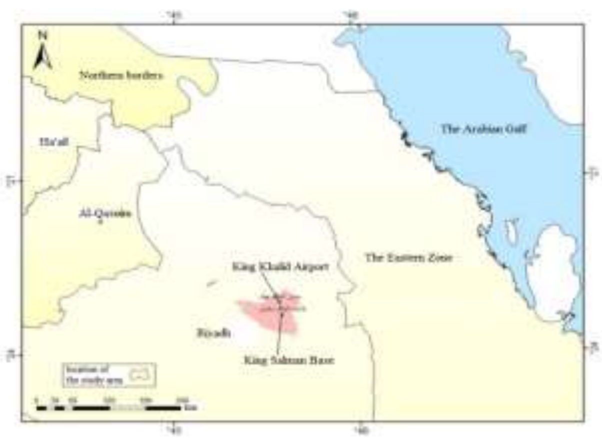
Table (3) climatic stations in the study area

Station number	**Station name**	**Geographical location**		**Altitude above sea level)in meter)**	**The study period**
		Latitude (north)	Longitude (east)		

40405	Al-Qasium	^{5} 26 18 28	^{5}43 46 03	646.71	25
40437	King Khalid Airport	^{5}24 55 31	^{5}46 34 19	613.55	25
40438	King Salman Base	^{5}24 42 40	^{5}46 44 18	619.36	25

Source: From the researchers' work from the field study

Figure (4) climatic stations in the study area



Source: The work of the researchers, according to Table (3)

3.2.1.2.Temperature

Temperature is one of the most critical climatic elements in terms of its direct effect on other climatic elements, reflected in marshes' emergence and development.

The importance of temperature as a climatic element lies in identifying the mean daily maximum and minimum extremes in the study area stations.

Table (4) temperatures (° C) for climate stations for the period from 1985 to 2010 AD

station	Climate elements		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual rate
Al-Qasim	Me	Minimum temperatu	6.2	8.1	11.9	17.4	22.6	24.9	25.7	26.2	23.3	18.6	12.9	8.1	17.2

	dium	re													
		maximum temperature	19.2	22.4	26.7	32.6	38.8	42.3	43.3	43.7	41	35.6	27	21.5	32.8
	Thermal run		13	14.3	14.8	15.2	16.2	17.4	17.6	17.5	17.7	17	14.1	13.4	15.7
	End	Minimum temperature	-5	-3.6	1	8.5	13	19	15.6	19.8	4.7	10	2.5	-2	7.8
		Maximum temperature	32.4	34	39	42	73.7	47.5	48.4	49	48	43	37	33	43.9
King Khalid Airport	Medium	Minimum temperature	6.8	9.2	13.2	18.3	23.4	25.2	26.4	26.3	22.8	18.2	13.4	8.5	17.6
		Maximum temperature	20.1	23.3	27.7	33.3	39.4	42.6	43.7	43.7	40.6	35.5	28.2	22.2	33.4
	Thermal run		13.3	14.1	14.5	15	16	17.4	17.3	17.4	17.8	17.3	14.8	13.7	15.7
	End	Minimum temperature	-5.4	-3.3	2.1	9.4	14	20	21	17.5	11.4	10.5	2	-2	8.1
		Maximum temperature	31	34.5	38	42	46	47.5	48	48.2	45.6	42	45	31.2	41.6
King Salman	Me	Minimum temperatu	9	11.2	15.2	20.4	25.9	28	29.3	29.2	25.9	21.2	15.5	10.6	20.1

Base	dium	re													
		Maximum temperature	20.2	23.4	27.7	33.4	39.4	42.5	43.5	43.6	40.4	35.3	27.8	22.2	33.3
	Thermal run		11.2	12.2	12.5	13	13.5	14.5	14.2	14.4	14.5	14.1	12.3	11.6	13.1
	End	Minimum temperature	-2.2	0.5	4.5	11	18	16	23.6	22.7	16.1	14	7	1.4	11.1
		Maximum temperature	31.5	34.8	38	42	45.1	47.2	48	47.8	45	41	38	31	40.8

Source: Presidency of Meteorology and Environment, National Center of Meteorology and Environment, unpublished data

3.2.1.3.Wind

The scarcity of vegetation in the Sabkhat al-Qasab area helped increase wind activity in raising sandstorms in the study area.

Table (5) wind speed and direction (knots / hour) for the study area for the period from 1985 to 2010.

Wind		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	**Average**
Al-Qasim	Maximum speed	35	42	40	55	52	30	45	40	30	33	36		39.6
	Direction	North	North	North	North	North	North	North	North	**East Northeast**	**East North North**	**East Northeast**	North	-

King Khalid Airport	Maximum speed	36	36	***	55	55	35	40	***	36	35	40	30	39.8
	Direction	**Southeast South**	**Southeast South**	**Southeast South**	**Southeast South**	North	North	North	North	North	South	North	**Southeast South**	-
King Salman Base	Maximum speed	35	31	55	70	51	35	35	***	30	35	26	30	39.4
	Direction	Southeast South	Southeast South	Southeast South	Southeast South	North	North	North	North	North	Southeast South	Southeast South	**Southeast South**	-

Source: Presidency of Meteorology and Environment, National Center of Meteorology and Environment, unpublished data.

3.2.1.4. Rain

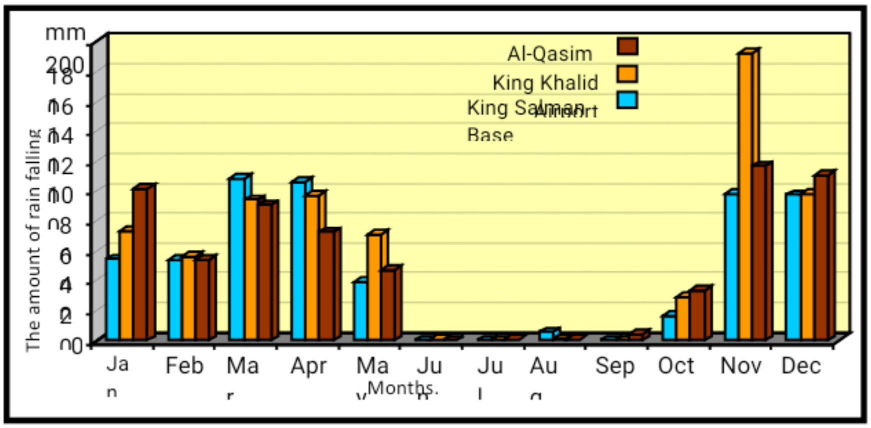
Rainfall is one of the sources of supplying water to the sabkhat, as the rain causes the occurrence of what is known as torrent flow from the headwaters of the valleys over the mountains to the floods (the level of the base of the sabkha).

Table (6) Average amounts of precipitation (mm) in the study stations for the period from 1985 to 2010.

station		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Al-Qasim	Average	21.8	10.8	26.6	24.7	8.4	0	0	0	0.2	3.7	23.2	16.9	11.4
	Maximum rainfall	101.6	54	91	72.7	47.1	0	0.5	0.7	4	33.5	117.1	110.8	117.1
King Khalid Airport	Average	15.5	9.6	21.6	26.6	6.2	0	0	0	0	1.2	12.8	17.7	9.3
	Maximum rainfall	73.6	56.1	94.4	97.1	70.6	0.2	0	1.2	0	28.9	192.8	98.6	59.5
King Salman Base	Average	11.9	6.4	21	23.8	4.9	0	0	0.4	0	0.8	8.7	14.6	7.7
	Maximum rainfall	54.6	53.9	108.9	106.6	39.5	0	0	5.6	0	16.5	98	97.8	48.5

Source: Presidency of Meteorology and Environment, National Center of Meteorology and Environment, unpublished data.

Figure (5) Maximum precipitation of the stations in the study area for the period from 1985 to 2010.



Source: The work of the two researchers according to Table (6)

Table (7) the percentages (%) of seasonal rains (mm) for the study stations for the period from 1985-2010.

Station.	Winter	Spring	Summer	Fall	Total
Al-Qasim	36.3	43.8	0	19.9	100
King Khalid airport	38.5	48.9	0	12.6	100
King Salman base	35.6	53.7	0.4	10.3	100

Source: Presidency of Meteorology and Environment, National Center of Meteorology and Environment, unpublished data.

3.2.1.5. Evaporation:

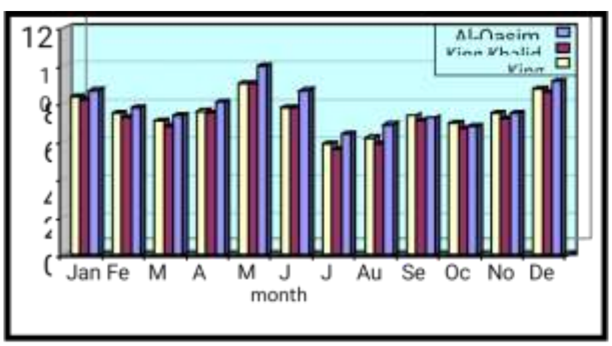
The annual rate of evaporation in the study area is 7.6 mm / day, the average maximum value of evaporation in the spring season is 8.4 mm / day, and the lowest average evaporation value in the summer is 6.5 mm.

Table (8) Average evaporation (mm) for the study stations for the period from 1985-2010.

Seasons	Winter			Spring			Summer			Fall			Annual average
Station	Dec	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	
Al-Qasim	8.7	7.8	7.4	8.1	10	8.7	6.4	6.9	7.3	6.8	7.5	9.2	7.9
King Khalid airport	8.2	7.3	6.8	7.5	9.1	7.8	5.6	5.9	7.1	6.7	7.2	8.6	7.3
King Salman base	8.4	7.5	7.1	7.6	9.1	7.8	5.9	6.2	7.4	7	7.5	8.8	7.5
Quarterly average	7.7			8.4			6.5			7.7			-

Source: Presidency of Meteorology and Environment, National Center of Meteorology and Environment, unpublished data.

Figure (6): Average evaporation at study stations for the period from 1985 to 2010



Source: Researcher preparation based on

3.2.1.6. Relative humidity:

The relative humidity element is considered one of the most critical factors affecting the energy of evaporation of brine solutions. Consequently, the sedimentation of evaporation deposits on sabkha surfaces due to the geographical location of the sabkha and its location within the desert zone.

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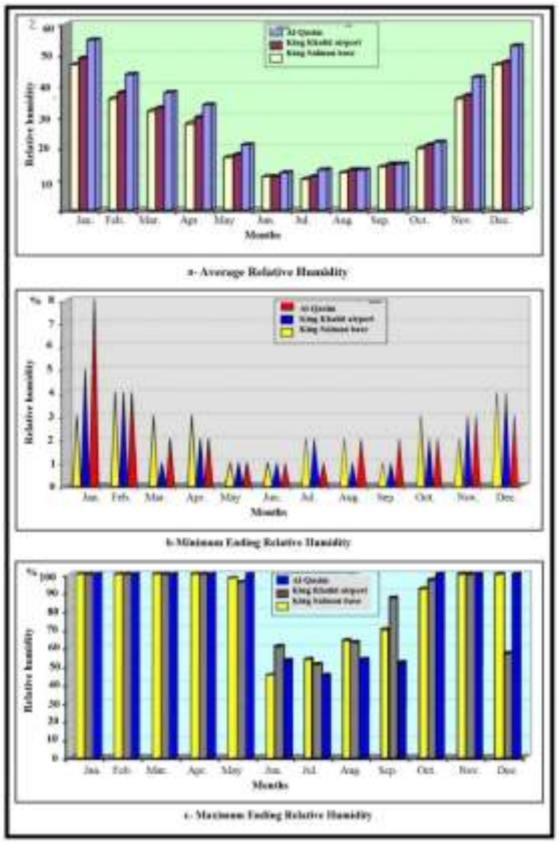
Table (9) Average Relative Humidity (%) for the study stations from 1985 to 2010.

station / month	Al-Qasim			King Khalid airport			King Salman base		
	Average relative humidity %	%	Maximum %ending	Average relative humidity%	Minimum ending %	Maximum %ending	Average relative humidity %	Minimum ending %	Maximum %ending
Jan.	55	8	100	49	5	100	47	3	100
Feb.	44	4	100	38	4	100	36	4	100
Mar.	38	2	100	33	1	100	32	3	100
Apr.	34	2	100	30	2	100	28	3	100
May	21	1	100	18	1	96	17	1	98
Jun.	12	1	53	11	1	61	11	1	45
Jul.	13	1	45	11	2	51	10	2	54
Aug.	13	2	54	13	1	63	12	2	64
Sep.	15	2	52	15	1	87	14	1	70
Oct.	22	2	100	21	2	97	20	3	92
Nov.	43	3	100	37	3	100	36	2	100
Dec.	53	3	100	48	4	557	47	4	100
Average	30.3	2.6	83.7	27	2.3	126	25.8	2.4	85.3

Source: Presidency of Meteorology and Environmental Protection, National Center of Meteorology and Environment, unpublished data.

Figure (7) The relative humidity of the study stations for the period from 1985 to 2010

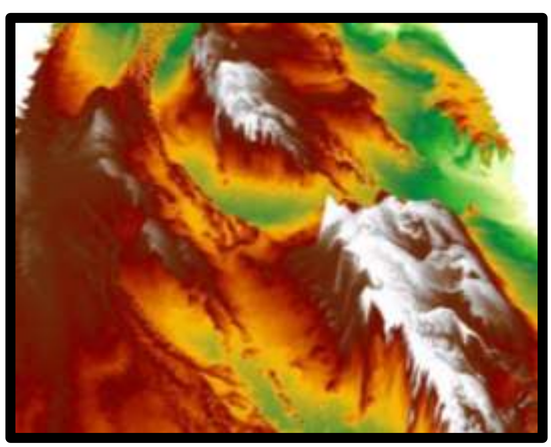


Source: The work of the two researchers according to Table (9)

3.3. Terrain Characteristics.

The study of topographic characteristics aims to define the general features of the topography of the study area.

Figure (8) An illustration of the sabkha al-qasb basin.

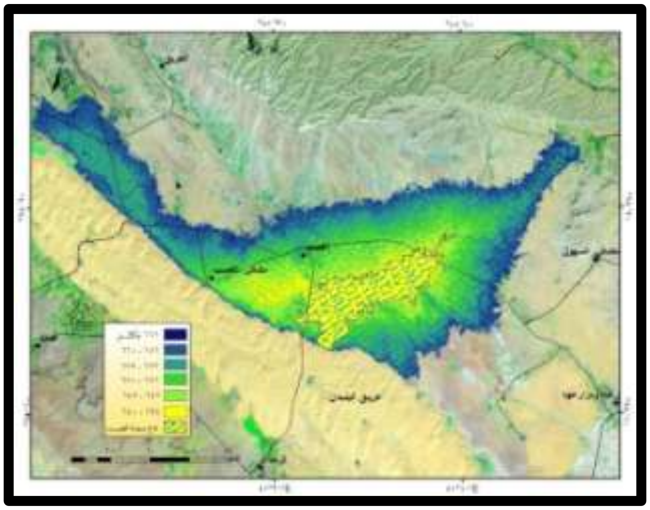


Source: From the researchers' work, based on the DEM digital elevation model and ArcScene 10.4

3.3.1. The heights

The sabkha Al-Qasb is considered to have a central drainage, as it is defined by a contour of 660 meters down to the sabkha in the middle of the basin.

Figure (9) The elevations in the Sabkhat al-Qaseb depression.



Source: The work of the two researchers based on the digital elevation model using the ARC GIS program.

Table (11) of the regression classes of the low-lying Sabkhat Al-Qasb.

Category	Area (km2)	The ratio (%)
0 - 2 O	3.79	0.89
2 O - 5 O	10.68	2.5
5 O - 10 O	39.6	9.3
10 O - 18 O	129.3	30.2
18 O - 30 O	140.7	32.91
30 O - 45 O	84.89	19.9
45 O And more	18.3	4.3
Total	426.7	100

Table (10) elevation classes for the low-lying bottom of Sebkha al-Qasab.

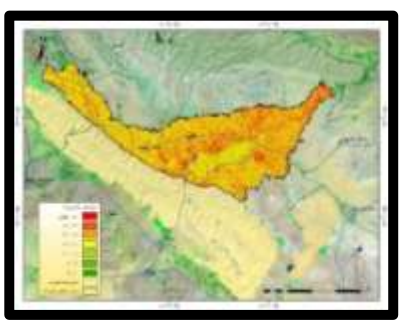
Height classes (Meters)	Area (Km2)	The ratio(%)
624 - 640	50.9	12
641 - 645	62	14.5
646 - 650	86.6	20.2
651 - 655	110.5	25.8
656 - 660	106.6	24.9
661 And more	11.3	2.6
Total	427.9	100

Source: The work of the two researchers, based on the digital altitude model using the ARC GIS program.

3.3.2. Regressions.

Surface slopes control the shape of the sabkha and the area of evaporation.

Fig. (10) The slopes of the Sabkha al-qasb depression

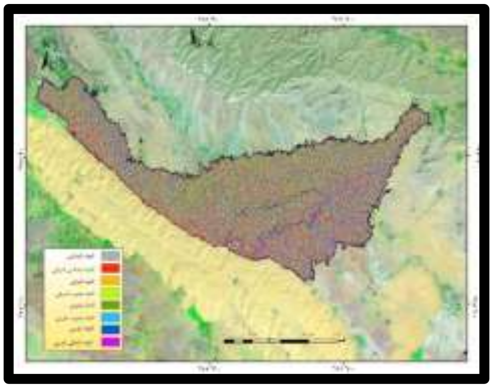


Source: According to Figure (9), using the ARC GIS program.

Source: According to Figure (10), using the ARC GIS program.

- Direction of slope: By studying the direction of slope, the surface of the depression was divided into eight directions.

Figure (11) a map of the slope direction of the Sabkhat al-Qaseb depression.



Source: The work of the two researchers based on the digital elevation model of 30m, using the ARC GIS program.

Table (12) Categories of the slope direction of the Sabkha Al-Qaseb Depression

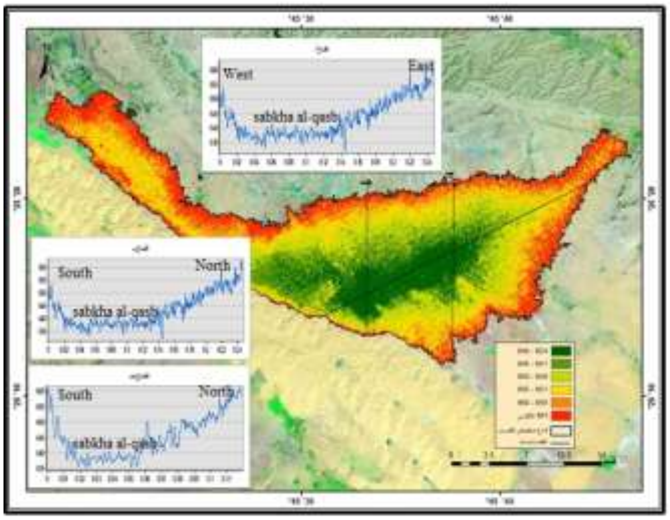
	North direction	**Northeast direction**	**Eastern direction**	**Southeast direction**	**South direction**	**South west direction**	**Western direction**	**North west direction**	**Total area of depression**
Area (km2)	59.5	53.9	49.5	52.1	53.8	53.1	51	53.8	426.7
The ratio (%)	14	12.6	11.6	12.2	12.6	12.5	11.9	12.6	100

Source: depending on Figure (11)

3.3.3. Terrestrial sectors.

Three cross-sectional and longitudinal terrain sectors were established. Their results demonstrate the geomorphological characteristics of the Sabkha Basin area.

Figure (12) Terrain Sectors of Sabkhat Al Qasab



Source: The work of the researchers, based on the digital altitude model using the ARC GIS program.

3.4. Detection of the morphology of Sabkhat al-Qasab:

The morphology of Sabkhat al-Qasab was studied from the satellite visualization analysis of the American Landsat 8 satellite.

Steps to monitor the morphology of the Sabkha:

- Making some enhancements to the photographs, such as applying some filters to remove the distortion percentage from the atmosphere, distributing the data of these photographs in a more extended range to show their complete data (Stretching Histogram), in addition to adjusting the color contrast to display the photographic data with high efficiency.

- The use of spectral spaces (2, 7, 5), as these bands are the most differentiated between Sabkhas and the Natural phenomena close to them.

- Supervised classification of the spectral spaces for different years by converting the visuals to the Thematic Maps for the Sabkha area's land cover, then converting them from Raster to Vector to obtain the extent.

Detection of the change using change detection method: to monitor and follow a specific area's changes through different visualizations of the sabkha area dates by observing it on satellite images for different years. Change detection has been addressed through satellite information in several studies. However, the problem lies in detecting changes due to the different places and the various surface terrain in them. Thus, the multiple reflections from them, with no consensus on a particular method **[3].**

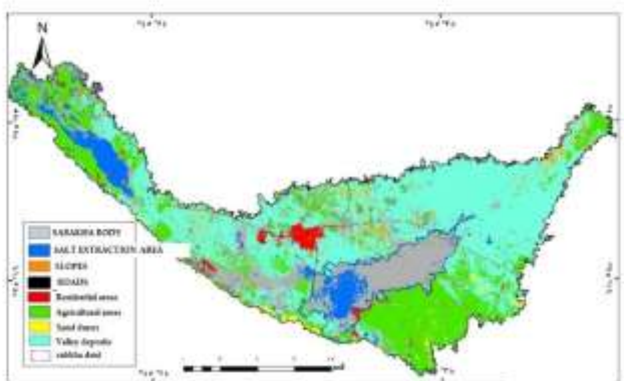
The detection methods are based on observing the difference in the reflection of electromagnetic energy, which can be followed by observing the brightness values' changes or as they are often called digital numbers for digital satellite images. Changes in numerical values for a goal are either an increase or a decrease. Increase such as converting parts of agricultural or mountainous lands into concrete installations or cultivating desert areas, as happened in the depression. Drops such as the transformation of parts of empty lands into water swamps. The difference in the energy reflection of any intention between two different dates employed In knowing the changes that occurred to the goal itself in terms of the type and size of the change. All of this has great importance in urban, regional, and environmental planning in general.

The study of change using satellite information takes place on two levels:

3.4.1 Targeted classification of Sabkha

The directed classification method is based on prior knowledge of the characteristics of the study area, and by relying on the field study in addition to topographic maps and satellite visuals, and by identifying seven categories that represent the land cover, namely: the body of the Sabkha, the saltpans, the mountain slopes, the roads, urbanization, dunes, and waterways, Figure (13)

Figure (13) Classification directed at the Sabkhat Al Qaseb Depression.



Source: The researchers' work based on the Landsat 8 satellite visual, using ARC GIS software.

Table (13) Classification results and area of land cover classes

Category	Size (Km2)	Ratio (%)	N. Samples
Sabkha body	45.6	10.9	20

Slopes	79.6	18.6	75
road	7.8	1.8	14
Residential areas	61.4	14.4	11
Agricultural areas	100.7	23.6	28
Dunes	4.5	1	32
Water Slides	108.9	25.5	38
salt evaporation pond	18.2	4.2	15
Sabkha depression	426.7	100	233

From the analysis of Figure (13) and Table (13):

Using the method of digital vectorization, the sabkha area was determined 426.7 km2, and then the taxonomic categories were converted from Raster grid to linear Vector, where 233 samples were taken for the sabkha basin for the total number of categories

Thus, the body of the reed sabkha covers an area of about 45.6 km2 from the Sabkha depression, to include about 10.9% of the size of the sabkha depression, noting the similarity of the Spectral Signature of the navigators inside and outside the sabkha body, so it is difficult to determine with great accuracy like the rest of the categories.

It was also classified in the salt evaporation pond category and handled by deleting and adding them, depending on the 2019 space visual used in the classification process.

- The urban area represented in the Al-Qasab city is estimated at 61.4 km2, which occupies 14.4% of the size of the Sabkha Depression. In contrast, the dunes designated in Aariq Al-buldan occupy only about 1% of the Sabkha Valley area in the southeastern parts.

The streams of the sediments of the dry valleys in the northern and eastern regions are the source of nutrition for depleting with Sabkha Al-Qasab 25.5% of the depression, Panel (1).

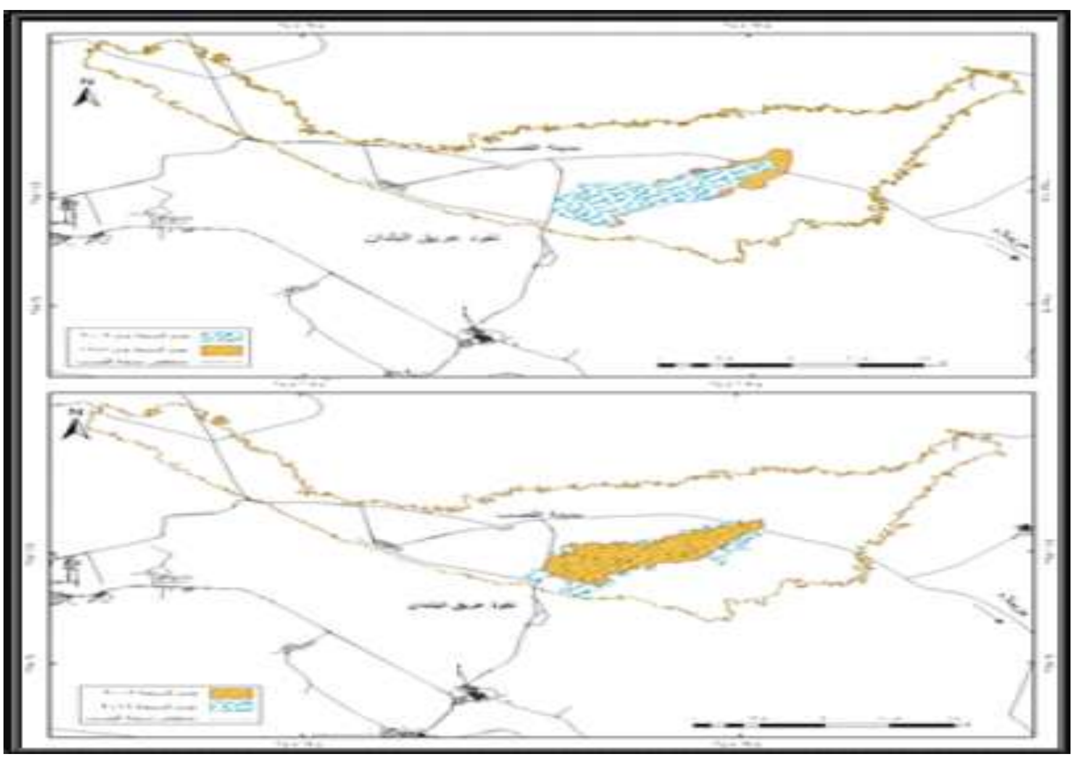
Panel (1) the passages of the torrents of the valleys descending from Jabal al-Safiha to mark the drainage paths (body of the sabkha) to protect the Harimila-al-Qasab road, looking towards the east

Source: Filming the researchers through the field study

3.4.2. Change Detection:

Given the importance of observing the environmental change of the nature of the Sabkha to reach accurate and distinct results about the dimensions and area of the Sabkha and its morphological characteristics to help understand its development **[4]**.Therefore, the 50.000: 1 scale topographic maps and the field study were relied on in addition to analyzing a set of satellite visuals. During the years 1987-2002-2019, (MSS), (ETM +), and (OLI), depending on ArcGIS10.

Figure (14) the morphometric development of the Sabkhat Al Qaseb during the period 1987-2019.



Source: The work of the two researchers based on satellite images of the years 2002, 2002 and 1987, using the ARC GIS program.

Table (14) monitoring the change of the Sabkhat Al Qaseb between 1987 and 2019.

1987	2002		2019		
Size (km2)	Size (km2)	Percent change% from 1987	Size (km2)	Percent change % from 1987	Percent change % from 2002
37.8	33.8	-10.8	45.8	21.1	35.8

Source: depending on the figure (14)? Areas were monitored with ArcGIS 9.1 software for years of study.

From the analysis of Figure (14) and Table (14), it is evident:

The difference in the dimensions of the area of the Sabkhat Al Qaseb based on the climate changes, especially the elements of precipitation and evaporation, which were observed during the study periods, as follows:

The first period (1987) AD: The area of the Sabkhat Al Qaseb reached 37.8 km2, according to the study of Al-Turkmani (1994), to 33.5 km2, to be approximately the same area in the second period (2002), 33.8 km2. This decrease is due to the filling of parts of the body of the Sabkha through Asphalt road to the Areq Al-Baldan in the West, in addition to the fluctuation of rain amounts between increase and decrease, as the body of the Sabkha is subjected to seasonal changes during the winter and summer seasons, and its area increases due to the high rates of evaporation and the lack of nourishing water from the northern and eastern valleys that drain to the depression to the end of the sabkha body. The increase in the area was monitored in the period between 2002 and 2019, as its average length in 2002 was about 4.1 km in its widest parts, increasing in 2019 AD to 5.4 km, due to human intervention as a geomorphological factor as a result of the expansion of human activity and the diversion of the western end of the sabkha body to extract salt, where cane salt is the first At the level of the Kingdom, in addition to the extension of roads through the body of Sabkha, to serve the economic activity there.

3.5. The geomorphological map of the Sabkha:

The Sabkha Al-Qasp is defined by a mountainous rim represented by the Tuwaiq Mountains in the north and a sand barrier represented by Areq Al-Baldan of the West. Therefore, the Sabkha Al-Qasp is classified as an internal sabkha. The geomorphology of Al-Qaspa was studied as follows:

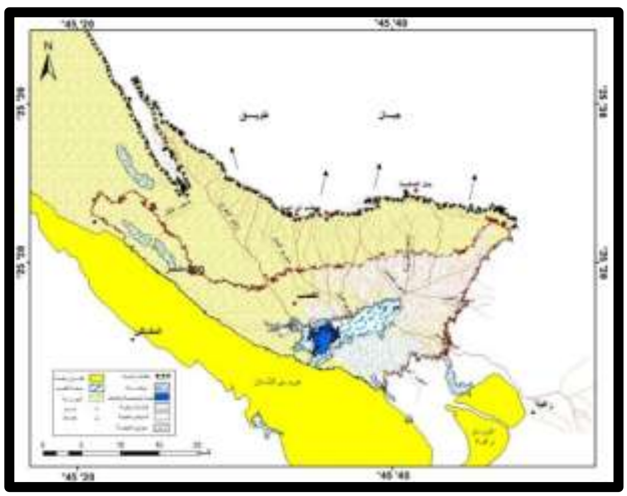
3.5.1. The shapes that occupy the surface of the Sabkha.

3.5.1.1 Mud cracks.

They are mud cracks that arise due to exposing the muddy sabkha surface to a high temperature. It is also formed as a result of saturation of sabkha sediments with water containing a measure of salts of low solubility, through the capillary property and the rise of the subsurface water to the top, and as a result of the broad daily heat range, and the occurrence of daytime drought, Then the processes of expansion and contraction occur that cause the clay blocks to diverge, forming mud fissures that are the beginning of the shapes associated with sabkhat.

The lengths of the mud cracks in the Sabkhat al-Qaseb ranged between 8-15 cm, and their width ranged between 6-18 cm, and the depth of these cracks ranged between 0.3-5 cm. As for the shape of these cracks, they take many forms, including the cracks with perpendicularity, regular, irregular, and oblique, Panel (2)

Figure (15) the geomorphological map of the Sabkhat al-Qaseb depression.



Source: The work of the two researchers based on Landsat 8 satellite visuals, and topographic maps of 50,000: 1, using ARC GIS software.

Panel (2) Shaped mud cracks on the surface of the Sabkhat al-Qaseb

.

Source: Photographed by researchers from the field study

3.5.1.2. Salty domes.

They consist of incomplete-growing polygons and sheets. It was evident from the field study that the phenomenon of domes existed in the southeastern part of the sabkha al-Qasab, due to the nature of the Sabkha, which is characterized by its fragile soil that allows the formation of domes. It takes many forms, including domes, parallel, and intersecting. However, it is characterized by empty openings inside it, which activate the gases produced by breathing the microorganisms on its surfaces. The heights of the sighs ranged between 0.50 cm and 1.5 cm, Panel (3).

Panel (3) Simple salty domes of sabkha al-Qasab

Source: Photographed by researchers from the field study

3.5.1.3. Ponds and wet salty surfaces:

There are salt ponds in the Sabkha's eastern parts, where the Shoaib al-Makhar and the northwest, where it led to al-Muqrah Valley and its upper tributaries, as it enters the body of the Sabkha through the Fidat Al-Ghaba, Panel (4). These surfaces are characterized by a high level of subsurface water in them, as their area increased, especially during the winter season where it fell rain, as well as water pools, which dry up in summer because of high temperatures and increased rates of evaporation, leaving salt crystals on the surface of the Sabkha, Panel (5).

Panel (4) listing the levels within the water pools in the sabkha al-qsab.

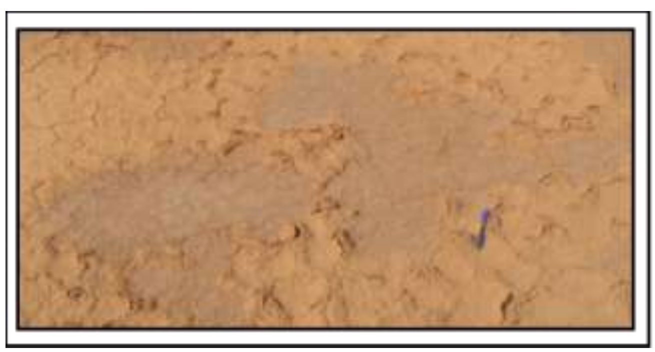
Source: Filming the researchers through the field study.

Panel (5) transforming water bodies into salt surfaces, in the sabkha al-qsaba.

3.5.1.4. Salty bridges:

They are salty edges with steep sides. Their appearance is related to salt polygons, and they are formed as a result of cracks filling with salts between the salt polygons. With the continued high temperature and evaporation, these bridges rise to a vacuum occupied by the gases resulting from microorganisms' death. Salty bridges are characterized by having two sides; they descend in opposite directions. Their high does not exceed 2 cm, The size of these bridges and the peaks and sides associated with them depend on the proportion of salts that it is the surface crust and the level of subsurface water, so the closer its level, the higher the evaporation rates of its saline solutions resulting Due to the high temperature, the precipitation of salts on the surface increases. Then their size and the taper of their peaks and vice versa. It has been observed through the field study that some areas of salt polygons are almost devoid of those bridges, which is due to the activity of air erosion agents due to the nature of the topographic depression.

Image (2) Fine salt bridges, in the sabkha al-qsaba.



Source: Filming the researchers through the field study.

3.5.2. The phenomena that occupy the boundaries of Sabkha:

Some of the precise geomorphological phenomena presented around the Sabkha Al-Qsab and inside the depression result from geomorphological phenomena of sedimentary origin on the Sabkha depression edges. The Sabkha is limited by the alluvial fans that combine to form the plains of the Bahada valley at the northern and eastern valleys' exits. Affluence and the meadows in the south and northwest, in addition to the sand beds.

As a result of the expansion of alluvial fans located inside the depression north of Sabkha al-Qasab and descending from the Tuwaiq Mountains, and their union with the plains of Al-Bahada valley, Panel (6), it led to the transfer of sediments from its upper streams to Al-Busaita area represented in the range of fans near the body of Sabkha Al-Qasab. The thickness of the Bahada sediments varies as They are of little thickness. They do not exceed 10 meters near the edge of Jabal Tuwaiq, represented in the upper sewers, where we find coarse sediments dominated by gravel and stones. In comparison, it exceeds 20 meters around the Sabkha Al-Qasab represented in the range of the fans and the Bahada, where sediments are graded from gravel to Sandy and silty clay.

Panel (6) The northern edge of the Tuwaiq Mountains, adjacent to the Sabkha al-Qaseb depression.

Source: Filming the researchers through the field study.

The Affluence and meadows occupy low parts around the sabkha body and form relatively small areas. The Affluence represents the valleys and reefs' estuaries, the most important of which is the Al-Ghaba Affluence in Sabkha Depression: 648 meters northwest of the Sabkhat Al-Qaseb body, with an area of 1.94 km2 and 1.5 km long. Al-Muqrah valley is poured from its upper sources at a height 760 meters from its eastern tributaries, sloping from the Tuwaiq Mountains, and 839 meters from its western branches, the slope of Al-Sih, which does not derive water from it, as it forms a barrier that obstructs the flow of the body of the Sabkha with its flood sediments, and air erosion has an apparent effect on transporting the sediments of Ariq Al-Buldan.

One of the most important meadows is Bardawan meadow, located to the east of Ariq Al-Baladan south of Al-Qasab sabkha. Thus, rainwater escaping from it collects in it, in addition to the rain falling on it with an area of 2.38 km. The clay plains spread in the southern and southeastern parts of the Sabkha and are distinguished by their flat surface, which makes them poorly drained.

The Sand covers is spread as a result of the wind erosion operations. One of the most massive air manifestations is the Ariq Al-Buldan, which are fossilized dunes topped by transverse dunes. It extends in a northwest-southeast direction of the Sabkha al-Qaseb depression, with a length of 64.4 km and an area of 494.4 km, and a maximum width of 16.7 km. The body of the Sabkha al-Qaseb in some places has a distance of no more than 0.4 km due to its increase in its area. It has a role in the leakage of quantities of rainwater, whether falling on it or leaking from the valleys and reefs to its West, such as Shuaib Al-Raymah, Al-Salim, Al-Samma, Al-Awar, Al-Kaft, and Al-Jamal Valley, in addition to The Ariq Raghbat of the southeast of the Sabkha depression appears on two parts, the area of the first is 43.9 km and the second is 30.4 km. It is about 11.4 km from the body of the Sabkha.

3.5.2.1. Drainage networks:

Dry valleys and reefs are among the most important geomorphological phenomena affecting the emergence and development of Sabkhat al-Qaseb. There is a network of a daring system that drains into the sabkha basin. The drainage networks characterized by different morphometric characteristics, so that the Sabkhat al-Qaseb is distinguished as having natural central drainage from all sides except for the western and southern sides where it is connected indirectly to these valleys through the Ariq Al-Buldan that act as a natural reservoir of rain falling on it in addition to the water of that Valleys.

Morphometric studies of drainage networks depend on the analysis of elevation levels using the digital elevation model in addition to the numerical numbering of the level points on topographic maps of the scale of 50.000: 1 to increase the accuracy of the elevation values to obtain a DEM model expressing the digital representation of the Sabkhat al-Qaseb basin.

It was possible to obtain drainage basins and networks of valleys, and by treating the digital elevation model to get the drainage networks, the following should be done:

- Processing the pits or depressions that accompany the creation of the digital model of elevations, known as the Fill step. Figure (6).

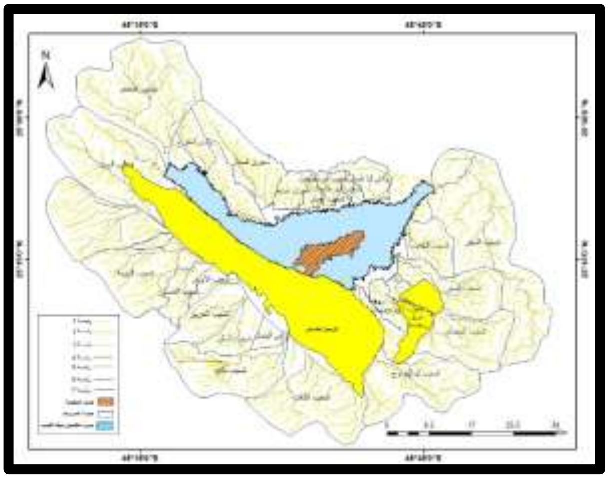
- Automatic determination of flow directions and paths from the data of the digital model of altitudes after filling in the spaces with it, as each cell of the digital elevation model, has a value of a height level, and by tracking the height values, it is possible to determine the directions and paths of the flow automatically.

- Obtaining the stream order ranks for classifying streams. According to the Strahler system **[5]**, it is then converted from Raster to Vector form via Stream To Feature.

From the analysis of Figure (16) and Table (4):

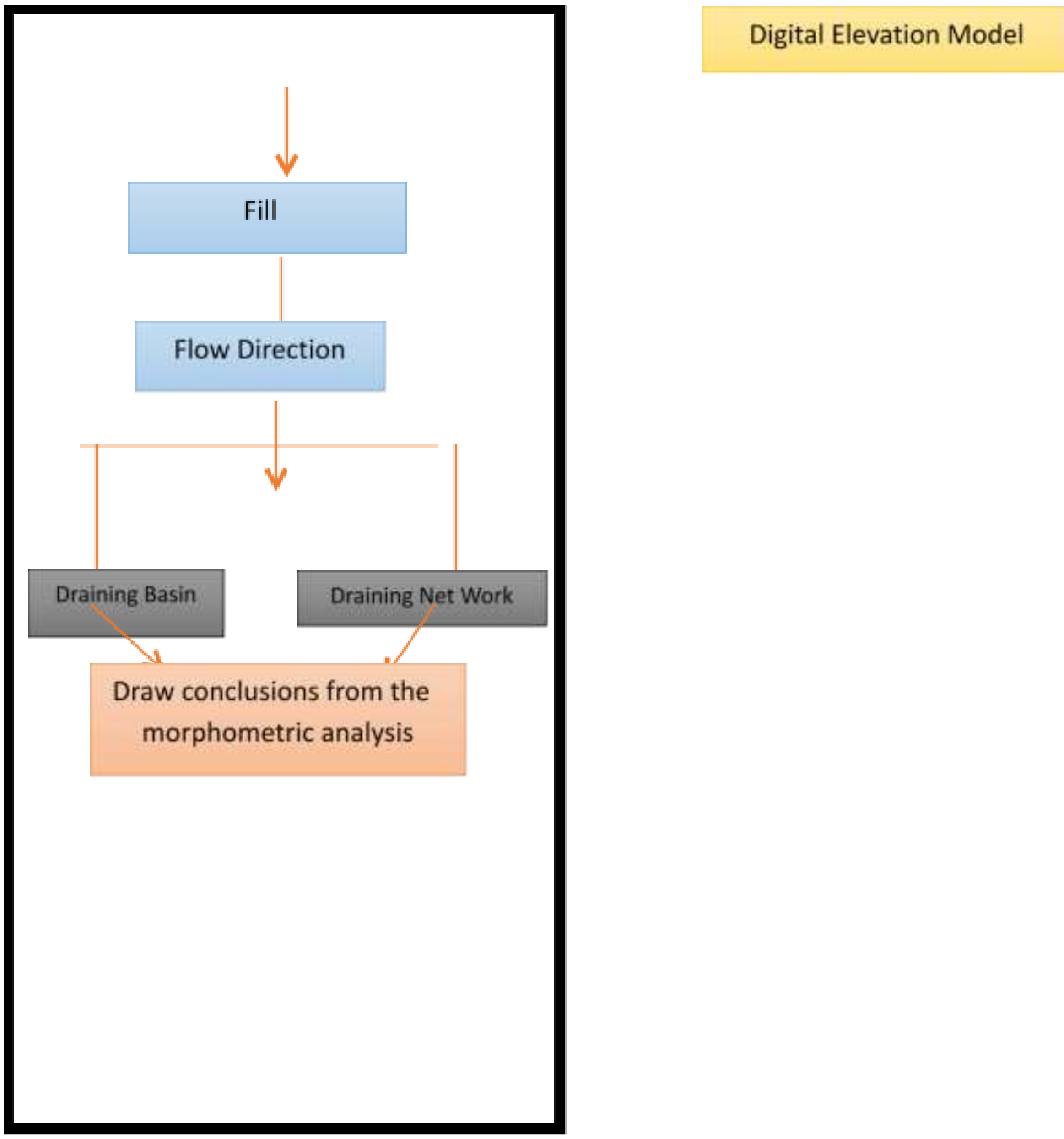
The area of the drainage basins was calculated by relying on the digital heights model and following the upper reaches of the valley's streams feeding the Sabkha depression, where it became evident that 29 drainage networks were providing the Sabkha lowland of the reed of various ranks, areas, and lengths, where the ranks of the waterways according to Stehler's classification reached seven ranks of the Al-Sabkha stream. There are two ranks for the Al-Khubayb stream. The drainage networks vary in area, as it exceeds between 200 km2, such as Shuaib Al-Mashqar, Al-Mukhar, Aba Al-Fansh, Al-Kaft, and Al-Obeib, and less than 30 km2 for Shuaib Abu Fahahel, Al-Sidr, and Dweiger, taking into account the presence of some waterways without a name.

Figure (16) Drainage basins around Sabkhat al-Qaseb.



Source: The work of researchers based on topographic maps, scale 1: 50,000

Figure (17) Folw chart for extracting drainge basins and networks for the sabkhat al Qaseb Depressions.



The total length of the drainage networks of valleys sloping towards Sabkha reached 4,099.4 km, and the Eastern Mukhar, Shuaib al-Ubayb, and Shuaib al-Mashqar streams constitute (12.8%, 8.2%, and 8.4%), respectively, of the total lengths of their streams. Simultaneously, the remaining basins range from 2.1% to 11.3% due to the structural situation in which the study area stands, represented in the Tuwaiq Mountains in the north, east, and southeast of the Sabkha Depression. The drainage networks in the Sabkha al-Qasb Basin can be divided into direct drainage networks such as Shuaib Al-Mashqar, Al-Muqrah Valley, Al-Ammar Stream, Abu Fahahel, and Aba Al-Sidr in the north. And the stream of the eastern makhar, the southern one in the east and the southeast, in addition to networks of indirect drainage such as al-Jamal Valley, Shuaib al-Salim, Shuaib al-Awar, and Shuaib al-Raymah through Ariq al-Baladan to the West and Ariq Raghba that descent through the slope of Shoaib Aoyuj and Al-Hussan.

Table (15) Morphometric (and area) Characteristics of Drainage Basins Sloping towards Sabkhat Al Qaseb.

Basin	Area (km2)	Network length (km2)	Rank	The number of drains in the basin	Total lengths of waterways (km)
Shoaib Al-Mashqar	333.2	27.4	5	435	420.9
Muqrah Valley	45.1	13.5	4	61	64.4
Al-Amar stream	133.9	24.6	4	167	179.9
Doegger stream	11.9	7.4	4	11	18.3
Abu Talihat stream	26.5	8.1	3	33	39.7
Sidr stream	27.9	8.4	3	19	26.2
Shuaib Abu Fahahel	8.5	6.2	3	10	11.4
Aba Sidr valley	51.8	8.7	4	65	52.9
The eastern Shoaib Al Makher	424.6	34.9	7	511	492.9

The southern Shoaib Al Makher	143.1	21.2	4	150	192.9
Shoaib Al-Khubayb	74.7	14.3	2	88	99.3
Shoaib AL-Hissan	199.6	26.9	5	220	248.8
Shoaib Aiuj	54.8	12.2	3	67	54.4
Shoaib Aba Al-Fanouh	266.3	30.1	5	348	344.2
Shoaib Cavt	247.5	25.1	5	258	293.6
Shoaib Al-Abib	498.4	29.7	7	334	33.8

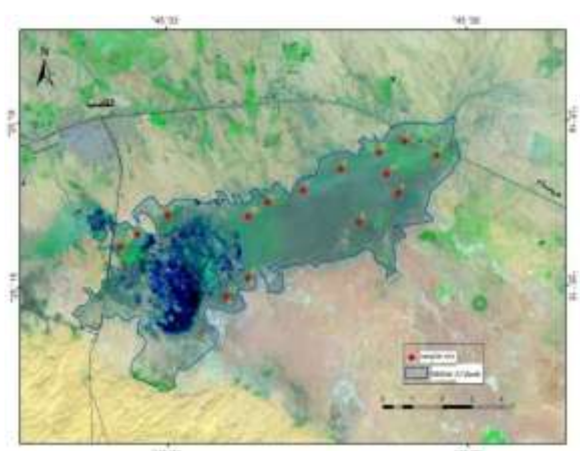
Source: depending on the figure (5)

3.6. The volumetric and chemical properties of the:

3.6.1. Volumetric characteristics of sabkha deposits.

Samples were taken from the surface layer to a depth of 40 cm due to the subsurface water level's proximity in some samples near the salt basins, West of al-Sabkha, and subsurface samples in eastern al-Sabkha, Fig. (18) and Panel (7).

Figure (18) The locations of the study samples in Sabkhat Al Qasab.



Source: The work of the two researchers, based on the field study.

Panel (7) of the excavation sites of some samples in Sabkha al-Qaseb

Source: Filming the researchers through the field study.

Table (16) results of the mechanical analysis of the sediments of Sabkha Al-Qasab.

Number of Samples	Level of sample	Type of sediment	Particle size%		
			clay	slurry	Sand
1	Subsurface	Clay	8,6	49.6	19.9
2	Superficial	Clay silt	7.1	52.4	41
3	Subsurface	Sandy clay	6.6	42.33	53.2
4	Superficial	Sandy clay	5.6	44.1	45.1
5	Subsurface	Sandy clay	5.9	41.9	54.8
6	Superficial	Sandy clay	4.6	39.8	56.8

7	Subsurface	Sandy clay	5.9	45.8	48.8
8	Superficial	Sandy clay	6.7	44.6	51.6
9	Subsurface	Sandy clay	5.9	39.9	45.4
10	Superficial	Sandy clay	5.8	40.5	54.8
11	Subsurface	Sandy clay	7.9	61.9	63.3
12	Superficial	Sandy clay	8.8	55.8	56.4
13	Subsurface	Sandy clay	8.6	51.6	57.4
14	Superficial	Sandy clay	7.8	56.9	65.7
15	Subsurface	Clay silt	9	54.8	20.3

Source: The mechanical analysis was performed at the Soil and Food Research Center, Faculty of Information and Technology, Zagazig University, Egypt.

It is clear from the analysis of Table (16):

- The sediments of sabkha al-reed generally consist of three types: sand, clay, and silt. Their percentage varies between 65.7% for sand, 61.9% for baskets, and 9% for clay. Gravel present in the samples is neglectable, which is a result of the location of the Sabkha in the low center drainage network of the area around the body of the Sabkha (low sabkha area difference), which is estimated at 381.1 km2, where these sloping materials are deposited in it.

- The percentage of clay increases in the study samples (1,12,13,15), reaching 33.4% for the volume of clay in the selected samples, and for the portion of silt, it ranged between 39.8% in sample No. 6 and 61.9% in sample No. 11.

-The percentage of sand increases in the samples of Study No. (11,12,13,14), reaching about 33% of the total volume of sand in the studied samples; perhaps the high percentage of sand in all samples of sabkha sediments in the study area is due to the proximity of these sabkhas to sand sources, as the Ariq al-Buldan surround them with their borders to the West.

3.6.2. Chemical analysis of sabkha water.

The study of the chemical analysis of (brine) sabkha water aims to determine the salinity of the sabkha water and the degree of concentration of cations and anions prevailing in this water, panel (8) and thus to identify the origin and source of that water.

Table (17) chemical analysis of sabkhat water in the study area.

Sample	**Anions (ppm)**			**Cations (ppm)**				**Alkaline**	**Total dis-solved salts(ppm)**
	Carbonates	**Chlorides**	**Sulfate**	**Calcium**	**Magnesium**	**Sodium**	**Potassium**		
1	890	1530	1630	2696	4116	21500	6455	8.2	52200
2	1346	2124	2385	4690	6345	24987	8256	9.1	53299
3	1100	2665	2465	4780	6322	25632	8642	9.3	56300
4	1322	1989	2365	4132	5987	22658	7986	8.1	52342

Source: The chemical analysis was performed at the Soil and Food Research Center, Faculty of Information and Technology, Zagazig University, Egypt.

From a study of Table (17), it is clear that:

Sodium cation represents the predominant element in Sabkha al-Qaseb water, where the highest value is recorded in the third sample. Their increase in concentration is due to the severity of its solubility in water, followed by the potassium cation, where the highest value was recorded in the same sample (8642 parts / million). In contrast, both calcium and Magnesium were the lowest concentration in the sabkha water, where the percentage of calcium ranged between 2696 - 4780 parts / million, with an average of 4074.5 parts / million in total samples, while the share of Magnesium went between 4116-5987 parts / million with an average of 5692.5 parts / million of the total cations.

- Sulfates are one of the soluble components, and the reason for their precipitation is due to the evaporation of water. The Sabkha al-Qaseb is witnessing a rise in the concentration of sulfate salts, as the highest concentration of sulfate was recorded in the third sample, reaching 2465 parts / million.

Calcium sulfate (gypsum) and potassium are the predominant salts in the Sabkha al-Qaseb due to the high temperature required for these salts' deposition and increased evaporation rates.

As a result of the climatic conditions in the Sabkha al-Qaseb, where the temperature increases and the evaporation energy increases, the chloride salts' concentrations rise in the sabkha water, where the third sample's highest concentration reached 2665 parts / million because it is one of the dissolved components. The Sabkha's essential chloride salts are halite (sodium chloride), which is salt Predominant (al-Qaseb salt) in all study samples, whether in their sediments or water. , As a result of this, salt being severely affected by climatic factors, given that its deposition conditions require severe drought conditions for an extended period **[6].**

- The total dissolved salts in the water for the samples in the study area are very high, as they ranged between 56,300 ppm as the highest concentration in the third sample and 52,200 ppm as the lowest concentration in the first sample. Sample and these high concentrations of salts are sufficient to precipitate gypsum into the sediment. The marshes result from the proximity of the groundwater level to the high salinity, increasing their salinity and appearance on the surface with capillary properties, especially under conditions of continuous evaporation and concentration of salts. The source of the salts is since the detectors of rock formations form a range and times of adjacent areas of salinity from which the valleys such as gypsum and hydrate arise, and they contain minerals that dissolve quickly in rainwater and transfer to the Sabkha**.**

The levels of bicarbonate and carbonate in the water of the samples of the study area increased, exceeding 1000 parts / million, except for the first sample; as for the alkalinity, it ranges between 8.1 in the first sample and 9.3 in the third sample, indicating the predominance of the alkaline medium in the swamp waters.

Panel (8) of the salt ponds in the Sabkha al-Qaseb.

Source: Photographs of the two researc hers, based on the field study.

3.7. The economic importance of the reed beds.

Sabkha al-Qaseb is widely known in the Kingdom of Saudi Arabia because of its salt, as pure salt is extracted from two joints, near and far or upper and lower, according to what is known among people and between them a distance of one km,

As for the number of ponds in the upper Jaffara, it does not exceed 40 pounds, some of them are almost neglected, and as for the ponds in the new Jaffara, their number is 300 ponds, distributed over about 20 properties. Personal interview with Mr. Muhammad Al Humaidi, one of the owners of salted ponds from the people of the Al-Qaseb city. the owners of these ponds can extract the salt, or the salt remains inside and use those ponds as natural stores, which is called the reed. It is a process called the process of transporting and extracting salt from the pond, and the salt in it is wet and placed on the sides outside of piles that aim to dry under the rays of the sun and exposed to the air so that the buyer can see the quality of the product.

Panel (9) Extraction of salt in Sabkha al-Qaseb.

Source: Photographs by the researchers, based on the field study

The production of salt ranges per basin from 1000 tons to 1500 tons annually with an approximate area of 50 meters * 100 meters, panel (9). the estimated production value for a medium pool 50 * 100 meters between 400 thousand Riyals to one million Riyals per cycle and the cycles are repeated every two years Or three **[7]**. Accordingly, it is possible to expand the production of table salt by increasing the number of basins exploited, especially since table salt is considered the raw material for many industries and within its components, either mainly or secondary, in addition to being used in food industries, such as Bakery and cheese in addition to other sectors, for example, the manufacture of fertilizers, textiles, glass manufacturing, and the manufacture of medicines in addition to its importance for the human body as it needs about 6 kg annually to balance the required solutions for the body's systems in addition to considering it an alternative to treat iodine deficiency and the complications associated with it that lead to Goiter also affects children's growth and intelligence.

While the Sabkha al-Qaseb soil suffers from many problems represented in the fragile ground due to its high salinity level in addition to the high level of groundwater, as it was mentioned that they find their little need of salt From the trace left by camel feet while walking on the marsh floor, where these feet go to a depth of 10cm, forming circular pits filled with saltwater, As random cavities are created as soon as a month passes, white salt is formed in them and they taken it in form of hard disks, which makes it challenging to use Sabkha in human activities such as construction and laying roads, so its fragile and moist soil will lead to subsidence of foundations In addition to that, the high concentration of sodium, chloride and sulfate salts in its water, which necessarily affects its sediments and dyes them, makes it challenging to build on it, so we find the al-Qaseb city north of the Sabkha and outside its borders at a level of 667 meters, also the sabkha soil is not suitable for agricultural activity due to the high salinity of its water.

IV. Conclusion:

A geomorphological study of the Sabkha al-Qaseb in Riyadh, Saudi Arabia, concluded with several findings and recommendations, as follows:

--The reed sabkha is located at two circles of width 25/13 43 and 25 18 23 north, longitude 45 32 49 and 45 40 31 east, with an area of about 45.6 km2, with a width ranging between 1 and 5.8 km and a length of up to To 14.3 km.

-- The Sabkha is located within a basin depression surrounded by contour 660 meters above sea level, with an area of 426.7 km2. Sabkha depression levels vary from 625 to 673 meters. The Sabkha al-Qaseb starts at 634 meters, and the deepest point is located in the far West at a level of 625 meters.

-- The geological conditions played an essential role in the emergence of Sabkha al-Qasab, as the geological formations had an influential role in the construction of sabkha sediments within the basin depression, through the Middle Jurassic sediments (Darma formation) ending with gravel deposits belonging to the fourth geological time that occupied 23% of the total area of the Sabkha depression. The edges of the Tuwaiq Mountains, north of the Sabkha Depression, also played a role in the emergence and development of Sabkha al-Qasab deposits represented by sediments loaded with salts brought by the streams sloping from those ridges towards the bottom of the depression, which affects the extension of the Sabkha, whether on the horizontal level in the area or terms of the vertical level through An increase in its level due to the accumulation of these sediments on the surface and the formation of the shapes associated with them.

Geomorphology The Sabkha al-Qasab basin divided into two areas:

The first: the shapes that occupy the Sabkha's surface, represented by (mud cracks - salty domes- pools and wet salt surfaces - salt bridges).

The second: the phenomena that occupy the sabkha boundaries, represented in (meadows and affluence – sand coverage - drainage networks).

- The Sabkha al-Qasab sediments consist of sand, clay, and silt, whose percentage varies between 65.7% for sand, 61.9% for mud, and 9% for clay. Sodium cation is the predominant component in Sabkha al-Qasab water, followed by potassium cation, which recorded the highest value in the same sample (8642 ppm),

V. Recommandations:

To classifying the study area as an internal sabkha mentioned (Azza Ahmad Abdullah, 1995, p. 428) that in general, internal Sabkha has less salt compared to coastal Sabkha. Therefore, it can be:

1- Growing it with certain types of plants, such as:

VI. Saltbush (Atriplex halimus), one of the pasture plants suitable for feeding animals, is characterized by a tolerance of high degrees of salinity and can remove salts by excreting them through small vesicles filled with salt.

VII. Sea Rush (sammar, nammas) plant, its fiber is used in the manufacture of paper, and it has a reasonable economic return.

2- Encouraging industries based on salt extraction and following up distributing the product to consumers.

3- Conducting more studies using remote sensing to follow up on the Sabkha al-Qasab development and growth.

4- The necessity of preserving the Sabkha al-Qasab from the environmental dangers, such as the Sand encroachment, primarily since the salt ponds are located west of the reed bed near the Ariq Al-buldan, in addition to the risks of underground water pollution, salinization of the soil, and waterlogging of the ground.

5- Emphasizing the need to implement the environmental laws' provisions by not throwing any waste so that the underground water is not polluted.

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