Basrah Journal of Science Vol.37(2), 237-251,2019

Hydrodynamic of the Sediments Movement in the Southern Part of the Shatt al-Arab and North-Western of the Gulf

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Doi 10.29072/basjs.20190207, Article inf., Received: 3/7/2019 Accepted: 16/8/2019 Published: 31/8/2019

Abstract

The Aims of study are the movement and distribution of sediments in the southern and northern parts of Shatt al-Arab River, and the north-west of the Arabian Gulf. The study includes observing the suspended sediment and the speed of the currents atnine stationsAbu Floss north of the junction of the Karun River, Fao, the entrance of the Shatt al-Arab River external dam, Khor Al-Umaya, the entrance of Khor Abdullah in front of the Port of Mubarak, Khor Shitanah, Umm Qasr and finally Khor al-Zubayr. The Rate of suspended sediment in Fao area and the entrance of the Shatt al-Arab River reaches more than 3 g /L in the tide, and (0.6) g / L in the ebb. This indicates that the sediments came from the entrance of Shatt al-Arab River because of the erosion in the banks of Marqet Abdullah. While the area of Abu Flos, the suspended sediment was at least. It indicates that the movement of sediments in the north of Shatt al-Arab has a little load, whereas Al-Siba is affected by the sediments of the Karun River. It has been shown that there is a redistribution of sediments in the area. This is due to the absence of the discharge capacity of the Karun River, and remaining the energy of the flood tide and ebb, which constitute the main force of the movement of sediments in the area. Therefore, these sediments are the same ones that coming from the entrance of the Shatt al-Arab during the tide. In the ebb tide, the region of Shatt Al-Arab estuary effected by the hydraulic nature of the sub-rivers that drag clayey silt bed material for the main river.

Key Words: Shatt Al-Arab, Hydrodynamic, Suspended Load, Salinity.

1-Introduction

During the last century, one of the most important problems facing the Iraq ports where the processes of sediment transport caused toresult the huge amounts of sediments. Iraq still spending money for the dredging operations and cleaning the navigational channels. The lack of drainage, which appears clearly in the Shatt al-Arab Canal and its large proportions at the present time, differs from the previous one that took place in the eighties of the last century. The discharge reached more than 700 m^3 /s. In the nineties, it was between300-600 m^3 /s. It was reduced in the last ten years, as a result of the establishment of dam projects in the neighboring countries to become less than 10 m /s [1].

There are two phenomena that affect the dynamics of sediment movement in this area, namely the phenomenon of tides, which is the natural phenomenon of two phases occur in the water of the oceans and seas. The tidal phase involves a gradual rise in the level of the ocean or sea surface water River. The ebb phase involves a gradual decline of hydraulic gradient toward the gulf. The phenomenon of tide classified semi-daily, i.e., most days of the month, two tides a day, two ebbs a day, or one flood tide and ebb a day and vice versa[2].

The second phenomena are Carioles, which is known as a physical condition. It is interested in studying the force affecting the rotation of the earth, as a moving object. It depends on following the tendency of the earth on the right axis in both the northern section and the southern section. This means the movement of water currents, which come from the Shatt al-Arab River, takes the right direction, namely towards Khor 'Abed Allah, and enters with loaded sediments,[3]**.**

In study of, [4] pointed the northern part of the Shatt al-Arab in the calculation of the river load out that the discharge of the Shatt al-Arab, at the port of the ALmakal, during the month of April and June 1990, was between 5-9 kg / s.

In Al-Mansouri study [5],the suspended sediment of 15 mg / L, was observed in the mouth of Karun River in May, 1995, and it reaches 10 mg / L in Al-Siba at the same interval, and 20 mg / l in Ras Al-Bisha. Whereas the discharge of the suspended sediment in Karun River reached 20 million tons per year, and the other half is precipitated. In 1996, the coastal load, along the distance between the junction of the Karun River and the Shatt al-Arab basin, had reached about 9500000 tons per year as a suspended load, and 85000 tons annually as a landfill. The sedimentation rates were estimated to be south of the confluence of the Karun River at Shatt al-Arab River In the same year of between (167,000-203,200) tons.

[6] Confirmed that the sediment of the Shatt al-Arab (Delta) sediments mainly consists of 60% silt, 25% clay and 15% sand.

The factors controlling the distribution of sediments in the mouth of the Shatt al-Arab River consist of three main forces: river discharge, tide energy and wave energy. They have made the shape of the delta a bell like [7], where the transported sediments become bidirectional. As a resultof the confluence of the sea.

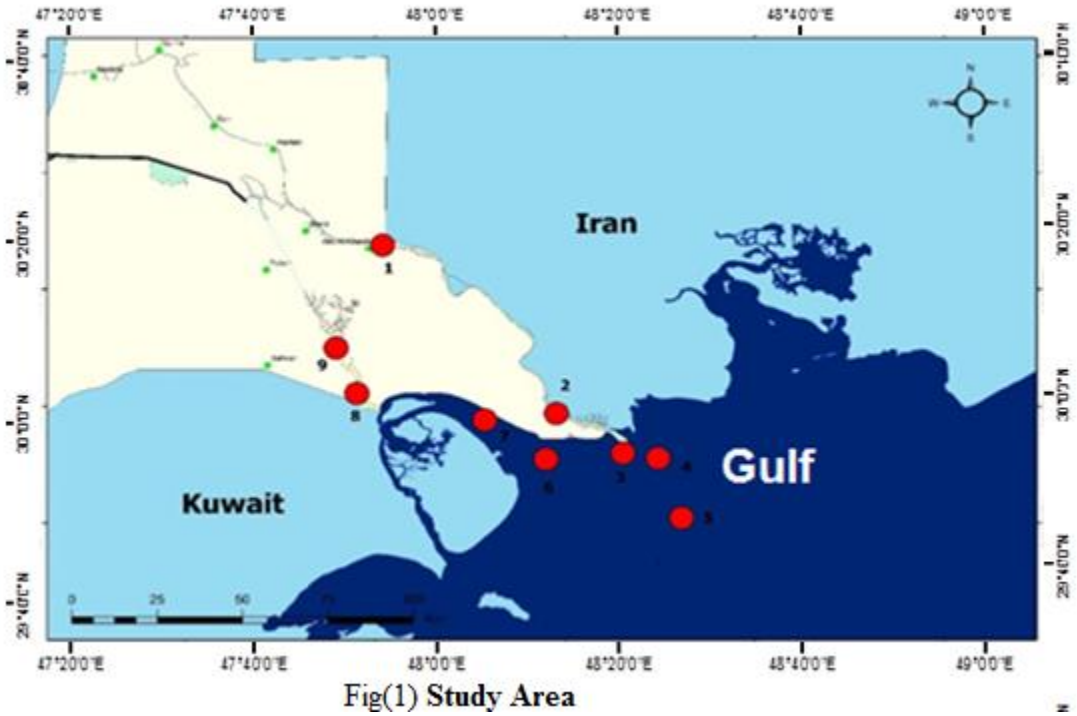
[8] pointed out that the discharge of the suspended sediments in the area of Fao reached 1 g / l in the periodflood tide and 0.3 g / l in the ebb period between the years 1948-1960, [5] , reported that the discharge of the suspended sediments in the Fao area reaches 6 g / L in the flood tide, and 0.82 g / L in the ebbs period between the two years 1994-1995.

[9] pointed out that Palinurus Shoal, Northwest of the Arabian Gulf was affected by the high velocity currents of the Shatt al-Arab, so its environment was turbulent.

The current study aims to evaluate the changes in the movement and discharge of the river load of Shatt al - Arab and territorial waters north - west of the Gulf.

2-The Materials and Methods

Nine stations were selected along Shatt al-Arab River And territorial waters, Abu Flus port, Fao, Ras Al-Bisha, Khor Al-Umaya, Khor Abdullah entrance, Mid Khor Abdullah, Khor al-Zubair at side the port, KhorShitanah, Umm Qasr(Fig1).



Fig(1) **Study Area**

The Field work was launched on 20/6/2012 to 29/6/2012 on-board of the scientific vessel (Albahth),The name of the trip pearl of Basrah. It was organized by the Marine Sciences Center include nine stations, starting from the Shatt Al-Arab (Kornish) to Umm Qasr. The journey includes were: set of field tests and measurements, which include: measurement of the suspended load at the same stations using the water sampling device. The number of samples in each hour is 7 samples to represent the river section in each station. During the 13 hours per station, except for the Abu Floss station. The measurement is 25 hours. The sampling was limited by the, and the Iraqi side and sea stations. The samples are only from the location of the samples in all stations are about 532 samples.

The field measurement velocity current of the stations with half of a tide course, i.e. 13 hours (tide and ebb) in most stations, except Abu Floss and Fao stations were 25 hours, because the tide course in the area includes two tides and ebbs per day, using the ADCP device (Acoustic Doppler Current Profiler), The device is used to measure the speed and direction of water currents. Bottom sediments from all the stations were taken using the Grab Sampler. Pipette method was used to measure the sand, silt and clay as mention by[10].

According method [11] and[12] suspended Load Calculation uses through which the suspended load calculate uses the filtration method of water samples by the filtration apparatus and sheets 45 Micron.

3-Results and discussion

The rate of velocities in the period of ebb in of Abu Floss station is $0.41m^3$ / s, and the currents of the ebbs are two powerful vehicles, namely the discharge of the Shatt al-Arab plus the mass of water returning from the tide. The overall current velocity of the ebb downstream is greater than the velocity of the flood (upstream) currents, which was $0.326m^3$ / s. whereas the velocity of flood tide of Fao currents is 0.491 m^3 /s, and the flood tide is $0.551m^3$ / s. (Table 1).

It is noted that cross section of all station (Fig 2) and the velocity of the flood tide currents is higher than that of the ebbs near the mouth of the Shatt al – Arab River (Table 1) because of the proximity of the area of Fao to the Gulf. The Ras al Bisha and the external dam of the Shatt al-Arab shall be the average velocity of the currents in the period of the ebbs was $0.386m^3$ /s, and in the flood tide period the average velocity of currents was $0.65m^3$ / s which is the mouth of the Shatt al - Arab in the Gulf. Then, velocity current decreases, when we move towards the sea. The average velocity the current in the flood tide in the Khor Al Umaya is $0.16m^3$ / s. While the velocity of currents the period of the ebbs was $0.148m^3$ / s.

At the entrance of Khor Abdullah, the rate of the flood tidal currents is 0.994m^3 /s.and the velocity current rate in the period of the ebbs was 1.23 m^3 /s. Because there are sources of discharge and the movement of the currents represents the mass of the water in the KhorAbd Allah channel. The average velocity of the currents,the flood tidal in KhorShaytana area was within the rate at the limit of 0.987m^3 / s. While the period of the ebb was 1.39 m^3 /s,that are working on the erosion of the bottom bed, formation the suspended load.

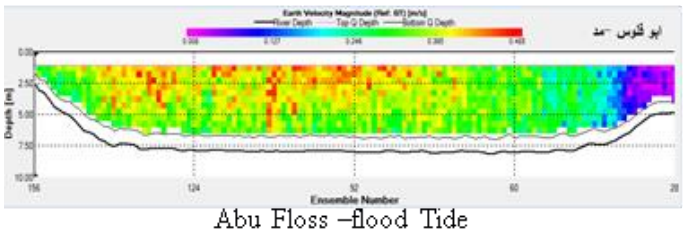
The average velocity currents of the period,ebb lowered in the Umm Qasr canal to be 0.168m / s., and the rate of the flood tidal currents is 0.12m /s. Because the Umm Qasr canal It got closed in down canal. But the velocity of currents of flood tidal in Khor al Zubair became about 0. 32 m^3 /s. While the period of the ebb was 0.46 m3 /s., As a result, the mass movement of the water mass entered at the time of the ebb.

In Abu Floss station the suspended load was 0.16 g / l, (Table 2) in the ebb period. While the suspended load in flood tidal was 0.136 g/l. which is of a small quantity because of the reduction of Shatt al-Arab discharge in this area,which is of a small quantity because of the reduction of Shatt al-Arab discharge in this area,it's low rate of discharge in Shatt al-Arab which is about 10 m3/s in this area, the low amount of water that comes from upstream Shatt al-Arab River which does not exceed less 50 m3/s, and also , the suspended load becomes few. As well as the limited effect of the sediments of the Karun River now in the Fao in the ebb period and the return of the tidal water (back flow), The total load is suspended 0.6 g / L, (Fig 4),While the suspended load in flood tide period was 3.08 g / l.(Fig 3).This load consists of from the erosion of the bottom bed the Market Abdullah and the Shatt al-Arab Delta(Fig 5) [13] .

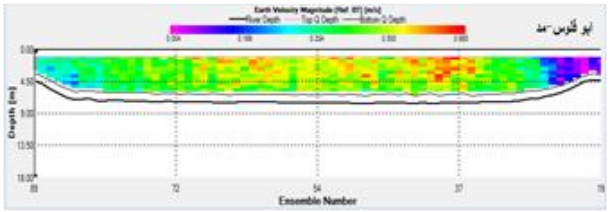
And the hydraulic withdrawals of the sediments in the sub-rivers associated with Shat Al Arab due to the high salinity of the droppings and the death of the protective vegetation to the river banks [14].

Table (1) the velocity and currents

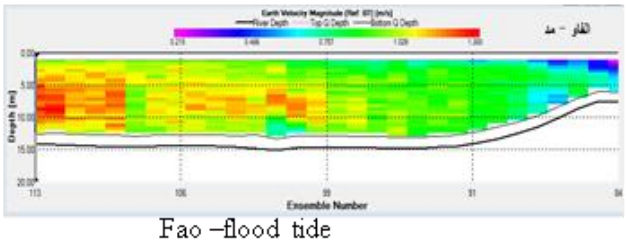
Transect	Top Q m^3/s	Meas. Q m^3/s	Bottom Q m^3/s	Left Q m^3/s	Right Q m^3/s	Width m	Total Area m^2	Q/Area m/s	Flow Speed m/s	Flow Dir. °
Abu Floss (flood Tide)	-141.1	-626.11	-126.3	-11.43	-6.01	420.5	2939.9	0.31	0.32	283.6
Abu Floss (Ebb)	161.5	715.3	158.4	14.72	9.28	418.1	2794.8	0.37	0.41	106.9
Fao (Ebb)	-205.3	-2073.8	-256.8	-765.0	-82.7	373.8	3959.5	0.85	0.95	305.9
Fao (flood Tide)	87.78	767.4	103.3	252.9	33.45	332.4	3199.2	0.39	0.49	121.3
the Shatt al-Arab external dam (Ebb)	130.4	947.5	149.1	320.2	10.8	383.4	3164.9	0.49	0.55	324.3
the Shatt al-Arab external dam (flood Tide)	-4340	-16569	-3860	-206.8	-1618	28059	137323	0.45	0.65	305.8
Khor Al Umaya (Ebb)	20.70	193.6	30.26	0	0	400.5	4786.4	0.05	0.14	142.1
Khor Al Umaya (flood Tide)	-24.23	-205.7	-36.1	0	0	400.5	4786.4	0.07	0.16	322.1
Khor Abdullah (flood Tide)	-30.0	-15.73	-3.12	0	0	14.6	127.7	0.17	0.99	306.0
Khor Abdullah (Ebb)	39. 0	18.41	5.32	0	0	14.6	148.2	0.22	1.23	126.0
Khor Shaytana (Ebb)	989.2	2567.8	582.1	0	0	1159	4498.3	0.92	0.98	128.2
Khor Shaytana (flood Tide)	-995.1	-2719	-622	0	0	1159	4878.3	1.02	1.39	308.0
Umm Qasr (Ebb)	51.45	518.66	47.9	0	0	323.7	3924	0.15	0.16	136.2
Umm Qasr (flood Tide)	-44.65	-453.3	-39.6	0	0	323.7	3924	0.11	0.12	316.1
Khor al Zubair (Ebb)	1.01	8.66	0.84	0	0	2.35	28.8	0.36	0. 46	0.46
Khor al Zubair (flood Tide)	-13.2	-7.89	-0.95	0	0	1.78	28.8	0.38	0.32	180.37



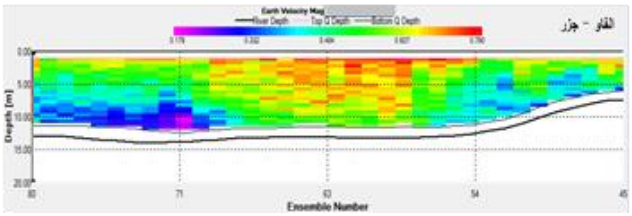
Abu Floss –flood Tide



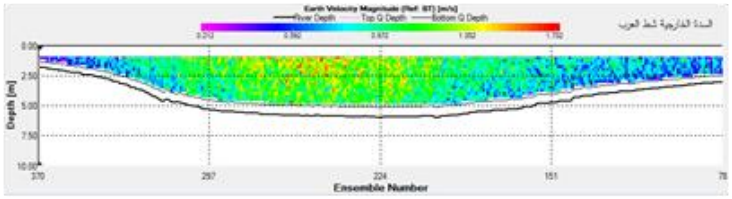
Abu Floss –Ebb



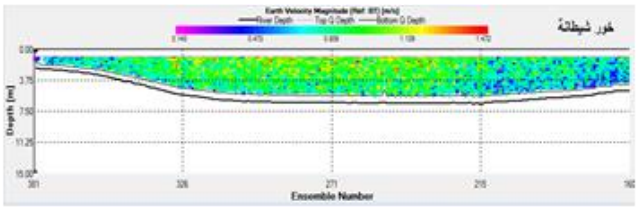
Fao –flood tide



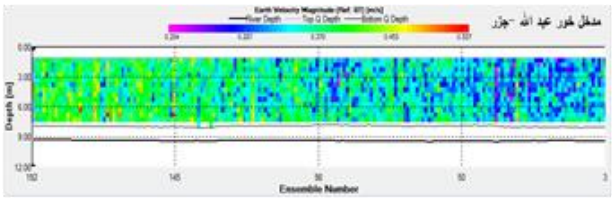
Fao-(Ebb)



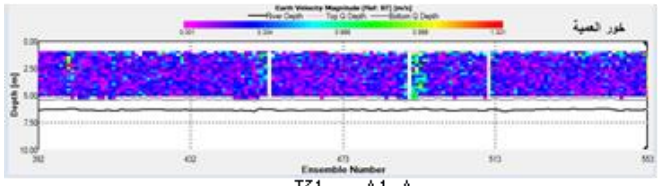
the Shatt al-Arab external dam



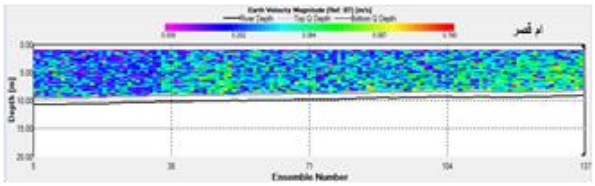
KhorShaytana



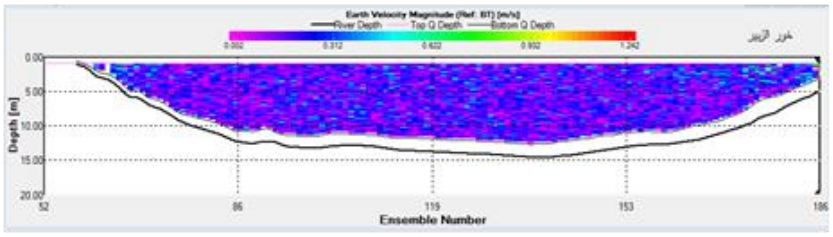
Khor Abdullah



Khor Al Amaya



Umm Qasr



Khor al Zubair

Fig(2)Cross sections and velocity of currents in station

Locations	Date	Ebb g/L	Flood Tide g/L
Abu Floss	2012/6/21-20	0.16	0.136
Fao	2012/6/22-21	0.6	3.08
Ras al Bisha	2012/6/23-22	1.8	2.4
Khor al Umaia	2012/6/24-23	0.088	0.068
Entrance of Khor Abdullah	2012/6/25-24	0.6	1.28
Middle of the Khor Abdullah	2012/6/26-25	0.68	0.96
Khor Shaytana	2012/6/28-27	0.48	0.812
Umm Qasr	2012/6/29-28	0.964	0.804
Khor al-Zubayr	2012/6/27-26	0.832	0.612

Table (2) the suspended load rates at all stations for flood tide and ebb periods

The suspended load at Ras Al-Bishawas highest during the flood tide period (Fig 3).

In addition to the suspended load of the sediment which comes from Fao to cause a redeployment of the sediments. And the bottom bed will be formed of the clay precipitations and which affected quickly by erosion, as it is shown in table (3), due to the lack of river discharge.

And in Khor Al-Umaia the rate of suspended loads reached in the ebb period was 0.088 g / l. (Fig 4), and in the flood tide period was 0.068 g / l. (Fig 3).

The currents of the vortex occur, thus erasing the bottom, whereas the suspended load in Khor al Umaia does not differ between the tidal periods, due to the weakness of the drainage of the Shatt al-Arab. So the water will be pure and the effect of the sediments will be clear too. The suspended load becomes in the ebb period was 0.6 g / l. (Fig 4).

In the Entrance of Khor Abdullah and in the flood tide period was1.28 g / l. (Fig 3). This is due to the movement of the sea currents towards the right side of the Shatt al-Arab, being affected by the phenomenon of the Coriolis force. This result agrees with [14].

This rate increased in the middle of the channel as a result of the sea currents generated by the movement of ships. The Khor Abdallah canal is considered as the main channel of the Iraqi navigational movement, and the movement of the currents in Khor

Shaytana is increasing. It is considered as the junction of the Khor Abdallah and Khor al-Sakka.

The suspended load in Khor Shaytana in the flood tide period was 0.812 g /l.(Fig 3).The movement of currents in the tide period becomes high because of the currents of the vortex in the area generated by the entry of currents of river discharge and the rise of the mass of the tide the tide water appears and in the ebbs period in directions to become 0.48 g /l. This area refers to a source of high suspended load, formed by the erosion of the bottom.

This is due to the currents which consist of the withdrawal of water in two directions, and because of the movement of ships in Khor al-Zubayr, which is regarded as the waterway to the port of Khor al-Zubayr. These Ships work to form currents that affect the erosion of the banks of the channel. Which the Umm Qasr canal the suspended load reaches in the flood tide period was 0.832 g /l. (Fig 3). This load increases in the period of the ebbs in Umm Qasr canal reaches 0.964 g/l, (Fig 3).

As it is a closed one from one side, and the movement of currents includes the decrease of the mass of water in the tide and its back to the main canal (Table2). Then the canal of Umm Qasr then is the industrial one of the ports of Umm Qasr.

The changes that have occurred in the area caused by erosion and the redeployment of sediments, the cessation of the Caron River from the processing of sediment, and the construction of a dam on it. It is noted that there is a burden suspended load inRas Al-Bisha in the tide, which is higher than it is in ebbs.

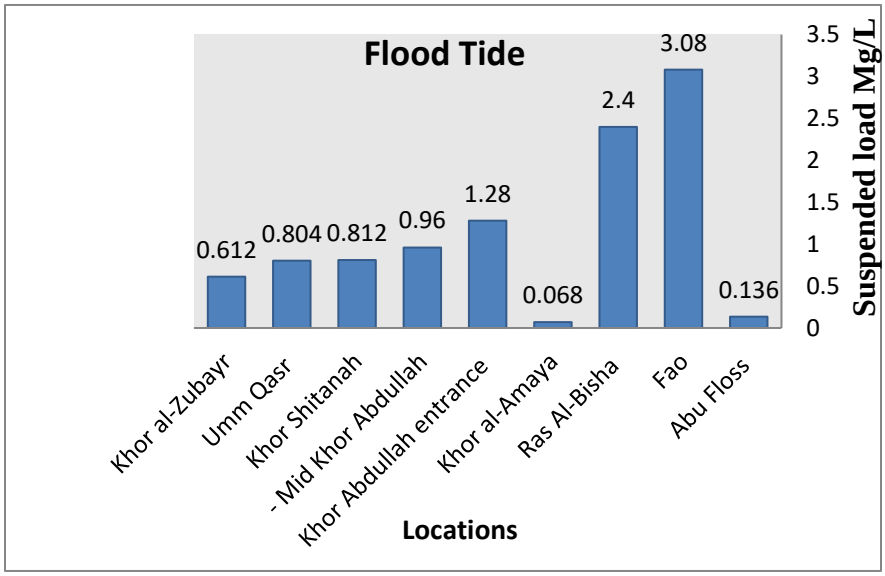


Fig (3) the suspended load in the Flood Tide

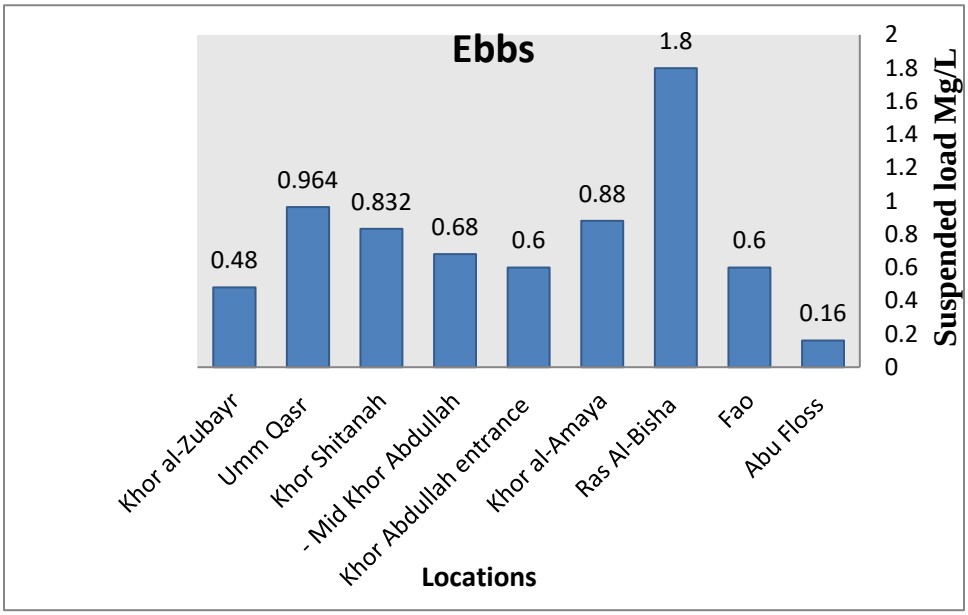


Fig (4) the suspended load in the Ebbs

The distribution of sedimentary deposits can be observed as in the table 3 below:

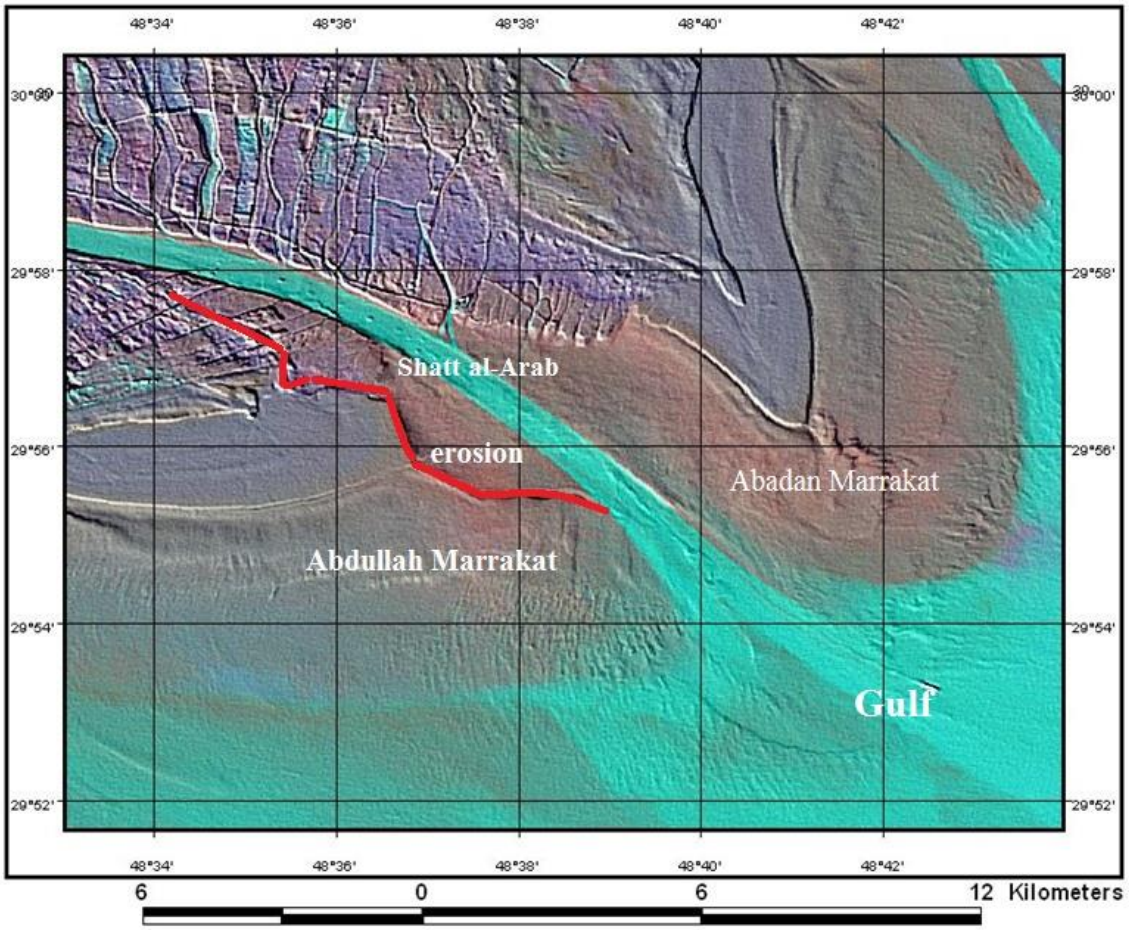
Table (3) The distribution of sedimentary deposits in station

No.	Locations	Sand	Silt	Clay
1	Abu Floss	12	77	11
2	Ras al BishaMid	5	84	11
3	Ras al Bisha/right	27	49	24
4	Khor al Umaia	40	45	15
5	Entrance ofKhorAbdullah	33	56	11
6	Middle of the Khor Abdullah /L	4	82	14
7	Middle of the Khor Abdullah /R	1	87	12
8	KhorShaytanaMid	96	2	2
9	Khor Shaytana/R	4	72	24
10	Umm Qasr/R	2	60	38
11	Umm Qasr/L	2	69	29
12	Khor al-ZubayrMid	21	64	15
13	Khor al-Zubayr/L	1	77	22
14	Khor al-Zubayr/R	5	74	21

It is clear that most of the sediment in the area is silty clay, and the proportion of clay, silt and sand changes according to the impact of the movement of currents, They are large volume suspended load by the strong currents was because of the erosion of the bottom.

The sediments suspended load in Ras Al-Bisha and Khor Abdullah are large volume, where erosion that becaused of the movement of the tide and wave energy and the phenomenon of Cariolos in which the currents move to the right and thus eat the delta(Fig 5), and this agrees With Abdul[12].

While in Khor Shaytana station we note the existence of high rates of sand of in the middle of the channel, Because of the presence of eddy currents.



Conclusions

1. It is noted that the suspended load at Abu Floss station is little in comparison with other stations, because it lies to the north of the junction of the Karon River and thus it causes less impact only in the tide period and a little as well as the lack of shortening, which causes a clear change in the movement and distribution of sediments.

2. The suspended load at Fao is High altitude due to the erosion of the soil from the Fao after the increase of salt and the death of the vegetation cover that protects the banks, and can be seen by increasing sediment in the case of tide, by pushing the sediment to Fao.

3. There is a reshaping of the entrance of Shatt al-Arab through the erosion of the banks of Abdullah (the Iraqi bank) and the deposition of the higher in the opposite side (the Iranian bank).

4. Clear change Shatt al-Arab Delta Because of redistribute its deposits at the entrance of the Shatt al-Arab or the entry of those sediments to Khor Abdullah by the tide currents.

5. The effect of the sediment is clear at the entrance of Khor Abdullah because of the nature of the sediments composed of Khor, which is a very soft clay sediment, moving by tide and ebb currents, leading to instability in the shape of the bottom and the area in general.

6. Khor Shaytana exposed to erosion of the bottom as a result of the movement of currents of the tide and ebb and the confluence of Boubyan Khor with Khor Abdullah and Khor al-Sakka.

7. The increase in the suspended load in the canal of Umm Qasr because of the entry of these sediments in the flood tide, and then starting withdrawal **with** less energy. Because of the closeness of the Umm Qasr Canal**,** which increases the **opportunity** to enter the sediment and start sedimentation in the area.

8. The impact of sediments in Khor al-Zubayr is limited on the area only, the movement of suspended load due to tide and ebb currents, and without an effect on the depths of the Channel because of the distance from sediment sources, whereas the effect of local sediments remains.

9. The sediments are very few in the deep seaport station because the impact of the Shatt al-Arab is not reached as a result of the leakage.

Recommendations

1. Stabilizing the banks of the Shatt al-Arab from erosion, especially the Ras Al-Bisha as a border area on the joint between Iraqi and Iranian borders.

2. Finding ways of treatment to stabilize the sediments at the entrance to the Shatt al - Arab and the corridors of Abdullah, which maintains the entrance of the Shatt al - Arab deviation, as well as reducing the movement of sediments in Khor Abdullah.

3. Making stations to monitor the movement of sediments because of the importance of the area economically and intensifying studies around it.

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هيدروديناميكية حركة الرواسب في الجزء الجنوبي من شط العرب والشمال الغربي من الخليج العربي

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مستخلص

تهدف الدراسة الحالية إلى دراسة حركة وتوزيع الرواسب في الجزء الجنوبي لنهر شط العرب، والجزء الشمالي الغربي للخليج العربي. تضمنت الدراسة ملاحظة الرواسب العالقة وسرعة التيارات في تسع محطات.وزعت المحطات على طول منطقة الدراسة (أبوفلوس شمال ملتقى نهر الكارون، الفاو مدخل شط العرب السدة الخارجية، خور العمية، مدخل خور عبدالله أمام ميناء مبارك، خور شيطانة، أم قصر، وأخيرا خورالزبير.يظهر من خلال التحاليل إن الحمل العالق في الفاو ومدخل شط العرب يصل الى اكثر من 3 غرام/لتر في حالة المد أما في الجزر يكون بحدود 0.6 غرام/لتر وهذا يدل على أن الرواسب تأتي من منطقة مدخل شط العرب بسبب عمليات التعرية في مرقات عبدالله، أما في منطقة ابو فلوس فكانت هي الاقل. وهذا يدل على أن حركة الرواسب شمال شط العرب تكون قليلة الحمولة، اما السيبة فهي تتأثر برواسب نهر الكارون. وتبين أن هناك إعادة توزيع للرواسب في المنطقة بسبب غياب طاقة التصريف لنهر الكارون وبقاء طاقة المد والجزر والتي تشكل القوة الرئيسية لحركة الرواسب في المنطقة وبالتالي فأن هذه الرواسب هي نفس الرواسب القادمة من مدخل شط العرب اثناء المد، في حالة الجزر، تتأثر منطقة مصب شط العرب بالطبيعة الهيدروليكية للأنهار الفرعية التي تؤدي إلى سحب رواسب الغرينية الطينية وتنقلها إلى قناة النهر الرئيسية.