### Tidal Range and Sea Level Changes at The Area in front of Umm Qasr Port South of Iraq



Adel Jassim Al-Fartusi Marine Science Center –University of Basra, Iraq

#### ARTICLE INFO

Received: 9 / 9 /2020 Accepted: 30 / 9 / 2020 Available online: 1 / 12/ 2020

DOI: http://dx.doi.org/10.37652/JUAPS.2020.14.2.1 4

Keywords: Sea level, Umm Qasr port, tidal sea level, meteorological elements

### ABSTRACT

The high maximum and low for sea level in north west of Arabian Gulf in the area next to Umm Qasr port were studied for a nodal lunar cycle that equal nineteen years (1999 – 2017). It was found that the sea level is rising. Depending on, the sea level monitoring of the nineteen years' interval, the essential characteristics of Umm Qasr's tidal range have been identified. This study addressed the problems of the collective impact of tides and meteorological elements at sea level, more precise characterization is given to this phenomenon through defining the frequency division for the tidal sea level, where it was found that the prevailing range within the two values are (3.0 - 4.0m), while the actual average tide is (3.908m). In addition, was comparing the calculated and registered range of the tide through the study period was found that the recorded range exceeded the calculated range and this increase due to meteorological elements which increases the effectiveness in the summer months in the study area.

### **1. INTRODUCTION**

Umm Qasr port located along Khor Al-Zubair Lagoon, which is part of the Iraqi marine water situated in the northwest of the Arabian Gulf and has important aspects for the country including economics, industrials, fisheries, and oil transportations. The tidal characteristics in the Iraqi marine

water are influenced by the tide of the Arabian Gulf. However, the tide of the Arabian Gulf is complex and shows a heterogeneous distribution between purely semi-diurnal or diurnal tide in some places and mixed tide in other places [1]. For preservation on sea coast at Umm Qasr, Precise knowledge is required regarding about the height of the highest and lowest water, besides to excessive sea level range and its seasonal variations, to this aim, excessive height for sea level fluctuations, which are important for coastal engineering. Studies conducted in the area in front of the Umm Qasr port are very few compared with the importance of this area of navigation and the Iraqi marine environment. The studies included aspects as. [2] the spread of oil stains by using of the mathematical model (Mike 2D). Hydrodynamic water masses in Khor Al-Zubair by using of the mathematical - model (Mike 1D) [3].

The hydrodynamic transmission of sediments in Khor Al-Zubair by utilizing of the mathematical model (Mike 1D) [4]. A study on wind waves [5]. As well as a study of broken winds [6], therefore, the present study is the first of its kind that deals with the high and low of sea level at the area, which discussed the basic properties of the tidal range, the collective

impact of tides, meteorological influences on sea level and determine the frequency division of the range of sea level during lunar nodal tidal cycle (for19 years), near an important economic port of Iraq. Because the unavailability of sea-level rise data that are recorded using the tide gauge continuously in the region and throughout the study period, the software (Total Tide) was used to predict tidal highs. This program records the highest and lowest of the tide in a promptly for a period of thirty consecutive days [7]. (figure 1a, b) expose a comparison of tide gauge measurements and (Total Tide) program registrations.

<sup>\*</sup>Corresponding author at: Marine Science Center –University of Basra, Iraq, Iraq. . E-Mail: <u>adel.jassim@yahoo.com</u>



Fig:.1:(a, b): Comparison between Tide gauge and Total tide program for Sea level Rise at Umm Qasr port

### 2. ANALYZING DATA

The daily mean high and low water level was estimated, respectively, from mean heights of two sequent high and two sequent low water, for nineteen years' interval (1999-2017). The range of tidal is the variance between low and high mean water. The type of tide in the study area is mixed, where there are two flow and ebb during the day are different in the high and low. The greatest possible monthly water level ranges have been derived through the variance between the lowest and the highest sea level in every month. The largest theoretical tide range is calculated through relationship, which is based on harmonic tidal constituents.

highest tide range = 2 (M2 + S2 + K1 + 01) = 353.8 cm. (3.538m) Where: M2=82.4cm

K1 = 43.8 cm

S2=25.3cm

O1=25.4cm

Four major harmonic constituents have been extracted through analysis sea level heights of the hourly (Dodson's relation) [8] during 29 days for study area according to Al Ramadan [9]. M2 Semi diurnal lunar constituent

K1 combined of lunar constituent and diurnal solar

S2 semi diurnal solar constituent

O1 lunar constituent

The theoretical mean Spring ranges = 2 (M2 + S2) = 215.4 cm.(2.154m)

The theoretical mean Neap range =2 (M2- S2) = 114.2 cm. (1.142m)

The registered Spring tide level each a month have been calculated through the mean of the two most clearly levels during a semi lunar interval (fifteen- day). Registered Neap tide level is the correspondent tide level for the least clear level that happen times of the Moon's first and third quarters.

### **3. RESULTS AND DISCUSSION**

#### 3.1. The Excessive Rises for Sea Level in Umm Qasr Port

Due to the importance of excessive water level heights in coastal infrastructure development, the average monthly high sea-level heights and the average low for the interval (1999-2017) has been calculated as exhibited in the (table 1), the table exhibit, the seasonal variations in excessive height levels provide a mean value of (0.771 m) for low average water below mean sea level, Whereas the corresponding mean high water level is (4.671 m). Additionally, the average monthly of low and high water during the study duration has been accounted for to find out the mean of sea level. The lowest low mean of sea level is observed during winter months (December, January, and February), whilst the high maximum was in summer (July, August, and September). The monthly average sea level diagram (fig. 2), exhibited seasonal tendency with low rates at the winter and higher over the summer, it is apparent the monthly mean amount is beneath their medium at first half from the year, whereas the elevation is through the second half of the year.



Fig:2: The seasonal fluctuation for sea level in Umm Qasr

The outcome of the yearly average of high and low water were illustrated in (fig. 3) where showed an upward tendency for both low-water mean and high-water mean over the examined interval. These results refer that, in spite of sea level elevation, the average of increase at low water is slight as compared to the rate of rise water. in the sea level, as a final result there is rising, that is consistent with [10]. This is due to the rising in global temperatures, these rates increased from their general levels, varying between (0.3-0.6 Co) over the past century, and it is elevating, caused the increasing in amount of evaporation, low amount of humidity and melting of ice in the north pole, leading to change sea level [11].



Fig: 3: (a, b, c): Mean high water, Mean low water and Mean range for (1999- 2017).

Table 1: Mean high water(MHW), Mean low water (MLW)	),
and the monthly tide range(m) of the period (1999-2017)	

Month	J	F	М	Α	М	J	J	A	$\mathbf{S}$	0	Z	D	Mean
-------	---	---	---	---	---	---	---	---	--------------	---	---	---	------

range	W	
Tide	ML	MHW
T.001	0.001	<b>7.001</b>
4 037	0 564	4 601
3.880	0.658	4.539
3.700	0./04	4.33
704 5	V 76 V	A nn
3.766	0.83	4.596
3.929	0.783	4.7125
4.03	0.778	4.808
3. <b>9</b> 91	0.832	4.823
3.077	0.09	4.707
2017	0.040	70.F
27/3	0.076	1 20 A
3.988	0.711	4.699 4.686
4.055	0.63	4.685
3.908	0.771	4.679

It is apparent from the data shown in table (1) that the tide range at Umm Qasr has seasonal variations, although their deviations from the average value (3.908m.) may be considered insignificant.

## **3.2.** The Collective Effect of Tides and Meteorological elements on Sea Levels at Umm Qasr

On the basis of sea level observations of nineteen years' period (1999-2017), the difference between the observing highest high of water (MHHW) and the lowest low of water(MLLW) for a months were determined as the most pronounced total sea-level range (h w). This range represents the largest possible variations in sea level due to tide and meteorological factors.

In order to give the characteristics of the regime of largest sea-level variations due to meteorological conditions, the range of sea-level changes attributed to tides (3.538 m) while the greatest range of sea level due to meteorological condition and tide as shown in Table (2). The results are illustrated in Fig. (4), which shown a pronounced difference in water rise along the year months, this indicates that the contribution of meteorological factors on sea level ranges. The contribution of meteorological factors (cmf) can be determined by subtracting the average of the largest monthly range of sea-level variation from tide calculated by the harmonic constituents where found (0.49 m), this indicating that the contribution of meteorological factors to sea level rise is few.

Table 2: The largest monthly range of sea level variation (h w) at Umm Qasr for the period (1999-2017).

a i të	33
D	3.8
N	4.1
0	3.7
S	3.9
Α	4.2
ſ	4.4
ſ	4.4
Μ	3.9
А	3.9
Μ	3.9
Ч	4.2
ſ	4.0
nth	(m)



Fig:4: Largest monthly range due to contribution meteorological condition.

# **3.3.** The Daily Distribution of the Tidal Range Frequencies at Umm Qasr

Another example of the interaction of the meteorological contribution to sea level with the extreme values of the tides were appeared the frequency distributions of daily mean sea level range for the nineteen years, the results are given in table (3). Although the mean tide range was calculated as (3.908), It can be seen the frequency distribution that the range of daily sea level variations is more pronounced in the values between (3.0 - 4.0 m), that represents in 68% of the total frequencies.

	Table 3:				
Range (m)	2.0 - 3.0	3.0 - 4.0	4.0 - 5.0		
Frequency %	17	68	15		

## **3.4.** The Seasonal Variation in the range of Spring and Neap tide.

Detailed knowledge concerning the tidal range and its relation to meteorological conditions is achieved by comparing with the theoretical and the observed range of tide during spring and neap tide. In this connection, the monthly average for both spring and neap tide range have been determined as well as the yearly average through the period of the nineteen years. (Table 4).

The mean spring range was determined on the basis of harmonic tidal constituents is (2.154m), while the corresponding recorded is given in Table (4) and determined from the average spring tide range of nineteen years which is (3.175 m). The same result was obtained for the neap tide range, where the theoretical is (1.142 m) while the observed is (2.166 m). It is noticed that both the recorded spring and neap tide range are higher than the calculated theoretical which proves the fact the sea level is consequently affected by the variations in the meteorological elements.

Table 4: Recorded monthly mean of spring and neap tide range (m) of the period (1999-2017)

Month	Spring range	Neap range
J	3	1.85
F	2.45	2.2
М	2.65	2.2
А	3	1.95
М	3.55	1.65
J	3.9	1.1
J	3.95	1.85
А	3.65	2.5
S	3.3	2.6
0	2.8	2.85
Ν	3.1	2.8
D	2.75	2.45
Mean	3.175	2.166

### 4. CONCLUSIONS

The higher of the highest and lowest sea levels in Umm Qasr indicate a sea-level rise. The recorded tide range of Umm Qasr was shown a seasonal fluctuation, it also gives a more pronounced range than the computing, these may be attributed to the effect of meteorological factors. The mean range of Umm Qasr tide is 3.908 m, while the most pronounced mean sea level range is between 3.0 - 4.0 m. The greatest possible range of tidal sea level variation is 4.033 m, it represents the largest possible variations in sea level due to the tide and meteorological conditions. Analysis of the results led to astronomical tide contributing about 96% of the changes in sea level.

#### REFERENCES

- Reynolds R.M.,1993 " Physical Oceanography of the Gulf, Strait of Hormuz, and the Gulf of Oman: Results from the Mt Mitchell Expedition". Marine Pollution Bulletin, 27(2): 35-59.
- [2] Al-Taei S.A. 2010, Applied two Dimensional Model for Oil Spill Movement in Khor Al-Zubair and Khor Abdulla, NW Arabian Gulf. a thesis of PhD, College of Education, University of Basra.
- [3] Ali A Lafta , Samer A. Al-Taei, and Adel J. Al-Fartusi, 2015"One dimensional hydrodynamics model for Khor Al-Zubair channel, south west of Iraq". Journal of international academic research for multidisciplinary,3(4): 437-445.
- [4] Adel J.Al-Fartusi, Samer A. Al-Taei, and Ali A.Lafta,2017" Numerical model simulates of sediments transport in Khor Al-Zuber, North west Arabian Gulf". Basra Research Journal (Science). (43). Part B.2. (in Arabic).
- [5] Mahmood.A. B.,2007" Wind Waves Hindcasting at the North West of the Arabian, Gulf Marine Science Center, Basra University, Iraq", J. Basra Researches (Sciences). 33(2): 31-42.
- [6] Mahmood.A. B, Al-Mahdi. A.A, and Abdullah S.S.,2009"Breaker wind waves energy at Iraqi coastline, Marine Science Center, Basra University, Iraq, Mesop" J. Mar. Sci., 24 (2): 112 – 121.
- [7] UKHO. (2003). Total tide software, Unitedkingdom hydrographic office, UK.

- [8] Dodson A. T., and Warburg H.D.,1980 "Admiralty manual of tide", Admiralty Charts and Publications, London, England, 270 p.1980.
- [9] Al-Ramadan B.M.,1993" Physical Oceanography for Arabian gulf, Arabian gulf-principal scientific studies" Marine Science Center, University of Basra.
- [10] Abden R.2013 "The rise of Gulf water levels at likely on southern Iraq and its environmental impacts. Gulf Arab "J. Basra University, Iraq, (52) :1-52. (in Arabic).
- [11] Titus Games G.,1998 "Rising Seas, Costal Erosion and The Takings Clause: how to save wetlands and beaches without hurting properly owners "Maryland Law Review, 57(4): 1303 p.1279.

### تغيرات نطاق المد والجزر ومستوى البحر في المنطقة الواقعة أمام ميناء أم قصر جنوب العراق

عادل جاسم الفرطوسي

### كلية علوم البحار / جامعة البصرة / العراق

الخلاصة:

تمت دراسة الحد الأقصى والمنخفض لمستوى سطح البحر في شمال غرب الخليج العربي في المنطقة المجاورة لميناء أم قصر لدورة قمرية عقدية تعادل تسعة عشر عامًا (2017-1999). وجد أن مستوى سطح البحر آخذ في الارتفاع. اعتمادًا على ملاحظات مستوى سطح البحر لفترة تسعة عشر عامًا، تم وصف الخصائص الأساسية لمدى المد والجزر في أم قصر. تمت مناقشة مشكلة التأثير المشترك للمد والجزر وعوامل الأرصاد الجوية على مستوى سطح البحر في هذه الدراسة. يتم إعطاء وصف أكثر تفصيلاً لهذه الظاهرة من خلال تحديد توزيعات التردد لمدى المد والجزر، حيث وجد أن النطاق السائد ضمن القيمتين (3.0 - 4.0 م) ، بينما متوسط المد الفعلي هو (3.908 م) . بالإضافة إلى ذلك، تمت مقارنة الدراسة بمقارنة المدى النظري والمدى المسجل للمد والجزر خلال فترة الدراسة، حيث وجد أن النطاق الموسط المد الفعلي هو (3.908 م) . بالإضافة الرينانية عن عام المسجل المدى المدى الموسجل المد والجزر خلال فترة الدراسة، حيث وجد أن النطاق المسجل تجاوز النطاق المارينية عور المسجل المورية الذي يوالمدى المسجل للمد والجزر خلال فترة الدراسة، حيث وجد أن النطاق المسجل تجاوز الموازية عرجم إلى عوامل الأرصاد الجوية التى تزيد الفاعلية في أسهر الصيف في منطقة الدراسة.