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

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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.

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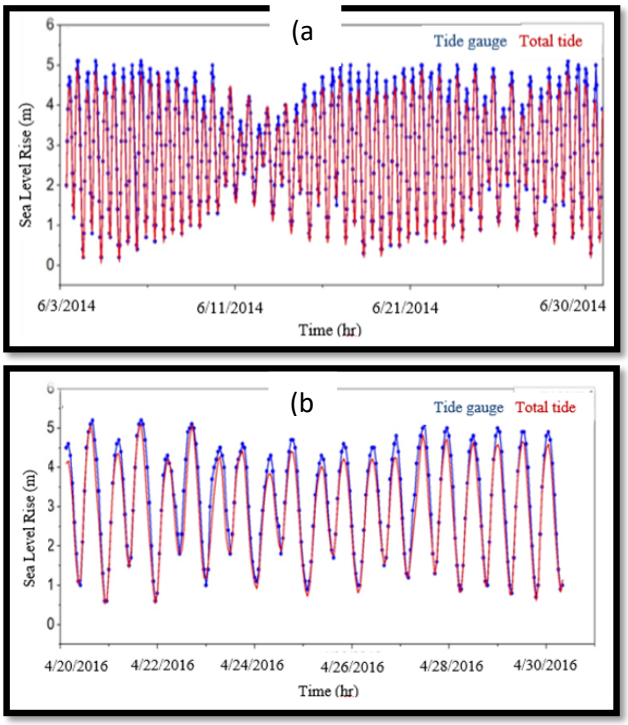

Fig:.1:(a, b): Comparison between Tide gauge and Total tide program for Sea level Rise at Umm Qasr port

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.

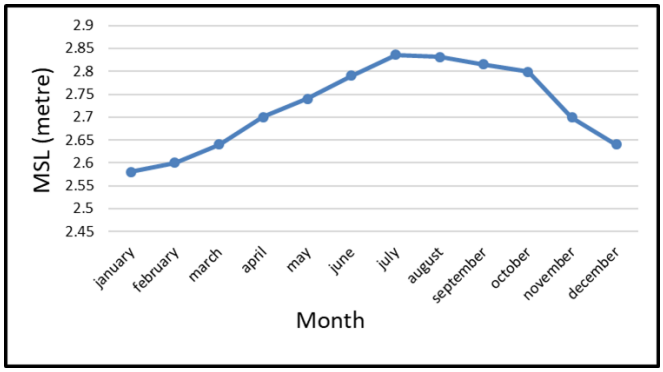

Fig:2: The seasonal fluctuation for sea level in Umm Qasr

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].

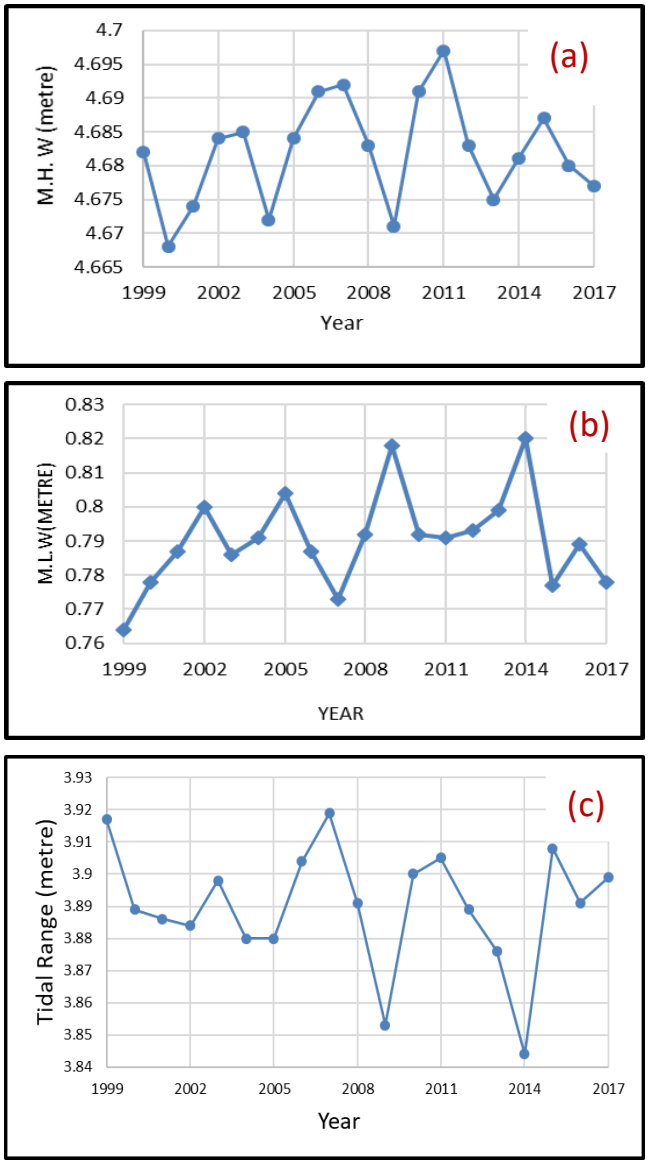

Fig: 3: (a, b, c): Mean high water, Mean low water and Mean range for (1999- 2017).

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

Month	MHW	MLW	Tide range
J	4.601	0.564	4.037
F	4.539	0.658	3.880
M	4.55	0.764	3.786
A	4.596	0.83	3.766
M	4.7125	0.783	3.929
J	4.808	0.778	4.02
J	4.823	0.832	3.991
A	4.767	0.89	3.877
S	4.69	0.946	3.743
O	4.686	0.870	3.816
N	4.699	0.711	3.988
D	4.685	0.63	4.055
Mean	4.679	0.771	3.908

It is evident from the data illustrated in the (table 1) that there are seasonal fluctuations in the tide range at Umm Qasr in spite of their deviations from the average value (3.908 m) which may be considered insignificant**.**

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

Based on nineteen-year duration measurements of sea level (1999-2017), the variance among the observing (MHHW) highest high of water and (MLLW) lowest low water of every month have been calculated (H w). This domain reflects greatest probable changes for sea level arising from the meteorological elements and the tide.

to grant the features of the pattern of the greatest sea elevation fluctuations by reason meteorological influence, the range of sea elevation variation attributed of tides (3.538 m) while the largest range for sea elevation due to meteorological condition and tide as shown at (table 2).

The outcome is explaining at (fig. 4), that shown clear variance in water rise along the year months, this indicate the share of meteorological elements in 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 were found (0.49 m), indicating that the participation of meteorological elements in 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).

Month	H_w (m)
J	4.0
F	4.2
M	3.9
A	3.9
M	3.9
J	4.4
J	4.4
A	4.2
S	3.9
O	3.7
N	4.1
D	3.8
Mean	4.033

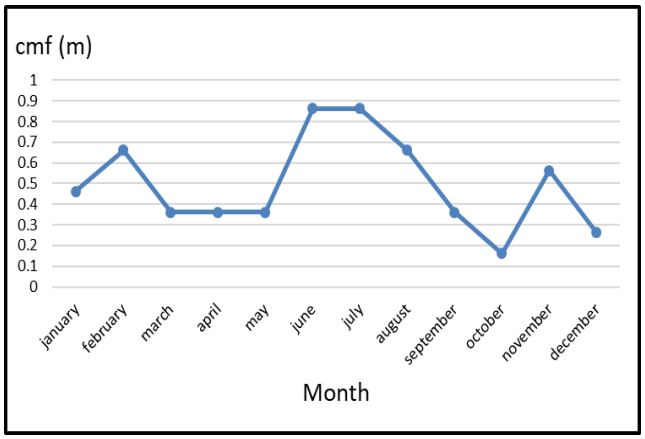

Fig:4: Largest monthly range due to contribution meteorological condition.

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

Another symbol of the relationship between the meteorological participation for sea elevation and excessive amount for the tides was the recurrence division for the average daily sea elevation domain for nineteen years, the outcome is shown at (table 3). In spite of the tidal range was determined is (3.908m), the frequency division can be shown that the range of daily fluctuations in the sea level is more clearly at the values (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.

Particular information on the tidal elevation in addition to the relationship with meteorological events are obtained during contrasting calculated and monitored tide levels through neap and spring tide. In this regard, the mean monthly range for neap and spring was calculated in addition to the annual average over the nineteen-years duration. (Table 4).

Depending on harmonic tidal constituents, the mean spring range was calculated is (2,154 m), whereas the corresponding registered is given at (table 4) and calculated for the nineteen-years from the mean spring tidal level (3,175 m).

Itself outcome has been gained for the neap tidal level, the calculated was (1.142 m) whilst the monitored is (2.166 m), where observed that the registered neap and spring tide range are higher than the theoretical, that demonstrate actuality the sea level elevation is influenced fluctuation at meteorological factors.

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
M	2.65	2.2
A	3	1.95
M	3.55	1.65
J	3.9	1.1
J	3.95	1.85
A	3.65	2.5
S	3.3	2.6
O	2.8	2.85
N	3.1	2.8
D	2.75	2.45
Mean	3.175	2.166

4. CONCLUSIONS

The lowest and the highest water levels in the Umm Qasr reference sea level elevation. The registered tidal level of Umm Qasr demonstrated seasonal variation, it too grants an extra clearly range than the computing, these referred to the impact meteorological elements. The tidal range for Umm Qasr (3.908 m), whilst the most clearly mean sea level range is (3.0 - 4.0 m). The largest possible range of tidal sea-level fluctuation is (4.033 m), this reflects the greatest potential changes at sea level because of meteorological influence and tide.

Analysis of results led to that astronomical tide contributes about 96% of the changes in sea level.

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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 (1999-2017). 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 المسجل تجاوز النطاق النظري للمقارنة وهذا الارتفاع يرجع إلى عوامل الأرصاد الجوية التي تزيد الفاعلية في أشهر الصيف في منطقة الدراسة.