Scientific Journal for Damietta Faculty of Science 9 (1) 2019, 32-37

ISSN Print 2314-8594
ISSN Online 2314-8616

Shoreline Changes in Front of New Mansoura City

Hatem Aboelkhair[1], Atef Ali Qaddah[2], Magdy Khalil[1], Ahmed Rakha[2], Mona Esmail[*2]

[1] Geology Department, Faculty of Science, Damietta University, New Damietta, Egypt
[2] Egyptian Environmental Affairs Agency, Egypt

Received: 14-08-2019 /Accepted: 14-09-2019
[*] Corresponding author: monaesmail1989@yahoo.com

Abstract

The shoreline changes of the coastal zone at New Mansoura City which extends about 27km, have been studied using GIS technique based on RS data. The shoreline spatial and temporal changes in the interval time between years;1984 and 2018 has been estimated. The results show that the coast of New Mansoura City has been affected by morphological changes due to the shoreline accretion and erosion. The area has been subjected to increase in the accretion areas by nearly 2.34 km^2, however, the erosional areas reach about 0.195 km^2.The average rate of the shoreline accretion area was around 3.12 m/y, while the rate of the shoreline erosion area was -1.23m/y. Accordingly, the shoreline in the study area is mostly an accretion shoreline and the erosion areas are very limited and should be protected.

Keywords: Shoreline changes, Landsat, GIS, Accretion, Erosion, New Mansoura City.

Introduction

New Mansoura City is located on the northern coastal area of the Nile Delta provenance, 15 km to the west of Gamasa City. It locates 12 km to the west of New Damietta City and 20 km to the east of Baltim City and occupies a length of about 6 km on the Mediterranean coast (Fig. 1). It is bounded by the latitudes 31° 33' 15" N and 31° 25' 15" N, longitudes 31° 32' 45" E, and 31° 17' 45" E. The city's capacity is expected to be over 1.5 million citizens on an area of 4,000 feddans between Gamasa, Damietta and Kafr El Sheikh cities.

The coastal area is the interface between sea and land and usually displays wide changes in environment and shape because of natural and human activities. Therefore, coastal zone monitoring is an important task in sustainable development and environmental protection.

The rising in sea level and sediments transportation led to erosion and deposition processes which controlled the dynamic changes in the shoreline landforms. Therefore, studying these changes become of a great concern matter. Consequently, it is necessary to perform suitable strategy to maintain the costal resource in order to perform the required sustainable development of coastal areas with respect to industries, agriculture, aquaculture, human settlements and infrastructure.

According to *Gens (2010)*, the vital bases in the coastal zone planning management, sustainable coastal development and environmental protection are; shoreline detection, extraction, and monitoring. The planning of such strategy

demands the timely detailed information of coastal processes, shoreline conditions, sediment dynamics and hazards.

Over the past three decades, several studies have been conducted to explore the feasibility and accuracy of image analysis applications for monitoring land cover change (Singh 1989, Coppin and Bauer 1996, Mas 1999, Lu et al. 2004) Several change detection techniques using digital images have been reported in the literature (see Singh, 1989 and Lu, et al. 2004). The most common methods applied for change detection include band ratio, band differencing, principal component analysis, vegetation index differencing, and post-classification change detection.

Geographic information system (GIS) and remote sensing (RS) are valuable tools for collection, analysis and interpretation of multiple coastal data. *Feng and Han (2012)* display that the remotely sensed imagery has been widely used to map shorelines and detect shoreline changes. *Saravanan et al. (2015)* studied the coastal vulnerability and shoreline extraction via water and land region's automatic extraction techniques. The shoreline change rates can be determined using modern and historic shorelines boundaries, classifications and associated features.

The New Mansoura city coastal zone which extents for a distance of 27 km has been selected as the area for shoreline change detection in the present study (Fig. 1). The shoreline spatial and temporal changes can be estimated using GIS technique based on RS data.

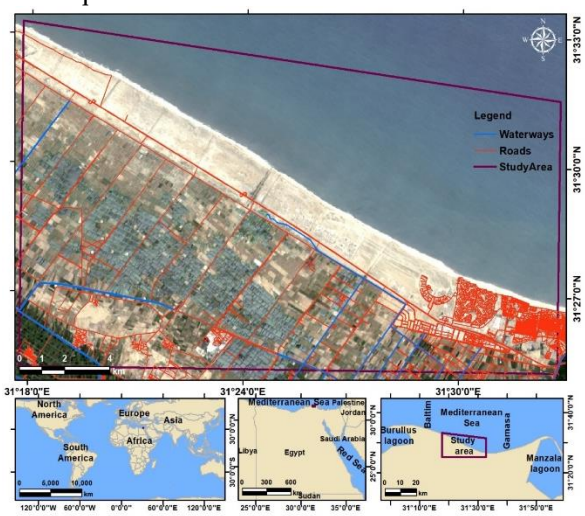

Figure 1: New Mansoura City coastal zone (google earth satellite images) of the study area

Material and Method

Numerous resources are available for extracting different shoreline positions and quantifying the related changes. GIS can analyze the changes (processes of accretion and erosion) in shoreline by determining the differences between yearly shorelines locations as presented in Fig. (2).

Data of temporal and multispectral satellite images for the years 1984, and 2018 (Landsat Thematic Mapper "TM" and Operational Land Imager (OLI) of 28.5 X 28.5 m ground resolution) were processed through ENVI 5.3 image processing software.

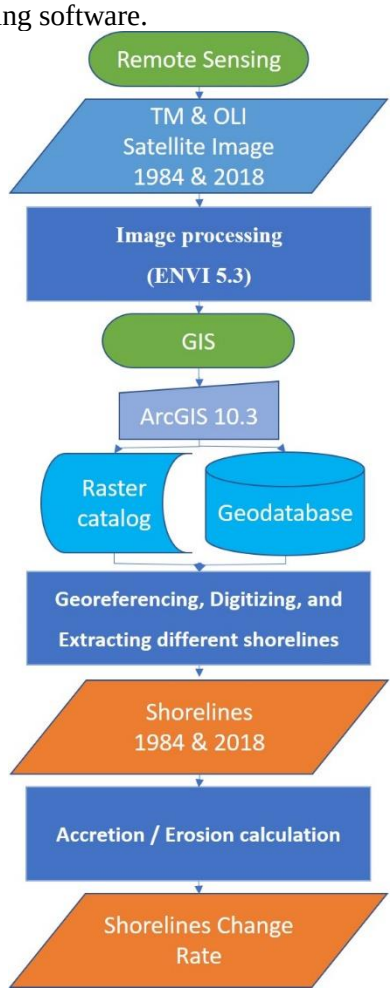

Figure 2: Workflow chart of shoreline changes study methodology

Results

Shoreline Extraction

In Arc catalog (via ArcGIS 10.3), Geodatabase containing feature dataset and feature classes were created to evaluate the rate of change for the study area. Feature class (with polyline type) has been

used to digitize the shoreline for the years 1984, and 2018 from the satellite images which were spatially re-projected to the Universal Transverse Mercator (UTM 1984). Digitization can easy handling where shoreline features could be recognized from different tones in the sand beach along the dry-wet sand boundaries.

It was relatively easy to distinguish the high-water line on the images as a wet/dry line. Therefore, the shoreline extraction was carried out using "Raster Calculator" (under Map Algebra/Spatial Analyst Tools/Arc Tool Box, via ArcGIS 10.3). In this way, we get a binary image (Fig. 3) with water and land classes only, (where water areas clusters were assigned with pixel value equal one and pixel value equal zero for land areas cluster).

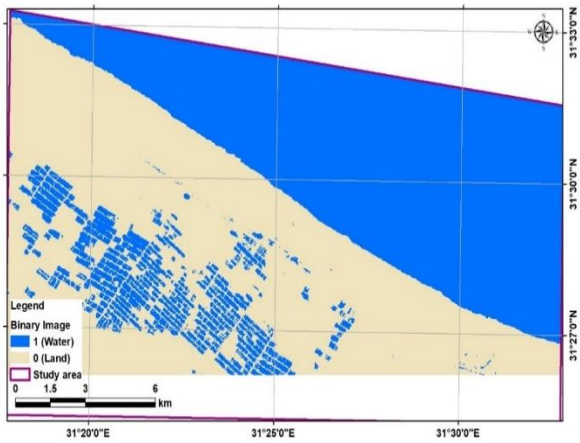

Figure 3: A binary image (water/land classes) with pixel value 1/0, of the coastal zone for the year 2018

Rate of Shoreline Change

After the shorelines were extracted, the next step is the evaluation of the shoreline changes. Therefore, there is a need to cast the perpendicular transects lines (which were created around at each 200 m) on the shorelines to measure the changed distances. The transect-shoreline intersections were consequently used to calculate the rate-of-change statistics.

Change rate from 1984 to 2018

During the study period of 1984 to 2018, the shorelines were extracted, their changes (accretion and erosion) were evaluated, and the rate-of-change statistics were calculated as shown in Fig. (4) and Tables (1, 2, 3 & 4).

It has been noticed that, the coast was affected by an increase in the accretion areas by nearly 2.34km^2, where the maximum change in accretion area was around 1.49 km^2 and its average change was around 0.23 km^2 (Table 1). While the coast defected by lost erosion areas by nearly 0.195 km^2, where the maximum change of erosion area was around 0.14 km^2 and its average change was around 0.02 km^2 (Table 2).

Shoreline accretion area has been observed at an average rate of around 3.12m/y (Tables 3), whereas, a nearly average value of -1.23 m/y was detected for shoreline erosion area (Table 4).

Table (1a): Accretion areas values and its shoreline length changes between years of 1984 & 2018.

Block ID	Perimeter (m)	Accretion Area (m^2)	1984 Shore length (m)	2018 Shore length (m)
1Acc	22700.521	1485100.990	11300.576	11269.305
2Acc	218.083	416.932	109.351	108.732
3Acc	240.977	1083.144	121.900	119.078
4Acc	328.619	1187.689	169.297	159.322
5Acc	10402.938	426770.146	5139.813	5263.126
6Acc	44.401	9.289	22.129	22.273
7Acc	6423.300	302880.456	3230.958	3192.342
8Acc	2034.937	42142.192	1014.416	1020.521
9Acc	566.015	4423.263	281.554	284.461
10Acc	2676.553	75497.439	1306.226	1370.327

Table (1b): Mini., Max., and Ave. values for different accretion parameter changes between years of 1984 & 2018.

Parameter	Minimum change	Maximum change	Average change
Perimeter (m)	44.401	22700.521	4563.635
Accretion Area (m^2)	9.289	1485100.990	233951.154
2002 Shore length (m)	22.129	11300.576	2269.622
2018 Shore length (m)	22.273	11269.305	2280.949

Table (2a): Erosion areas values and its shoreline length changes between years of 1984 & 2018.

Block ID	Perimeter (m)	Erosion Area (m2)	1984 Shore length (m)	2018 Shore length (m)
1Ero	207.809	636.047	105.413	102.396
2Ero	335.690	1906.428	166.752	168.938
3Ero	55.016	25.782	27.656	27.359
4Ero	42.907	51.141	22.949	19.958
5Ero	197.334	159.668	98.521	98.813
6Ero	2454.650	37691.043	1221.595	1233.055
7Ero	384.927	1873.304	195.708	189.219
8Ero	560.095	8089.431	278.154	281.940
9Ero	4858.677	143398.756	2413.918	2444.758
10Ero	183.420	1423.774	75.775	60.776

Table (2b): Mini., Max., and Ave. values for different erosion parameter changes between years of 1984 & 2018.

Parameter	Minimum change	Maximum change	Average change
Perimeter (m)	42.907	4858.677	928.052
Erosion Area (m^2)	25.782	143398.756	19525.537
2002 Shore length (m)	22.949	2413.918	460.644
2018 Shore length (m)	19.958	2444.758	462.721

Table (3a): Shoreline change rate for accretion areas between years of 1984 & 2018.

Block ID	Transect Length (m)	Change Rate (m/y)	Block ID	Transect Length (m)	Change Rate (m/y)	Block ID	Transect Length (m)	Change Rate (m/y)
1Acc	32.501	0.956	1Acc	176.776	5.199	5Acc	73.446	2.160
1Acc	96.473	2.837	1Acc	177.659	5.225	5Acc	36.069	1.061
1Acc	89.608	2.636	1Acc	185.461	5.455	5Acc	71.791	2.112
1Acc	139.744	4.110	1Acc	210.656	6.196	5Acc	87.565	2.575
1Acc	162.386	4.776	1Acc	178.303	5.244	5Acc	50.888	1.497
1Acc	166.426	4.895	1Acc	183.304	5.391	5Acc	96.319	2.833
1Acc	68.374	2.011	1Acc	175.972	5.176	5Acc	55.704	1.638
1Acc	90.130	2.651	1Acc	155.155	4.563	5Acc	69.671	2.049
1Acc	91.590	2.694	1Acc	139.940	4.116	5Acc	25.703	0.756
1Acc	82.029	2.413	1Acc	113.243	3.331	7Acc	13.323	0.392
1Acc	117.013	3.442	1Acc	127.380	3.746	7Acc	135.507	3.985
1Acc	77.347	2.275	1Acc	127.594	3.753	7Acc	93.377	2.746
1Acc	93.206	2.741	1Acc	152.907	4.497	7Acc	115.633	3.401
1Acc	116.966	3.440	1Acc	166.947	4.910	7Acc	103.965	3.058
1Acc	95.253	2.802	1Acc	189.160	5.564	7Acc	128.730	3.786
1Acc	119.395	3.512	1Acc	163.369	4.805	7Acc	166.934	4.910
1Acc	96.502	2.838	1Acc	152.454	4.484	7Acc	189.493	5.573
1Acc	113.537	3.339	1Acc	123.742	3.639	7Acc	132.908	3.909
1Acc	93.410	2.747	3Acc	15.051	0.443	7Acc	85.399	2.512
1Acc	150.982	4.441	4Acc	11.220	0.330	7Acc	121.470	3.573
1Acc	159.391	4.688	5Acc	5.270	0.155	7Acc	124.512	3.662
1Acc	195.798	5.759	5Acc	49.893	1.467	7Acc	43.208	1.271
1Acc	193.130	5.680	5Acc	119.691	3.520	7Acc	43.588	1.282
1Acc	146.604	4.312	5Acc	85.943	2.528	7Acc	44.464	1.308
1Acc	157.401	4.629	5Acc	57.934	1.704	7Acc	29.541	0.869
1Acc	156.870	4.614	5Acc	128.192	3.770	8Acc	31.043	0.913
1Acc	112.031	3.295	5Acc	66.740	1.963	8Acc	63.054	1.855
1Acc	167.191	4.917	5Acc	80.171	2.358	8Acc	72.043	2.119
1Acc	109.311	3.215	5Acc	98.894	2.909	8Acc	37.405	1.100
1Acc	114.484	3.367	5Acc	121.482	3.573	8Acc	7.472	0.220
1Acc	77.855	2.290	5Acc	90.988	2.676	9Acc	23.776	0.699
1Acc	98.896	2.909	5Acc	153.798	4.523	10Acc	55.749	1.640
1Acc	73.448	2.160	5Acc	181.033	5.325	10Acc	101.256	2.978
1Acc	105.695	3.109	5Acc	155.482	4.573	10Acc	104.984	3.088
1Acc	162.462	4.778	5Acc	105.796	3.112	10Acc	61.357	1.805
1Acc	201.997	5.941	5Acc	111.671	3.284	10Acc	32.671	0.961
1Acc	166.295	4.891	5Acc	38.647	1.137	10Acc	37.465	1.102
1Acc	183.844	5.407	5Acc	64.284	1.891	10Acc	17.250	0.507

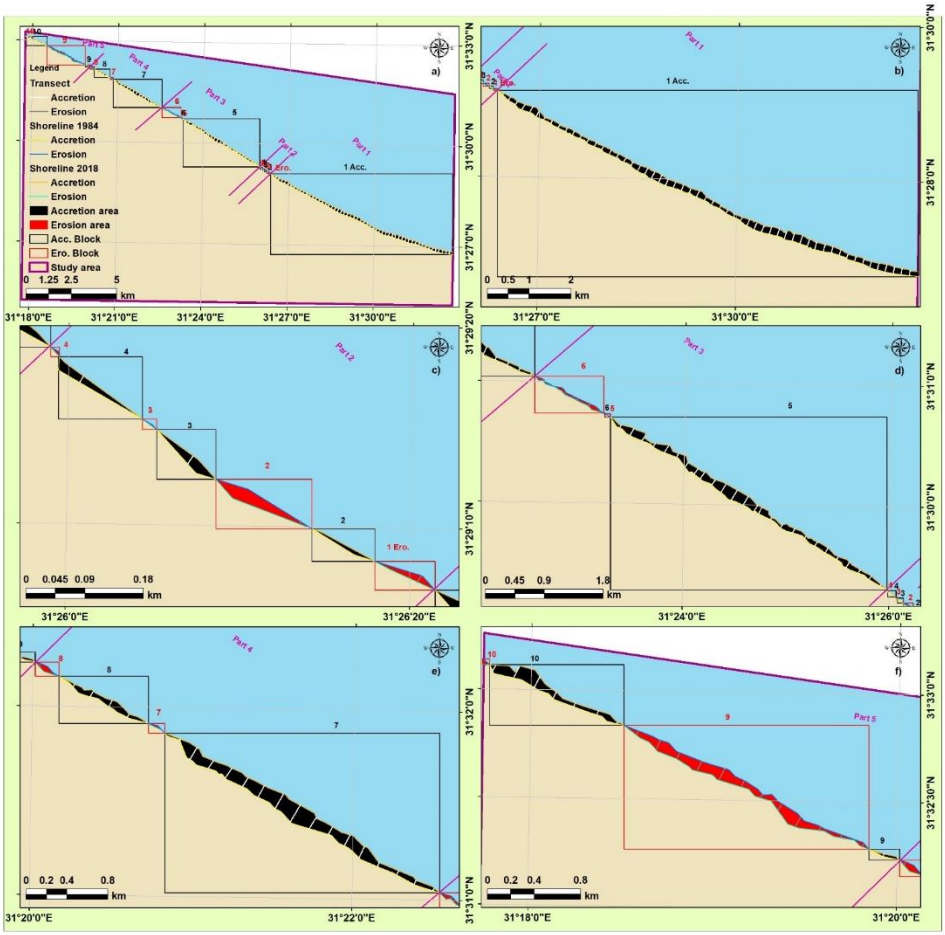

Figure (4): Shoreline changes (accretion and erosion) through years 1984 to 2018: a) the whole shoreline and viewing the blocks of Accretion & Erosion areas, b) part 1, c) part 2, d) part 3, e) part 4, and f) part 5 of the study area

Table (3b): Mini., Max., and Ave. values of change rate for accretion areas between years of 1984 & 2018.

Mini. Change Rate (m/y)	Max. Change Rate (m/y)	Ava. Change Rate (m/y)
0.155	6.196	3.122

Table (4a): Shoreline change rate values for erosion areas between years of 1984 & 2018.

Block ID	Transect Length (m)	Change Rate (m/y)	Block ID	Transect Length (m)	Change Rate (m/y)
1Ero	11.606	-0.341	9Ero	87.934	-2.586
2Ero	3.773	-0.111	9Ero	57.511	-1.691
6Ero	24.239	-0.713	9Ero	94.084	-2.767
6Ero	4.771	-0.140	9Ero	111.254	-3.272
6Ero	42.945	-1.263	9Ero	60.849	-1.790
6Ero	32.582	-0.958	9Ero	35.875	-1.055
6Ero	39.768	-1.170	9Ero	69.227	-2.036
6Ero	17.301	-0.509	9Ero	94.101	-2.768
7Ero	1.350	-0.040	9Ero	35.824	-1.054
8Ero	32.970	-0.970	9Ero	25.507	-0.750
8Ero	4.590	-0.135	9Ero	31.205	-0.918
9Ero	39.504	-1.162			

Table (4b): Mini., Max., and Ave. values for change rate for erosion areas between years of 1984 & 2018.

Max. Change Rate (m/y)	Mini. Change Rate (m/y)	Ava. Change Rate (m/y)
-3.272	-0.040	-1.226

Conclusions

The results of the present Study show that the New Mansoura city coastal zone during the period of 1984 ~ 2018 has affected by morphological changes due to the shoreline changes (such as accretion and erosion). The area has been affected by an increase of the accretional areas by nearly 2.34 km^2 and defected by lost erosional areas by nearly 0.195 km^2. Whereas the shoreline accretional zone has been observed with an average rate of around 3.12 m/y and a nearly average value of -1.23 m/y has been detected for shoreline erosional zone.

Accordingly, the shoreline in the study area is mostly an accretional shoreline and the erosional areas which may need protection are very limited.

References

Coppin, P.R. and Bauer, M.E. (1996), Digital change detection in forest ecosystems with remote sensing imagery. Remote Sensing Reviews, Vol. 13, p. 207–234.

Feng, Y., and Han, Z., (2012), Cellular automata approach to extract shoreline from remote sensing imageries and its application. J Image Graph 17(3), 441 - 446.

Gens, R., (2010), Remote sensing of coastlines: detection extraction and monitoring. International Journal of Remote Sensing. 31(7), pp. 1819 - 1836.

Lu, D., Mausel. P., Brondiozio, E. and Moran, E. (2004), Change detection techniques. Int J Rem Sens 25: p. 2365–2407.

Mass, J.F. (1999), Monitoring land-cover changes: a comparison of change detection techniques. Int J Remote Sens Vol. 20: p.139–152.

Saravanan. S., Parthasarathy K.S.S., Kumaresan.P.R., Vishnu prasath.S.R., Vasanth Kumar.T. (2015), Shoreline Change Detection for Chennai Coast Using Geospatial Techniques. International ITT Roorkee, India. 17 -19 December.

Singh, A. (1989), Digital change detection techniques using remotely sensed data. International Journal of Remote Sensing, Vol. 10, p.989–1003.

الملخص العربي

عنوان البحث: تغيرات خط الشاطئ أمام مدينة المنصورة الجديدة

حاتم أبو الخير[١]، عاطف على قدداح[٢]، مجدى محمود خليل[١]، أحمد رخا[٢]، منى اسماعيل[٢]

[١] كلية العلوم - جامعة دمياط - قسم الجيولوجيا
[٢] جهاز شئون البيئة - مصر

الملخص العربي

تقع مدينة المنصورة الجديدة على ساحل البحر الأبيض المتوسط بين مدينتي بلطيم وجمصه (حوالى ١٢كم غرب مدينة جمصه) .
خلال هذه الدراسة تم تقدير التغيرات (المكانية والزمانية) الحادثة لخط الشاطئ بالمنطقة الساحلية لمدينة المنصورة الجديدة (بامتداد حوالي ٢٧ كم^{٢}) في الفترة ما بين عام ١٩٨٤ وعام ٢٠١٨ وذلك باستخدام نظم المعلومات الجغرافية وبيانات الاستشعار عن بعد.
بينت نتائج الدراسة أن ساحل مدينة المنصورة الجديدة قد تأثر بتغيرات مورفولوجية بسبب عمليات الترسيب وتآكل السواحل، حيث تأثرت المنطقة بزيادة مساحات (مناطق ترسيب) تقدر بحوالي ٢,٣٤ كم^{٢}، كما فقدت بعض مساحات (مناطق تعرية) تقدر بحوالي ٠,١٩٥ كم^{٢}، ولقد لوحظ أن متوسط معدل الزيادة الشاطئية (مناطق الترسيب) قد قدر بحوالي ٣,١٢ متر/سنه، في حين بلغ متوسط قيمة تآكل السواحل (مناطق التعرية) ١,٢٣ متر/سنه تقريباً.
ومن هذه الدراسة يمكن اعتبار ساحل منطقة الدراسة في مجمله يتميز بترسيبات شاطئية وبعض مناطق تعرية قليلة قد تحتاج إلى حماية محدودة.