ISSN 2229-5518

Changes in coastal line and their impact on coastal tourist services in Damietta governorate, Egypt by Using Remote Sensing and GIS Techniques

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Abstract— Damietta coastal plain northern of Nile Delta, is a very promising area for energy resources, tourism and industrial activities. It suffered from several changes over the past century, especially in its boundaries and topography. The objective of this work was to study the spatial and temporal changes that took place along the coastal line of Damietta governorate by using RS and GIS techniques. This is in addition to providing an accurate estimation of the areas where erosion and deposition processes take place. For that purpose multi-temporal Landsat data were collected in 1984, 2000, 2011 and 2014. Also, two spectral indices were used in this study, which are the Normalized Difference Water Index (NDWI) and the World View Water Index (WVWI)) to study the changes along the coastal water/land interface. The obtained results indicated that the eroded areas were about 14.08 km^2 from 1984 to 2000, about 3.54 km^2 from 2000 to 2011, and about 2.05 km^2 from 2011 to 2014. The erosion rate during the studied period from 1984 to 2014 was about 0.41 km^2/ year. The areas were deposition take place was about 4.92 km^2 during the period from 1984 to 2000, about 4.94 km^2 from 2000 to 2011 and about 6.35 km2 from 2011 to 2014. The deposition rate during the whole studied period was about 0.291 km^2/ year. Accordingly, the deposition rate along the coastline was higher than the erosion rate, however it took place at different locations. Some of these areas were naturally occurred, however some others were human induced, especially after 2011. Accuracy assessment revealed that WVWI was more accurate than the NDWI in studying the changes along the coastal line. Different scenarios about the possibilities of costal submersion as a result of possible tsunamis or global warming were also studied. These scenarios indicated that a possible area of about 75.89 km^2 of the coastal land could be submerged in case of a sea level raised by about 5 meters. The obtained results and the hypothetical views were also considered in setting the criteria for selecting the most suitable and secure areas for tourist.

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Keywords: Coastal line, Erosion, Deposition, NDWI, WVWI, Change detection, Remote sensing, GIS.

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ISSN 2229-5518

1. INTRODUCTION

Coastal areas are very important for human beings since the beginning of time. Most of the big cities around the world are situated in coastal areas. About one-third of the human populations is lived in and around the seashore areas. Due to abundant natural resources, urbanization and population rapidly increase in coastal areas. Various developmental projects are made in the shoreline areas, placing great pressure on it, leading to diverse coastal hazards like sea erosion, seawater intrusion, coral bleaching, shoreline change; etc. Coastal landforms are highly dynamic in nature. They are continuously modified by natural and other human-induced processes **[1]**. Stated that a shoreline is one of the unique features of the earth's surface. It is one of the 27 features recognized by the International Geographic Data Committee (IGDC).

A shoreline is defined as the line of contact between land and water body. It is easy to define, but difficult to capture since it is always changing. Accurate demarcation and monitoring of shorelines either on the short-term or on the long-term are necessary for understanding various coastal processes **[2]**.

Remote Sensing satellite data are widely used to analyses the shoreline changes. It can provide more accurate information within a short span of time. Several studies using satellite data have proven its efficiency in understanding various coastal processes **[3]**. The major advantage of GIS is the integration of thematic information derived from satellite data and other collateral data, such as socioeconomic, cultural data, etc., which are significant factors in coastal zone management practices **[4]**. The Landsat imagery is well suited for generating land-water boundaries because of the strong contrast between land and water in the infrared portion of the electromagnetic spectrum. The studies on the shoreline change were very limited to the north-eastern parts of the studied area. Furthermore, various development projects have been recently started in this area. Therefore, this study utilized both remote sensing and GIS data and techniques, which will be very useful in assessing the impact of shoreline-change on the tourist services.

2. AREA OF STUDY AND ITS CHARACTERISTICS

2.1. Area of study

Damietta governorate is an Egypt's window on the Mediterranean coast. It is located at the eastern side of the Nile-Delta as shown in Figure 1. It is bounded between these coordinates 30° - 31.5° N, and 30.5° - 32.5° E. It covers an area of about1025 km², which represents about 5% of the Delta region and about 1% of the total area of Egypt. The governorate consist of 4 administrative centre 10 towns, 35 rural local units, 59 villages and 722 Kafr and gathered a total of 782 rural residential. It has a Mediterranean climate, which is generally hot and dry in summer and cold and wet in winter. Air temperatures varies from 18 to 19°C in winter and from 30 to 31°C in summer [5].

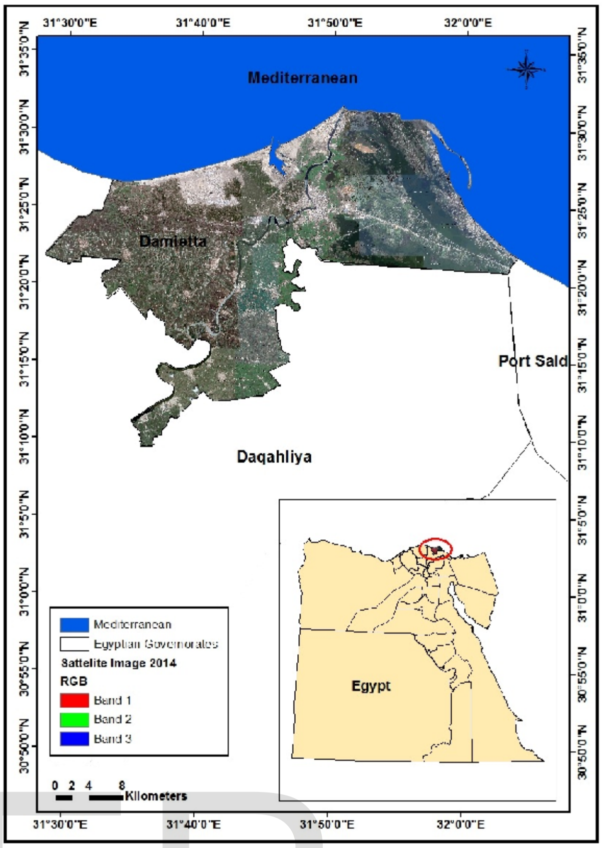

Fig. 1. Location map of the study area in Egypt.

2.2. Study Objectives

The objectives of this work were to study the spatial and temporal changes along the coastal line of Damietta governorate by using RS and GIS techniques and to provide an accurate assessment of the areas where erosion and deposition processes took place. This is in addition to studying the impact of coastal changes on tourist areas and developing a recommended map of best sites for tourist services.

2.3. Materials and Methods

Four multi-temporal satellite images from the Landsat archived on United States Geological Survey (USGS) server (http://earthexplorer.usgs.gov/) were used in this study. The selected Two Thematic Mapper (TM) datasets were separately acquired in September 30, 1984, and August 23, 2000, respectively. The Landsat Enhanced Thematic Mapper plus (ETM+) image was acquired in July 21, 2011. The Operational Land Imager and the Infrared Scanner (OLI-IRS) or Landsat 8 image was acquired in August 6, 2014. All images employed in this study are level-1 products of the USGS. They are referenced in the World Geodetic System (WGS84) datum, in GeoTiff format, and are projected using the Universal Transverse Mercator system (zone UTM 36 North).

ISSN 2229-5518

3. Methodology

3.1. Data Pre-Processing

The parameters used in McFeeters's NDWI and Xu's NDWI require physical units, such as at-sensor radiance or top-of-atmosphere (TOA) reflectance, rather than the raw quantized calibrated pixel value (DN). There are three advantages in using the TOA reflectance instead of at-sensor spectral radiance when comparing images from different sensors Chander el. al. [6]. First, TOA reflectance removes the cosine effect at different solar zenith angles due to the time difference between data acquisitions. Second, TOA reflectance compensates for different values of the Exo-atmospheric solar irradiance arising from spectral band differences. Third, TOA reflectance corrects for the variation in the earth-sun distance between different data acquisition dates. Therefore, the TOA reflectance of the studied images was used in this study. TOA reflectance for landsat TM and ETM+ can be obtained from the quantized Calibrated pixel value, as given by [6]:

$$P\lambda = (\pi . L\lambda . d2) / (ESUN \lambda . COS\theta s) \quad (1)$$

Where ϱλ is the TOA reflectance of wavelength λ [unitless], d is the earth-sun distance [astronomical Units], ESUN λ is mean Exo-atmospheric solar irradiance [W/ (m 2 · μm)], θ is the solar zenith angle [Degrees], and L λ S is the spectral radiance at wavelength λ at the sensor's aperture [[W/(m2·sr·μm)]. Lλ Can be obtained from the quantized calibrated pixel value also as given by [6]:

$$L\lambda = ((LMAX \lambda - LMIN \lambda) / (Q cal max / Qcal min)) (Q cal - Q cal min) + LMIN \lambda \quad (2)$$

Where LMAXλ is the spectral at-sensor radiance that is scaled to Qcalmax [W/(m2 Sr μm)], LMIN is spectral at-sensor radiance that is scaled to Qcalmin [W/(m2·sr·μm)], Q climax is the maximum quantized calibrated pixel value corresponding to LMAXλ [DN], Qcalmin (DN), Qcalmin is the minimum quantized calibrated pixel value corresponding to LMIN [DN], and call is quantized calibrated pixel value pixel value [DN].

The parameters in Equations (1) and (2) can be read from the header files of the TM, and ETM+ datasets or be retrieved from the USGS website (http://earthexplorer.usgs.gov/).

3.2 Geometric corrections

All the images were warped to a specific map projection, namely the Universal Transverse Mercator (UTM/zone 36, WGS 84) using a first order polynomial to transform algorithm in order to assure that each permanent feature is exactly at the same location in all images. A total of at least 20 prominent ground control points (GCP) was examined and matched with all images. These points included road intersections and prominent geomorphologic features. After rectification, the root mean square error (RMSE) does not exceed 0.5 pixels, revealing a high geometric matching of the images.

3.3. Gap-filling

On May 31, 2003 the Landsat 7 sensor had a Scan Line Corrector (SLC) failure. Since that time all Landsat 7 images have had a wedge-shaped gaps on both sides of each scene, resulting in approximately 22% data loss. These images are available for free download from the USGS website and are found under the Landat 7 (SLC-off) collection. [7], have developed a technique which can be used to fill gaps in one scene by using a linear transform to adjust the image based on the standard deviation and mean values of each band, of each scene. They developed a plug-in called "Landsat_gapfill. sav", which works under ENVI software package. This technique was used to fill the gaps in the ETM+ images acquired 2011.

3.4. Spectral Water Index Methods

Two spectral water indices were applied in this work. The first is the McFeeters's NDWI and the second is the Wolf's WVWI. The theory behind the Spectral water indices is that a water body has a strong absorbability and low radiation of longer wavelengths in both the visible and infrared portions of spectrum. The division of operations of the spectral water index method not only enhances the spectral signals by contrasting the reflectance between different wavelengths, but also cancels out a large portion of the noise components that are common in different wavelength regions [8].

McFeeters's NDWI [9] is calculated by using the following equation:

$$NDWI = (\varrho \ Green - \varrho \ NIR) / (\varrho \ Green + \varrho \ NIR) \quad (3)$$

Where ϱ Green and ϱ NIR are the reflectance of the green and NIR bands, respectively.

McFeeters's NDWI is designed to (1) maximize the reflectance of a water body by using green wavelengths, (2) minimize the low reflectance in NIR of water bodies, and (3) take advantage of the high reflectance in the NIR of vegetation and soil features [10]. As a result, the water body information will be enhanced and the background (vegetation and soil features) information will be restricted in McFeeters's NDWI images. This means that the water bodies can be identified by applying a threshold to McFeeters's NDWI images.

McFeeters's NDWI can enhance information about water bodies and restrict information about vegetation and soil features, but it cannot completely distinguish built-up features from water bodies. Wolf's WVWI is calculated according to the following equation [11]:

$$WVWI = (\varrho \ Blue \ (band1) - \varrho \ NIR \ (Band4)) / (\varrho \ Blue \ (band1) + \varrho \ NIR \ (Band4)) \quad (4)$$

Where ϱ Blue and ϱ NIR are the reflectance of the blue and NIR bands, respectively.

3.5. Accuracy Assessment

Accuracy Assessment was carried out on the obtained binary imaged from the three studied indices in 1984, 2000, 2011, and 2014 to determine how well each index accomplish classification of Coast line changes (Erosion or Deposition). The classified image was compared with a variety of data such as aerial photographs, topographic maps (scale 1:50000), high resolution images and ground truth data for the 2014 images). This task was accomplished by compiling an error matrix. An error matrix is a table of values that compares the value assigned to each type during the classification process (water = 0 and ground = 1) to the actual type from the above mentioned sources of data. These were compared on a point-by-point basis, where a random set of about 160 points were generated throughout the studied area. Then, using the aerial photos and the other resources of data, the change type for each point was identified. Then, these same random points were used to identify each point's known land use in the classified image. The error matrix table was completed by comparing these two values. An important component of accuracy assessment, Cohen's kappa co-efficient was also calculated from the error matrix. Kappa tells us how well the classification process performed as compared to randomly assign values [12].

3.6. Change Detection of Coast line

Change detection was developed by subtracting the NDWI and WVWI binary image for each two successive years. We have got three types of change, which are: 1. Erosion; 2. Deposition and; 3. No change. The objective of applying change detection was coast line areas to determine the extent of their impact on tourism services in Damietta Governorate.

3.7. The tourist ingredients for Damietta city.

One of the main tourism potential of the province of Damietta is the international coastal road Passage and its association with the city of Alexandria and Right up to Alexandria airport. In addition, the presence of Ras El Bar city, a place where the Nile River in the Mediterranean Sea as well as the existence of the new Damietta city and some old mosques and churches, which are a source of attraction for tourists, shown as figure 2.

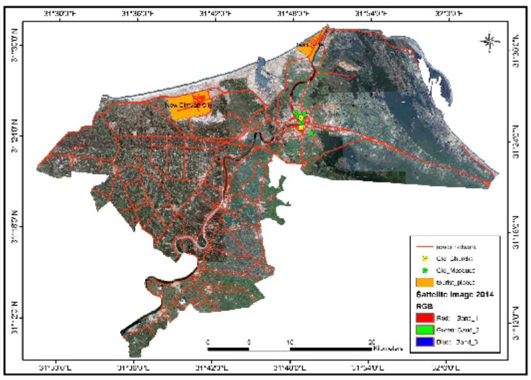

Fig. 2. Roads Network and tourist attractions in the Damietta governorate

3.8. Tsunami hazard in the coastal area of The Mediterranean

"The development of a nation can be measured by its response to natural catastrophes." The Mediterranean and the North-Eastern Atlantic and connected seas (NEAMTWS) are among the regions of the world with higher tsunami risk.

Tsunamis are relatively rare phenomena compared to other natural events affecting coastlines around the world, such as hurricanes, typhoons, storms surges and floods. However, tsunamis often have a devastating impact on coastal populations, not only in terms of human lives but also economically.

Thus, tsunami prevention (or the limitation of their impact) demands a dense system of instruments for monitoring tsunami sources and sea level [13].

In the eastern Mediterranean, induced by earthquakes pose potential hazards to shipping the north coast. Potential vulnerabilities of the North coast for the Nile delta to possible tsunami impacts are reviewed by reference to geological, historical, archeoseismological, and anecdotal data. Tsunami catalogues and databases compiled by earlier researchers are perused to estimate potential return periods for tsunami events that could directly affect the Suez Canal and North coast for the Nile delta and operational infrastructures. Analysis of these various records indicates a central return period, or multiples thereof, for long-wave repetition that could generally impact the Nile Delta, whereas numerical models indicate a multidecadal frequency [14].

TABLE 1
The greatest Tsunami catastrophes in The Mediterranean [15].

Date	Sea region	Affected region	Max wave height
21.05.2003	Algeria	N. Algeria, Mallorca	2,00 m
17.08.1999	Turkey	Kocaeli, Turkey	2,50 m
31.12.1995	Greece	W. Corinthos Gulf	2,00 m
20.04.1988	Italy	La Fossa Volcano, Vulcano Is.	5,50 m
19.02.1968	Greece	Lemnos Island, North Aegean Sea	1,20 m
06.07.1965	Greece	North Corinth Gulf, Greece	20,00 m
02.11.1956	Greece	Thessaloniki (Salonica), Greece	1,20 m
09.07.1956	Greece	Amorgos Island, Aegean Islands	20,00 m
22.04.1948	Greece	Ionian Islands	1,00 m
09.02.1948	Greece	Dodecanese, Karpathos Is.	k. A.
26.09.1932	Greece	Gulf Of Hierissos	k. A.
11.09.1927	Ukraine	Black Sea	1,00 m
27.11.1914	Greece	Ionian Islands	3,30 m
28.12.1908	Italy	Messina	1,00 m

A common perception of change in eustatic sea level is that it will rise, flooding low-lying coastal areas. Global sea-level rise will eventually affect the area, requiring the imposition of the sea locks to avoid flooding. A second noteworthy macro problem is the possibility of seismic jolts along the Suez–Cairo–Alexandria shear fault zone. Well-documented 21st-century earthquakes took place there on 29 June 2000, 7 July 2005, and 30 October 2007. Faults, shear zones, and lineament swarms, making up part of the tectonic pattern in NE Egypt in the recorded past caused tsunami run-ups on Egypt's coastline [14]

4. Results and Discussions

4.1The shoreline position change in Damietta Governorate based on the NDWI index:

The change in shoreline position between Damietta promontory and the beginning from Daqahliya governorate west to the mouth of the River Nile east is shown in Figure 3. This coastal reach is measured total 29.6 km. Along this coastal strip, four locations of erosion are measured total 1.08 km^2 and four locations of deposition were identified from satellite data is measured total 2.85 km^2.There are unaffected locations between these erosions and depositions segments.

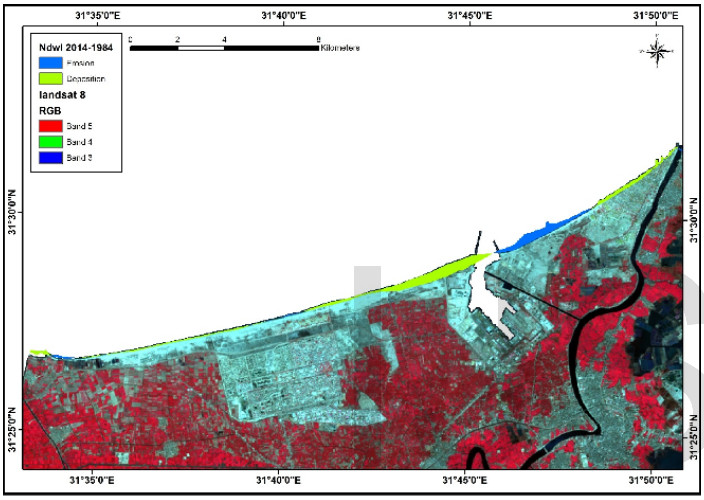

Fig. 3. The shoreline position changes along the coastal plain between Daqahliya governors east to the mouth of the River Nile west from NDWI index in 2014-1984.

In the other Site figure 4, from the mouth of the River Nile west of Port-Said governorate east, which extends for 30.7 km east to the promontory mouth witnessed the maximal erosion with a landward shoreline displacement of 11.19 km^2 between 1984 and 2014 in Twelve parts specially in part (A). At this site, the old coastal highway connecting Damietta and Port-Said cities was destroyed by the action of erosion. Recently, a new seawall revetment was constructed by the Shore Protection Authority (SPA) to protect this site and eight locations of deposition were identified from satellite data is measured total 5.24 km^2. There are unaffected locations between these erosions and depositions segments in this segment we have noted the cat-tail shape sandy spit formed from the eroded sediments at the headland. This spit was formed and elongated as a result of sediments which previously eroded from headland erosion [16]. At this location the shoreline is concave and some fish farms were established of this strip.

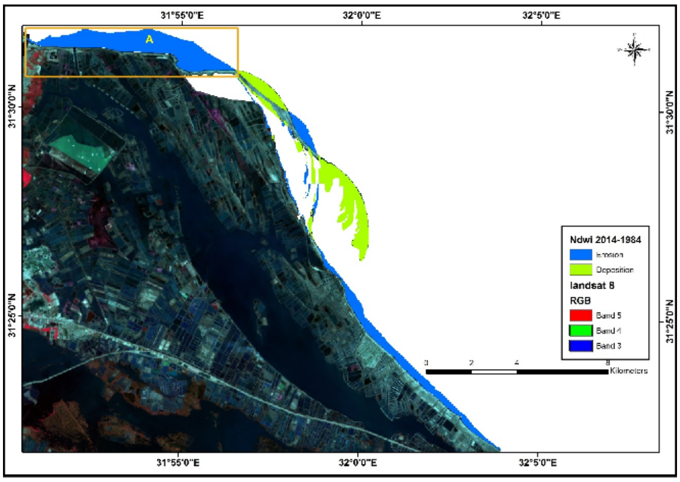

Fig. 4. The shoreline position change along the coastal plain between the mouths of the River Nile east to Port-Said governorate west from NDWI index in 2014-1984.

The shoreline position change along the coastal plain in Damietta governorate based on the NDWI index in 1984, 2000, 2011 and 2014 is represented in figure 5 and figure 6, Estimated erosion was about 13.29 km^2 in 1984-2000, and their Annual rate was about 0.83 km^2/year, While the deposition was about 5.29 km^2 in Same period, and their Annual rate was about 0.83 km^2/year. In 2000-2011 erosion was about 3.8 km^2, and their Annual rate was about 0.34 km^2/year, while the deposition was about 4.94 km^2 in same period, and their Annual rate were about 0.45 km^2/year. In 2011-2014 erosion was about 3.03 km^2, and their Annual rate was about 1.01 km^2/year, while the deposition was about 5.67 km^2 in same period, and their Annual rate was about 1.89 km^2/year. For all periods from 1984-2014 estimated erosion was about 12.19 km^2, and their Annual rate was about 0.41 km^2/year, While the deposition was about 8.07 km^2 in Same period, and their Annual rate was about 0.27 km2/year. These results indicate that the largest proportion erosion and deposition in Damietta governorate were during the period from 2011 to 2014. This could be attributed to the loss of governmental control over that period of time.

TABLE 2

Areas of shoreline's change and their percentage in Damietta governorate from 1984 to 2014 based on the NDWI index.

Change In Shoreline	1984-2000		2000-2011		2011-2014		1984-2014	
	Km^2	Annual rate km^2/year	Km^2	Annual rate km^2/year	Km^2	Annual rate km^2/year	Km^2	Annual rate km^2/year
Erosion	13.29	0.83	3.80	0.34	3.03	1.01	12.29	0.41

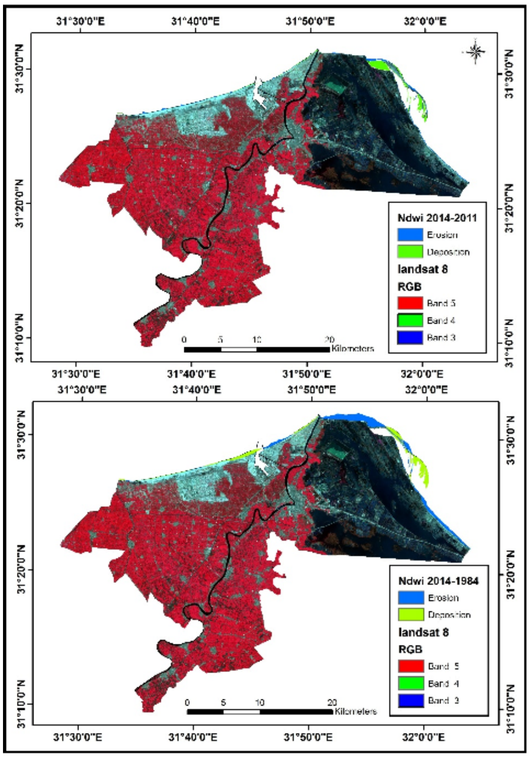

Fig. 5. The shoreline position change area along the coastal plain in Damietta Governorate Obtained from the NDWI index in 2014-2011 and 2014-1984

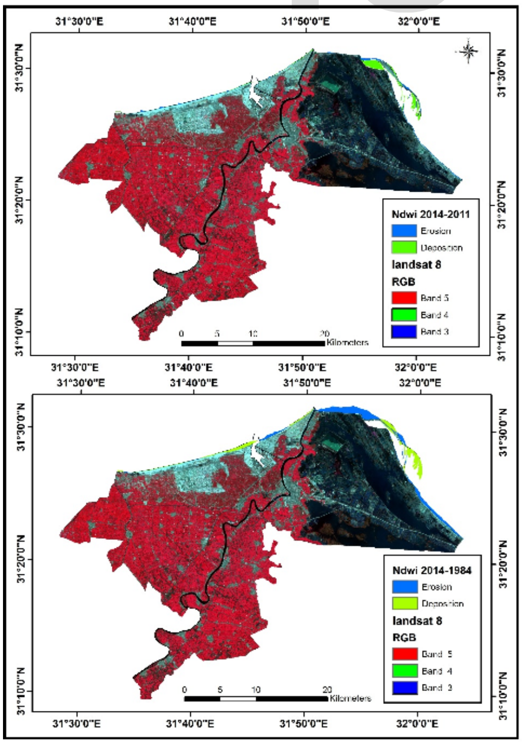

Fig. 6 The shoreline position change area along the coastal plain in Damietta Governorate Obtained from the NDWI index in 2011-2000 and 2000-1984

4.2 The shoreline position change in Damietta Governorate based on the WVWI index:

The change in shoreline position between Damietta promontory and the beginning from Daqahliya governorate west to the mouth of the River Nile east is shown in figure 7. This coastal reach is measured total 29.6 km. Along this coastal strip, two locations of erosion are measured total 1.04 km² and four locations of deposition were identified from satellite data is measured total 3.08 km².There are unaffected locations between these erosions and depositions segments.

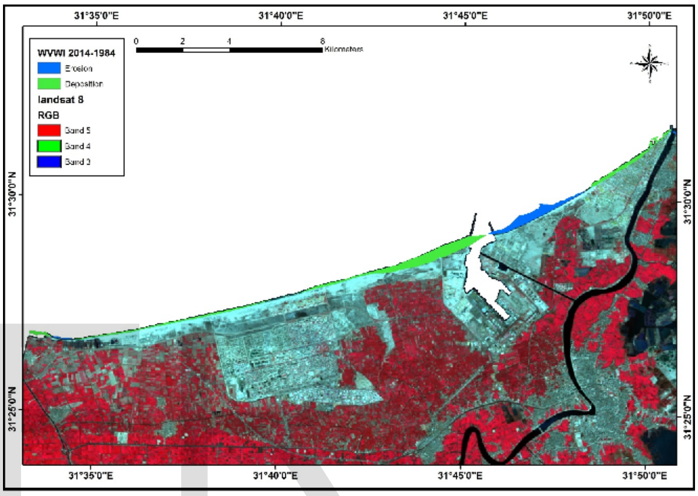

Fig. 7. The shoreline position changes along the coastal plain between Daqahliya governors east to the mouth of the River Nile west from WVWI index in 2014-1984

In the other Site figure 8, from the mouth of the River Nile west of Port-Said governorate east, which extends for 31.7 km east to the promontory mouth witnessed the maximal erosion with a landward shoreline displacement of 11.15 km² between 1984 and 2014 in eight parts specially in part (A). At this site, the old coastal highway connecting Damietta and Port-Said cities was destroyed by the action of erosion. Recently, a new seawall revetment was constructed by the Shore Protection Authority (SPA) to protect this site and twelve parts of the deposition were identified from satellite data is measured total 5.66 km².

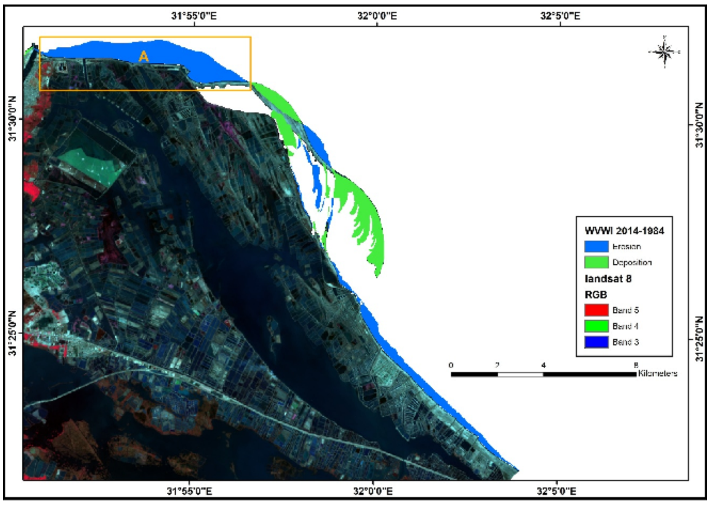

Fig. 8. The shoreline position change along the coastal plain between the mouths of the River Nile east to Port-Said governorate west from WVWI index in 2014-1984.

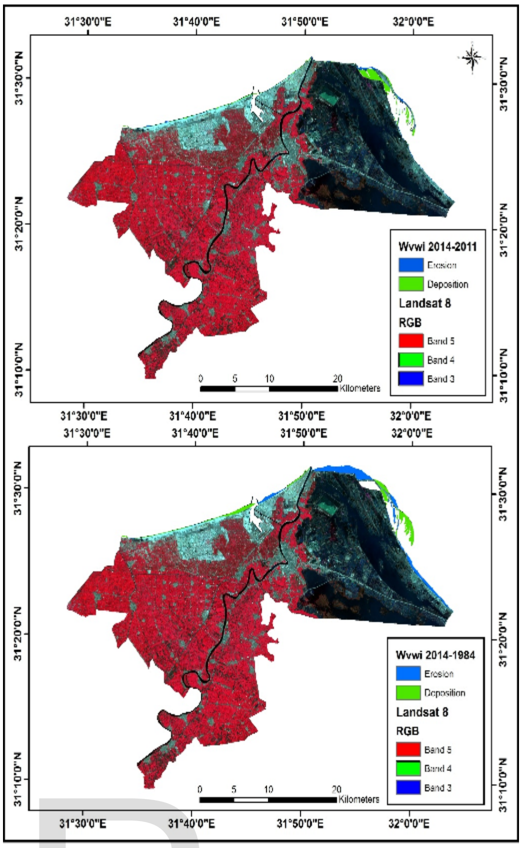

Fig.9 The shoreline position change area along the coastal plain in Damietta Governorate Obtained from the WVWI index in 2014-2011 and 2014-1984

The shoreline position change along the coastal plain in Damietta governorate based on the WVWI index in 1984, 2000, 2011 and 2014 is represented in figure 9. and figure 10, Estimated erosion were about 14.08 km^2 in 1984-2000, and their Annual rate was about 0.88 km^2/year, While the deposition was about 4.92 km^2 in Same period, and their Annual rate was about 0.31 km^2/year. In 2000-2011 erosion was about 3.54 km^2, and their Annual rate was about 0.32 km^2/year, while the deposition was about 4.94 km^2 in same period, and their Annual rate were about 0.40 km^2/year. In 2011-2014 erosion was about 2.05 km^2, and their Annual rate was about 0.68 km^2/year, while the deposition was about 6.35 km^2 in same period, and their Annual rate was about 2.12 km^2/year. For all periods from 1984-2014 estimated erosion was about 12.19 km^2, and their Annual rate was about 0.41 km^2/year, While the deposition was about 8.73 km^2 in Same period, and their Annual rate was about 0.29 km^2/year. These results indicate that the largest proportion erosion and deposition in Damietta governorate were during the period from 2011 to 2014. This could be attributed to the loss of governmental control over that period of time.

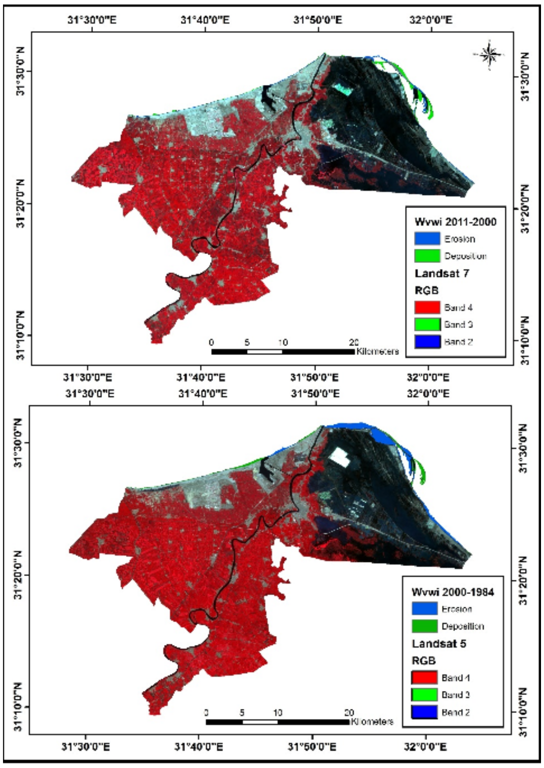

Fig. 10 The shoreline position change area along the coastal plain in Damietta Governorate Obtained from the WVWI index in 2011-2000 and 2000-19841984

TABLE 3

Areas of shoreline's change and their percentage in Damietta governorate from 1984 to 2014 based on the WVWI index.

Change In Shoreline	1984-2000		2000-2011		2011-2014		1984-2014	
	Km^2	Annual rate km2/year	Km^2	Annual rate km2/year	Km^2	Annual rate km2/year	Km^2	Area/year
Erosion	14.08	0.88	3.54	0.32	2.05	0.68	12.19	0.41
Deposition	4.92	0.30	4.94	0.45	6.35	2.12	8.73	0.29

4.3 Accuracy assessment of the studied indices

Accuracy Assessment was performed on the obtained binary imaged from the three studied indices (NDWI and WVWI) in 1984, 2000, 2011, and 2014 to evaluate the efficiency of each index in calculating the Changes in coastal line.

In this process the classified images were compared with the actual Changes in the coastal line for each year. The confusion matrix contained three types of accuracy, which are producer's, user's and overall accuracy as represented in Table 4. This also includes Cohen's kappa coefficient value for each index. It was observed that Changes in the coastal line in the studied area were classified with high accuracy using the two studied indices.

Data in Table 4 show that the lowest Producer's Accuracy for the area of Changes in coastal line was 95.06 % in 1984 with the WVVI, whereas the highest was 100 % in 1984 and 2000 with the WVVI and NDWI. The average values for Producer's Accuracy for the area of Changes in coastal line were 97.07 and 97.72 % for the NDWI and the WVWI, respectively. The lowest User's Accuracy for the NDVI for area of Changes in coastal line was 94.52% in 2014, whereas the highest was 100% in 1984 and 2000. The average values for User's Accuracy of Changes in coastal line were 97.27 and 97.89 % for the NDWI, and the WVWI, respectively. The lowest overall accuracy for the NDVI was 95.63% in 2014 and the highest was for the WVWI was 98.75 % in 2000, with an average value of 97.23% and 97.8 % for the NDWI, and the WVWI, respectively. The lowest Overall accuracy for the NDWI was 95.63% in 2014 and the highest for the WVWI was 98.75% in 2000, The obtained results also indicate that the lowest Kappa coefficient for the NDWI was 0.91 in 2014 and the highest for the WVWI was 0.97 in 2000, with an average value of 0.94 and 0.95 for the NDWI and WVWI index. It could be concluded from the accuracy assessment results that he area of Changes in the coastal line in the studied area was classified with high accuracy. However, the WVWI index had the highest accuracy when compared with the other indices.

TABLE.4.
Accuracy assessment of the NDWI and WVWI during the studied period from 1984 to 2014.

Year	Indices	Type	Producer's Accuracy	User's Accuracy	Overall Accuracy	Kappa
1984	DNWI	Erosion	96.25	96.34	97.50	0.95
		Deposition	98.75	98.72		
	WVWI	Erosion	95.06	95.18	97.50	0.95
		Deposition	100.00	100.00		
2000	DNWI	Erosion	95.65	96.81	98.13	0.96
		Deposition	100.00	100.00		
	WVWI	Erosion	97.10	97.85	98.75	0.97
		Deposition	100.00	100.00		
2011	DNWI	Erosion	95.77	96.70	97.50	0.95
		Deposition	98.88	98.55		
	WVWI	Erosion	95.71	96.70	97.48	0.95
		Deposition	98.88	98.53		
2014	DNWI	Erosion	95.83	96.55	95.63	0.91
		Deposition	95.45	94.52		
	WVWI	Erosion	96.34	96.20	97.48	0.95
		Deposition	98.70	98.75		

4.4 Secinarios of raising up of Water Level and Probability of inundation.

For Study and selection of tourist map for the city of Damietta should enter a risk factor for exposure to sea-level rise and exclude areas most prone to drowning from tourist map, It has been found that when sea level rise 3 meters it will be 8.78 km^2 from Damietta governorate would be drowning, While It has been found that when sea level rise 5 meters it will be 75.89 km^2 from Damietta governorate would be drowning shown as table 5 and figure 11.

TABLE 5
The Extreme Water Level and Probability of Flood risk

Type land	Sea elevation = 0 m		Sea elevation = +3 m		*Sea elevation = +5 m*	
	Area km^2	%	Area km^2	%	*Area km^2*	*%*
Land flooded	158.76	15.48	167.54	16.34	*234.65*	*22.89*
Land	866.24	84.52	857.46	83.66	*790.35*	*77.11*
Total	1025	100	1025	100	*1025*	*100*

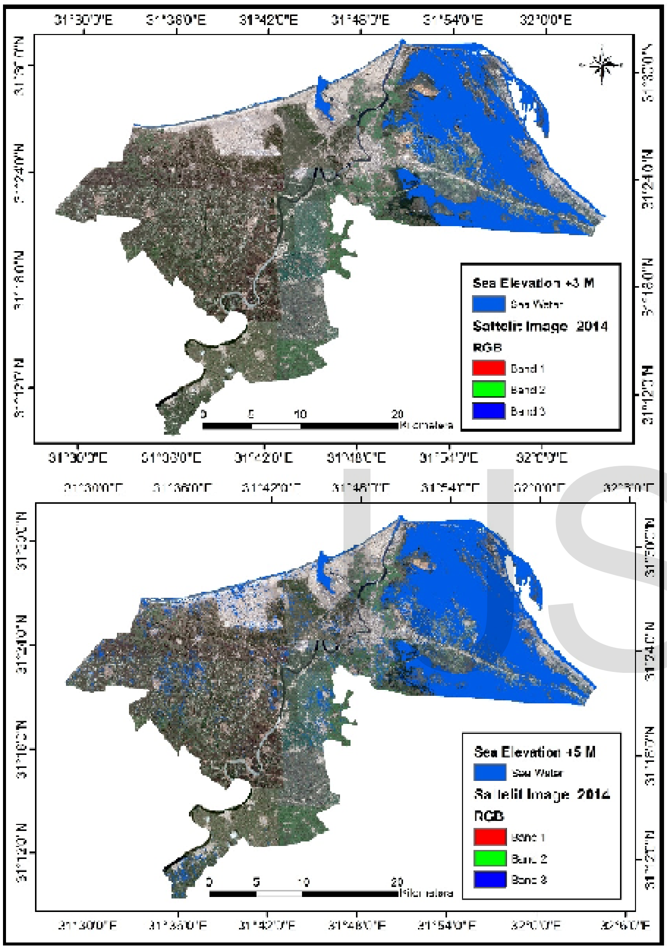

Fig.11. the increase in space flooded areas by rising sea levels

4.5 The proposed tourist sites

From the obtained results and other criteria required for tourist services (i.e., exposure to erosion and deposition, availability of road network, airports and infrastructure, the distance from the coast to proposed tourist Areas not less than 120 m (Egyptian standards), proximity to the international coastal road and not unlawfully occupied by people). Two areas can be proposed for tourist development projects in Damietta governorate as represented in Figure 12. The first area is to the north west of Damietta governorate, which is one of the important area for tourist development project in the governorate. It covers an area of more than 10 km². However, only about 147.7 km² of that area is currently cultivated. The second is to the south east of Damietta governorate and it covers an area of about 111 km² about 10% from total Damietta governorate area.

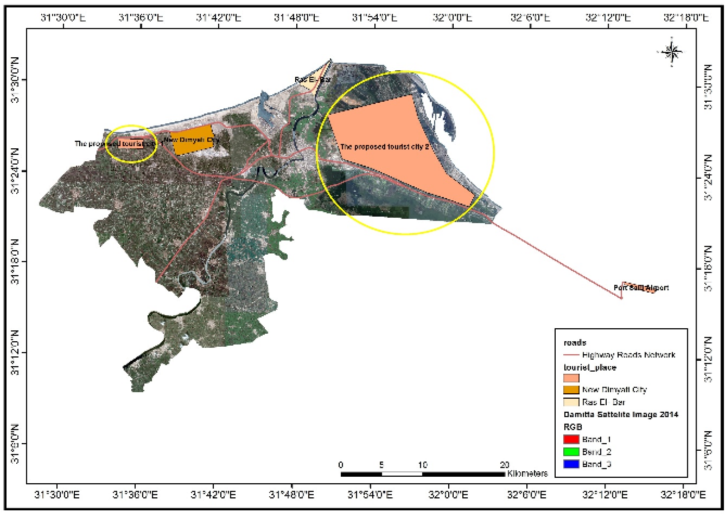

Fig. 12. The proposed tourist development projects in Damietta governorate.

5. Conclusions

Environmental impact assessment and change detection of the coastal desert along the central Nile Delta coast reveal detection of 7 units representing land use/cover including the wetlands, coastal plain, the coastal sand dunes, the urban, the fish farm, reclaimed, and agricul-tural areas. Change detections of these units using multi-temporal and multi sensor remote sensing Land-sat satellite data acquired from years 1984, 2000, 2011 and 2014 show considerable expansion in urban, fish farms, reclamation, and agricultural activities at the expense of shoreline and coastal plain, coastal sand dunes, and wetland areas. Most encountered environmental hazards are attributed to anthropogenic impact; of which are logging of areas around the northeast area due to waste water derived from different sources of agriculture, fish farms . Most of these areas are below present sea level and will be the most vulnerable to the risk of sinking in case of sea level rising. Removal of coastal sand dunes may trigger another hazard. These dunes represent the first natural defence line against coastal erosion. Urban expansion with the consequent overgrazing of agricultural area, the operations of uprooted palm trees and exported illegally to many Mediterranean countries in a corrupt example to exploit legal loopholes in the absence of state control, are examples of expected risk the study area faces and therefore they are the largest down risk on the coastal tourist services.

REFERENCES

[1] *Li, R., DI, K. And Ma, R. (2001). "A comparative study of shoreline mapping techniques". The Fourth International Symposium on Computer Mapping and GIS for Coastal Zone Management, Halifax, Nova Scotia, Canada.*

[2] *Nayak, S. (2002)." Use of satellite data in coastal mapping". Indian Cartographer, 5: 147-157.*

[3] *Murali,M.R., Shrivastava,D. and Vethamony,P.(2009). "Monitoringshoreline environment of Paradip, East coast of India using remote sensing". Current Science, 97 (1): 79-84.*

[4] *Desai,P.S., Gowda, H.H.and Kasturirangan,K. (2000). 'Ocean research in ndia;Perspective for space. Current Science, 87 (3): 268-278.*

[5] *Hereher, M. E. D. (2006)."Monitoring spatial and temporal changes of agricultural lands in the Nile Delta and their implications of soil characteristics using remote sensing".*

[6] *Chander, G., Markham, B. L., & Helder, D. L. (2009). "Summary of current radiometric calibration coefficients for Landsat MSS, TM, ETM+, and EO-1 ALI sensors". Remote sensing of environment, 113(5), 893-903.*

[7] *Scaramuzza, P., Micijevic, E., & Chander, G. (2004). "SLC gap-filled products phase one methodology". Landsat Technical Notes.*

[8] *Ji, L., Zhang, L., & Wylie, B. (2009). "Analysis of dynamic thresholds for the normalized difference water index". Photogrammetric Engineering & Remote Sensing, 75(11), 1307-1317..*

[9] *Mcfeeters, S.K. (1996). "The use of the normalized difference water index (NDWI) in the delineation of open water features". Int. J. Remote Sens., 17:7, 1425–1432.*

[10] *Karsli, F., Guneroglu, A., & Dihkan, M. (2011). Spatio-temporal shoreline changes along the southern Black Sea coastal zone. Journal of Applied Remote Sensing, 5(1), 053545-053545.*

[11] *Wolf, A. F. (2012, May). "Using Worldview-2 Vis-NIR multispectral imagery to support land mapping and feature extraction using normalized difference index ratios". In SPIE Defense, Security, and Sensing (pp. 83900N-83900N). International Society for Optics and Photonics.*

[12] *Campbell, J. B. and Wynne, R. H. (2011)." Introduction to Remote Sensing", 5th Ed. The Guilford Press, New York, USA.*

[13] *Intergovernmental Oceanographic Commission of UNESCO 2013. Tsunami Preparedness, Civil Protection – Good Practice Guide. (IOC Manuals and Guides, 65. 64 pp. (English). (IOC/2013/MG/65).*

[14] *Finkl, C. W., Pelinovsky, E., & Cathcart, R. B. (2012). "A review of potential tsunami impacts to the Suez Canal". Journal of Coastal Research, 28(4), 745-759.*

[15] *Tsunami Alarm System, (2014) .available: http://www.tsunami-alarm-system.com/en/phenomenon-tsunami/occurrences-mediterranean.html*

[16] *Frihy, O. E. (1988). "Nile Delta shoreline changes: aerial photographic study of a 28-year period". Journal of Coastal Research, 597-606.*

ISSN 2229-5518