Shore Line Delineation of Southern Caspian Sea Using ETM+ and IRS-ID Data

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Key words: Shore line, Delineation, Caspian Sea, ETM+, IRS-1D.

Abstract:

The Caspian Sea is the largest inland body of water in the word. Due to the occurrence of the sea level oscillations in the last decades and rapid sea level rising, the Caspian Sea Shorelines have shown to be changeable and floatable. Determination and awareness of accurate length of shore lines is significant parameters for coastal management. Remote sensing data with different spatial, spectral, temporal and radio metrical capabilities can be new potential tools to delineate the shore lines. In this study, multi spectral and panchromatic imagery of the ETM+ and IRS-LISSIII data from 2001-2004 years were used to investigate accurate length of the Iranian part of Caspian Sea shoreline as main objective. In addition, investigation on capability of images of sensors as well as impact of fusion techniques on the improvement of results was surveyed. The panchromatic image of ETM+ sensor was geo referenced using some ground control points from 1:25000 scale topography maps. Then, the ETM+ multi spectral bands were geo rectified with geo referenced panchromatic images trough image to image rectification method. This geo referencing was repeated for IRS-1D, too. The panchromatic and multi spectral bands of ETM+ as well as multi spectral bands and panchromatic bands of IRS-1D were fused by semi automatic and statistics Pansharp method using Geomatcia 9.1 software. For four kinds of data, after applying linear stretches on the images, the suitable false or true color composites were created using stretched visible and infrared bands. On screen digitizing was used to extract accurate shore lines. Results showed that length of digitized shore line of southern Caspian sea bordered in Iran using ETM+ multi spectral bands, ETM+ multi spectral and panchromatic fused bands, IRS- LISSIII multi spectral bands and IRS- LISSIII multi spectral bands fused with panchromatic band were obtained 1220, 1284, 1063.5 and 1115.2 km respectively for ETM+, ETM+ Fusion, LISSIII, and IRS Fusion. To accurate determining length of the southern Caspian Sea shore line and specifying the correction coefficients for each satellite data, six short lengths of shore line were measured trough field distance measuring. Results showed that correction coefficients were computed for four above mentioned data, 0.742772, 0.753830, 0.814468 and 0.760486 respectively. And with applying these coefficients on the digitized lengths, the accurate length of southern Caspian Sea were 906.2, 967.9, 866.2 and 848.1 km, respectively. Concerning to coefficient rates, the multi spectral IRS-LISSIII data has more capability to accurately delineation of shore line compared to other used data in this study. This study showed that Pansharp fusion process could not improve the results either for ETM+ or for IRS data.

Introduction:

The Caspian Sea is the largest inland body of water in the word. It washes five countries including Azerbaijan, Iran, Kazakhstan, Russia and Turkmenistan with different shoreline lengths. Determination and awareness of accurate length of shore lines is significant parameters for coastal management. It can be help to know impact of sea oscillation on the coast life and to specify the rate of probably degradations and destructions. Since, different values have been given for length of southern coastline of Caspian Sea bordered in Iran, in the some reports. Some reports have documented that The Caspian Sea has approximately 7000-km shorelines and the southern part of shorelines, which deal with Iranian coasts, is approximately 813 km (CSNRC, 2004).

Based on report of comprehensive study plan of water resources of Caspian Sea the border length of Iran was reported approximately 700 kilometers. Ghanghermeh (1998) using the 1: 50000 scale topography maps and measuring with curvimeter, was reported the length of Iranian border of Caspian Sea about 812 km. These reports were used different ways to compute length of coast line based on to be different in scale of topography maps and or invalid documents.
In other hands, Due to occurrence of the forward and backward progression of sea during the last decades, the Caspian Sea areas and shorelines indicate a fluctuating condition. in the last decades due to rapid sea level rising, the Caspian Sea Shorelines have shown to be changeable and floatable. From 1977 to 1995 years, the Caspian Mean Sea level (CMSL) raised about 2.3 meters that created sever social and economic damages for the human society in the coastline. It was serious and a critical problem for coastal civil managers. In historical period of 2200 years ago, the CMSL changed from minus 33 to minus 22 meters (kliege, 1992). Based on annual reports, the mean CMSL in last year (2004) was approximately minus 26.19 meter based on mean sea level in Persian Gulf level (Figure 1).

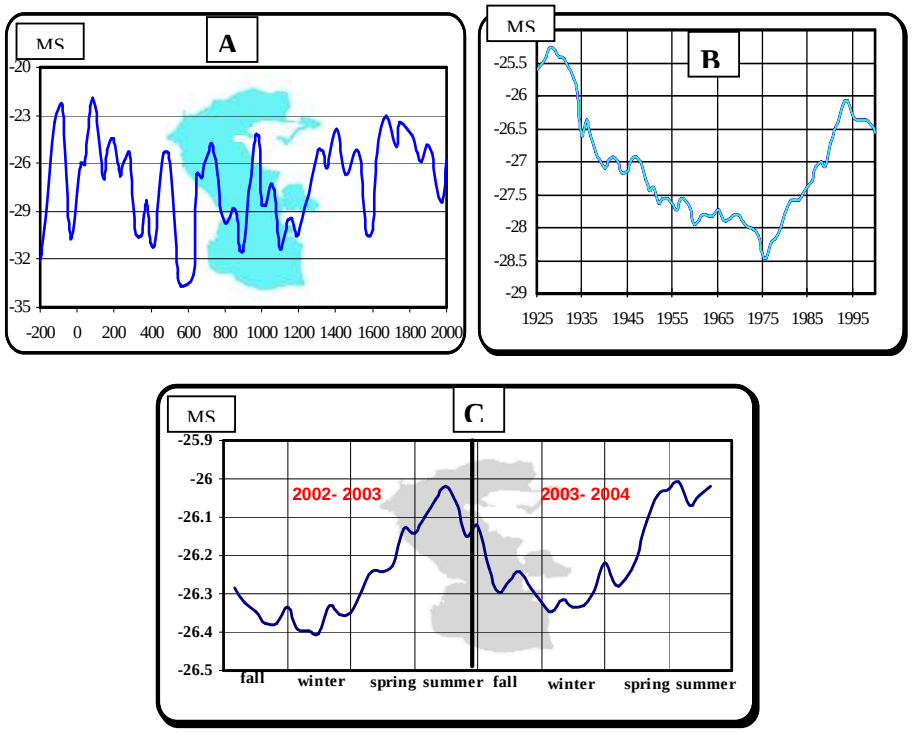

Figure 1: Mean sea level below the water level of Persian Golf (MSL), Caspian Sea fluctuations, (A) Based on historical Caspian Sea level change (kliege**,** 1992), (B) based on measuring data from Anzali Tide gage, duration 1925-2001 (CSNRC, 2001) and (C) show seasonal fluctuation in two last years (CSNRC, 2004).

Concerning to mentioned causes, up to dating of accurate length of shoreline seems to be necessary. Using accurate and up to dateable resource which to be able the coastal managers to compute length of shoreline is suitable. Remote sensing data with different spatial, spectral, temporal and radio metrical capabilities can be new potential tools for different proposals especially for delineating the shore lines. Kostiuk (2002) has extracted and measured the length of shoreline of kobskoke of Canada using on screen digitizing on false color composites of land sat-TM data. Wang (2003) was done Delaware inland bays shoreline extraction using unsupervised classification of landsat-7 imagery. Marfai and et. al (2007) were analyzed the coastal dynamic and shoreline mapping using multi-sources spatial data in Semarang Indonesia. Coastline change analysis of the Meric river was investigated by Ekercin and et. al (2003) using

multi temporal remotely sensed data. Ustan and et. al (2004) have done a comparison performance analysis of the classification and manual digitizing methods for the detection of coastline of Kucuk cekmece lake in Turkey using TM, SPOT-XS and fused TM bands with SPOT-pan band. In this study, the available multi spectral and panchromatic imagery of the ETM+ and IRS-1D satellite data from 2001-2004 years were used to investigate on accurate length delineation of shore lines in the Iranian part of Caspian Sea as main objective. In addition, investigation on capability of images of sensors as well as impact of fusion techniques on the improvement of results was surveyed.

Methods and materials:

Study area:

The southern coasts of Caspian Sea are bordered in the three provinces including Gilan, Mazandaran and Golestan from west to east, respectively. The southern parts of Caspian Sea where mostly belongs to Iran, are places for recreation and entertainment of Iranians and other citizens of Persian Gulf countries.

Figure 1: The three Iranian southern provinces of Caspian sea

Materials:

In this study the six ortho rectified ETM+ scenes from 2000 year were used and The IRS-1D imagery from six uncorrected scenes from 2002 to 2004 years was prepared from Iranian national geography organization (table1).

Table 1: descriptions of ETM+ and IRS-1D imagery

Geometric correction	date	Path-Row	Geometric correction	date	Path-Row
ETM+			IRS-1D		
Ortho rectified	2000-07-30	163-34	uncorrected	2003-05-03	70−44
Ortho rectified	2000-07-30	163-35	uncorrected	2002-10-29	69−44
Ortho rectified	2000-07-18	164-35	uncorrected	2004-10-01	68−44
Ortho rectified	2000-07-25	165-34	uncorrected	2002-11-01	67−44
Ortho rectified	2000-06-30	166-34	uncorrected	2003-09-01	66−44
Ortho rectified	2000-05-06	167-33	uncorrected	2002-05-04	65−43

Image registration:
Although the ETM+ imagery were before ortho rectified, but in order to accurate geo referencing, the panchromatic image of ETM+ was geo referenced using some ground control points from 1:25000 scale topography maps. Then, multi spectral bands of ETM+ were geo rectified with geo referenced panchromatic images trough image to image rectification method.
The IRS-1D panchromatic images were geo rectified with ETM+ panchromatic images and multi spectral LISSIII images geo rectified with geo referenced panchromatic images. The RMSe of all rectified images were lower than one pixel.

Image fusion:
The panchromatic and multi spectral bands of ETM+ as well as multi spectral bands and panchromatic bands of IRS-1D were fused by semi automatic and statistics Pansharp method using Geomatcia 9.1.

Generation Color composite and Shoreline delineation:
For four kinds of data, after applying linear stretches on the images, the suitable false or true color composites were created using stretched visible and infrared bands (Figure 2a). On screen digitizing was used to extract accurate shore lines on the ETM+ multi spectral bands, ETM+ multi spectral and panchromatic fused bands, IRS-1D multi spectral bands and IRS-1D multi spectral bands fused with panchromatic band (Figure 2b). Then, the digitized shore lines of each scene were glued to generate the Iranian border of Caspian Sea shore line (Figure 3).

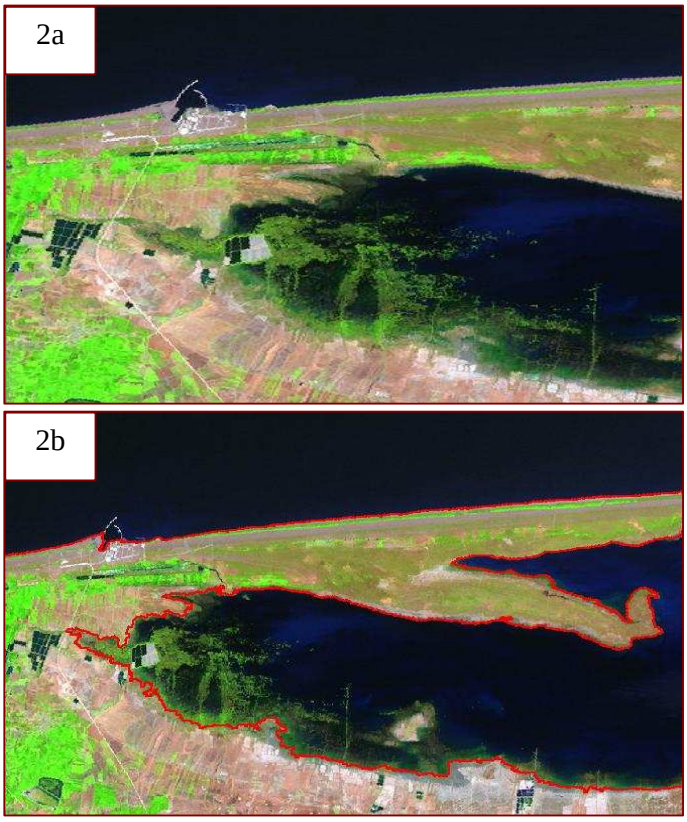

Figure 2: a) The false color composite 543(RGB) image from part of study area (Meiankaleh bay), b) digitized shore line on the false color composite image.

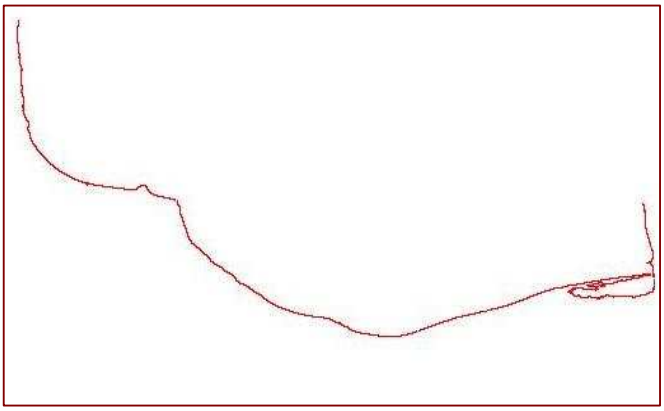

Figure 3: the Iranian border of Caspian Sea shore line

Length correction coefficient determination:

To accurate determining length of the southern Caspian Sea shore line and specifying the correction coefficients for each satellite data, six short lengths of shore line were measured by field distance measuring in the three provinces and at the different topography conditions (table 2). The accurate length of shore line on each four used images was computed using following formula:

$$FSL/DSL=CC \qquad (1)$$

Where
FSL is Field length of shore line
DSL is digitized shore line on different images
CC is correction coefficient

Table 2: the field measured distances in different region and province

Ground distance (m)	Region/province
6184.5	Jouibar/Mazandaran
3255	Feridonkenar/Mazandaran
860	Anzali port/Guilan
2690	Gasemabad/Guilan
2191.7	Bandartorkman/Golestan
1671	Chapaghli/Golestan

Results and discussion:

Results showed that length of digitized shore line of southern Caspian sea bordered in Iran using ETM+ multi spectral bands, ETM+ multi spectral and panchromatic fused bands, IRS-1D multi spectral bands and IRS-1D multi spectral bands fused with panchromatic band were obtained 1220, 1284, 1063.5 and 1115.2 km, respectively for ETM, ETM Fusion, IRS, and IRS Fusion. To accurate determining length of the southern Caspian Sea shore line and specifying the correction coefficients for each satellite data, three short lengths of shore line were measured trough fielding distance measuring. Results showed that correction coefficients were computed for four above mentioned data, 0.742772, 0.753830, 0.814468 and 0.760486, respectively. And with applying these coefficients on the digitized lengths, the accurate length of southern Caspian Sea were 906.2, 967.9, 866.2 and 848.1 km, respectively (table 3).

Table 3: Field measurement, digitized length on the used images and correction coefficient

	FSL		DSL (IRSfused)	DSL (IRS)	DSL (ETM+)	DSL (ETM+fused)
jouibar	6184.5	Length(m)	7900	7392	8534	8286
		CC	0.782848	0.836580	0.724630	0.741974
Feridonkenar	3255		4524	3823	4242	4175
			0.719496	0.851425	0.767326	o.779641
Anzali port	860		1144	1129	1209	1206
			0.751288	0.761736	0.711331	0.713101
Gasemabad	2690		3947	3695	3683	3694
			0.681530	0.724872	0.730382	0.728207
Bandartorkman	2191.7		2645	2345	2810	2645
			0.828620	0.934627	0.779964	0.824257
Chapaghli	1671		2091	2149	2249	2271
			0.799139	0.777571	0.742997	0.735799
mean		Mean CC	0.760486	**0.814468**	0.742772	0.753830
			1115.2	1063.5	1220	1284
			848.1	**866.2**	906.2	967.9

Concerning to high coefficient rates, the multi spectral IRS-LISSIII data has more capability to accurately delineation of shore line compared to other used data in this study. This result refers to resolution of IRS-LISSII imagery compare to ETM+ imagery. This study showed that Pansharp fusion process could not improve the results either for ETM+ or for IRS data. Low radiometric level of panchromatic of IRS imagery caused the merged images have not suitable quality to recognize the coastal zone and water body. In other hand, to be nearest the date of IRS imagery to time of study was effective on the results.

References:

-Ekercin, S., Cankut Ormeci & Cigdem Goksel, 2003, Coastline change analysis of the Meric River by using multitemporal remotely sensed data.

-Ghanghermeh, A., 1998. Estimation of coastline length of southern Caspian sea. Report of Caspian Sea national research center. 6pp.

-Marfai M. A., H. Almohammad, S. Dey, B. Susanto and L. King. (2007). Coastal dynamic and shoreline mapping: multi-sources spatial data analysis in Semarang Indonesia. Environmental Monitoring and Assessment**.**

-Ustan , B., Semih Ekercin & Nebiye Musaoglu , 2004. A performance analysis of the cclassification and manual digitizing methods for the detection of Coastline by Using Satellite image data.

-Wang, L.T. 2003. Delaware Inland Bays Shoreline Extraction Using Landsat 7 Satellite Imagery. Digital Mapping Techniques '03 — Workshop Proceedings. URL: --http:// pubs.usgs.gov /of/2003/of 03-471/wang/index.html