Assessment Sea Depth Measurements and LANDSAT-8 Images for Producing Bathymetric Maps for Eastern Harbor, Alexandria, Egypt*.

Presented by

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***As a part of M.Sc. Thesis in the College of Maritime Transport &Technology**

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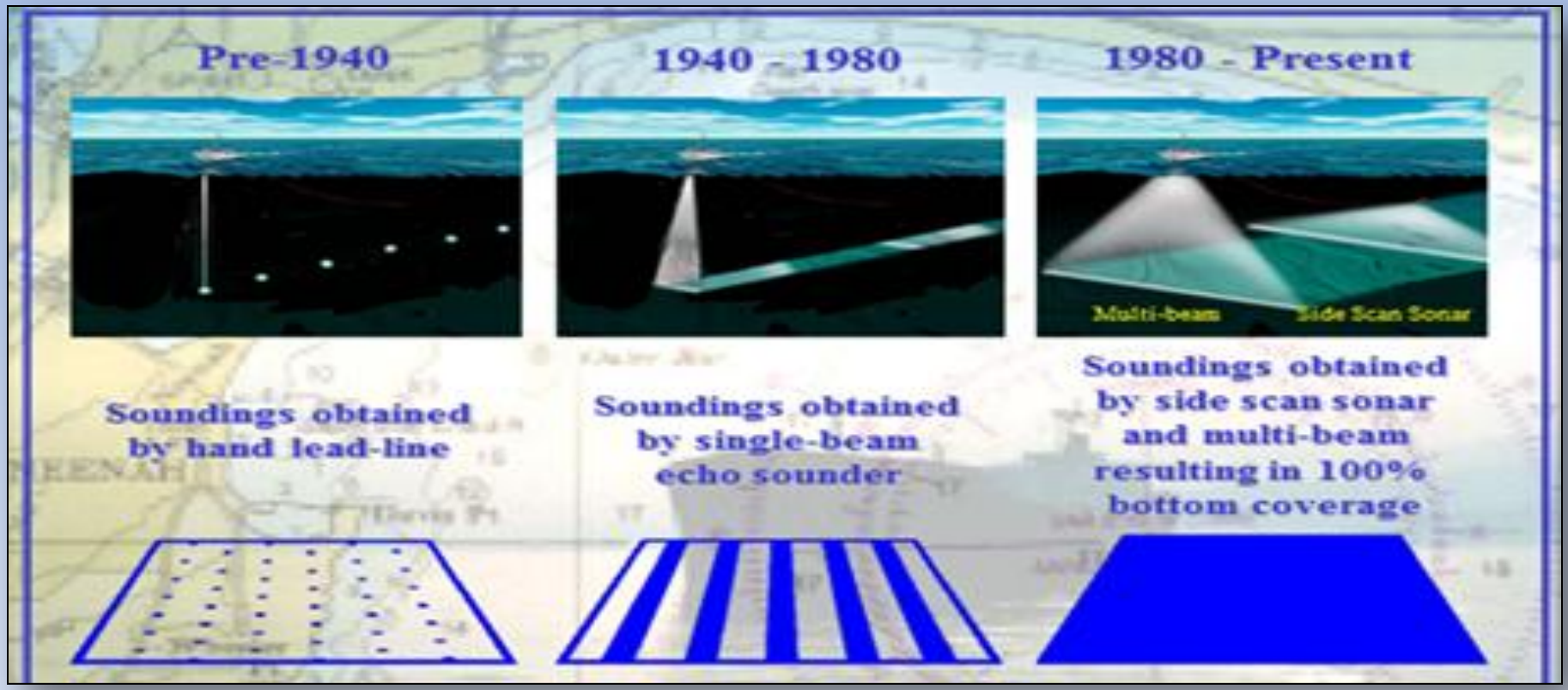
1) Introduction

- Bathymetry which is the technique of measuring the depth of water bodies, there are many techniques for calculating bathymetric measurements such as Sound Navigating and Ranging (SONAR), Airborne LIDAR Bathymetry (ALB), and satellite imagery. the primary reasons for mapping seafloor is the save of navigation.

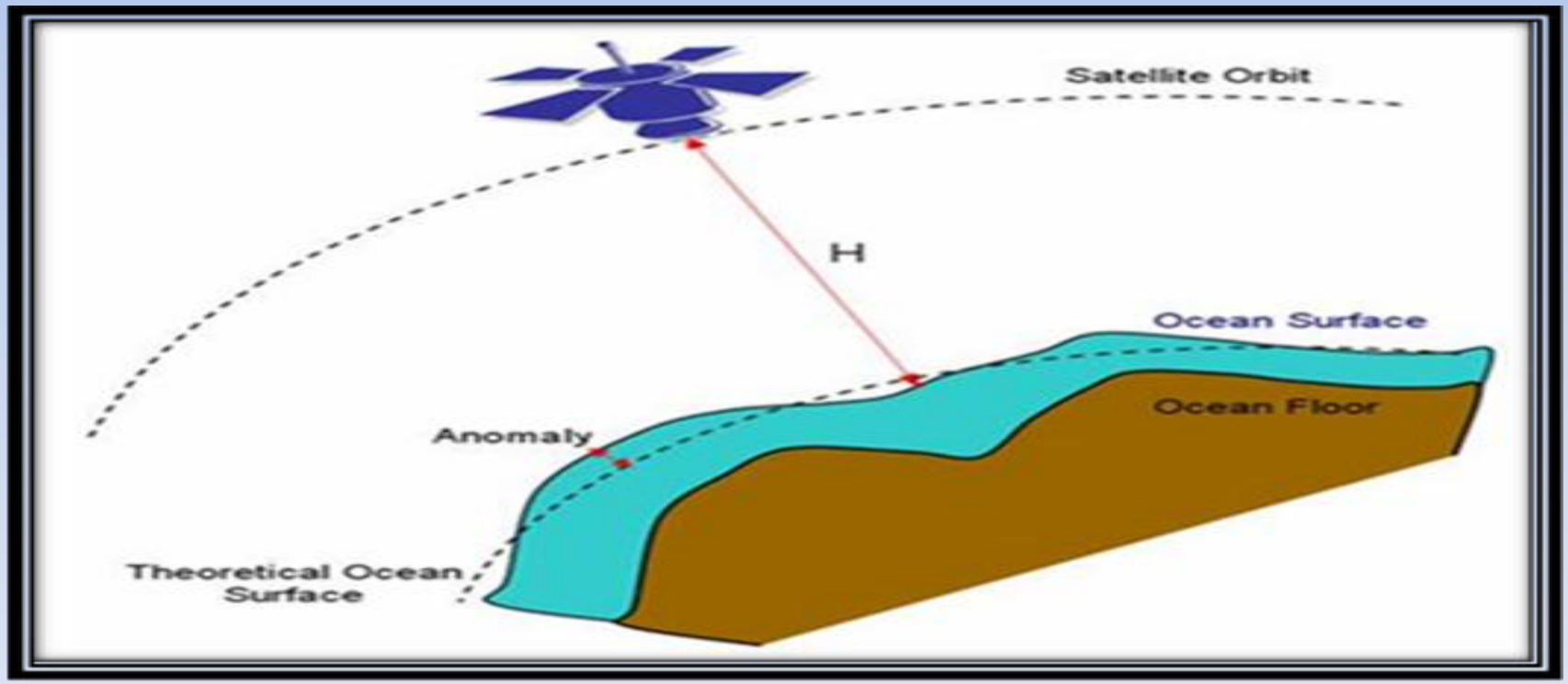
- Hydrographic Survey is the science of measuring, describing of seabed features which affect maritime navigation, marine construction, dredging, offshore oil exploration /offshore oil drilling.

- The history of hydrographic:



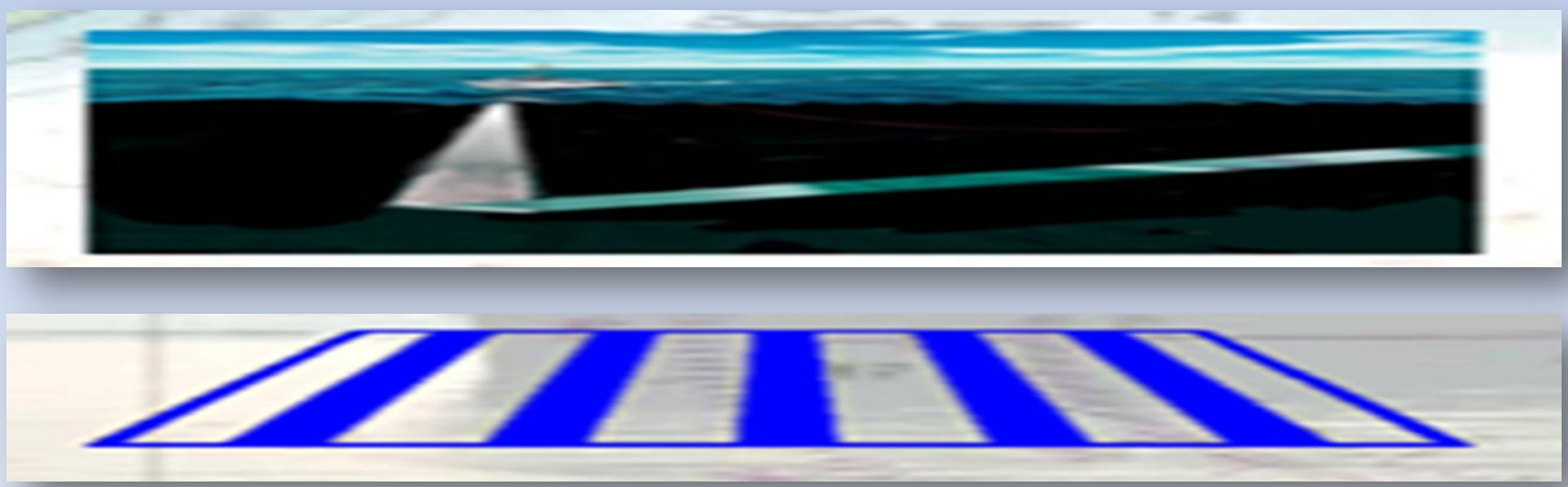
➢ Ocean Remote Sensing

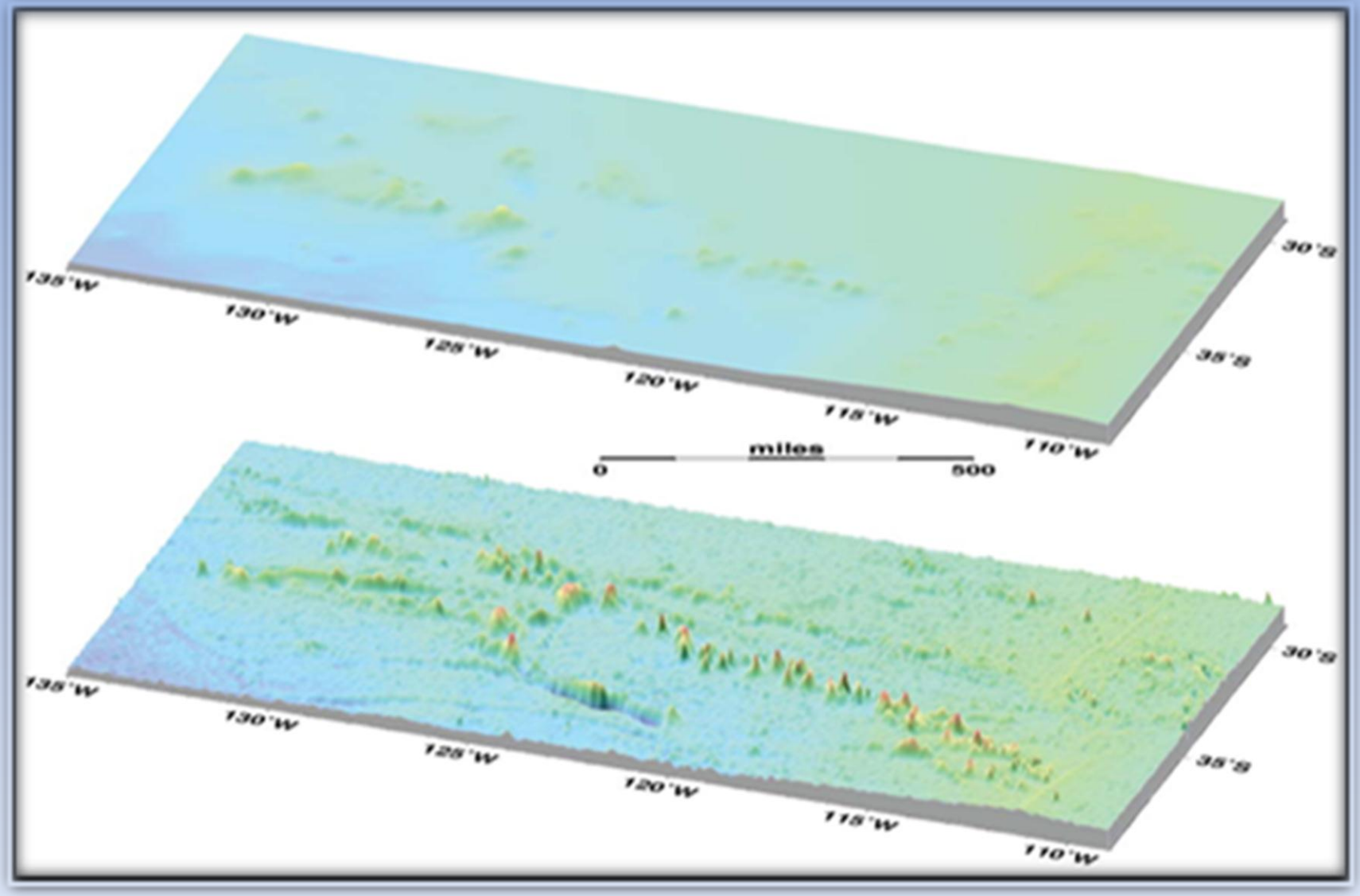
Since the 1970's, satellite remote sensing technology has been adopted as a possible technique in the collection of bathymetric data.



The Problem

- Traditional bathymetric mapping misses many important features of seafloor topography which located between survey lines. The single sonar beam produces a strip of measured depths in the direction travelling.




135°W
130°W
125°W
120°W
115°W
110°W
30°S
35°S
miles
0
500
135°W
130°W
125°W
120°W
115°W
110°W
30°S
35°S

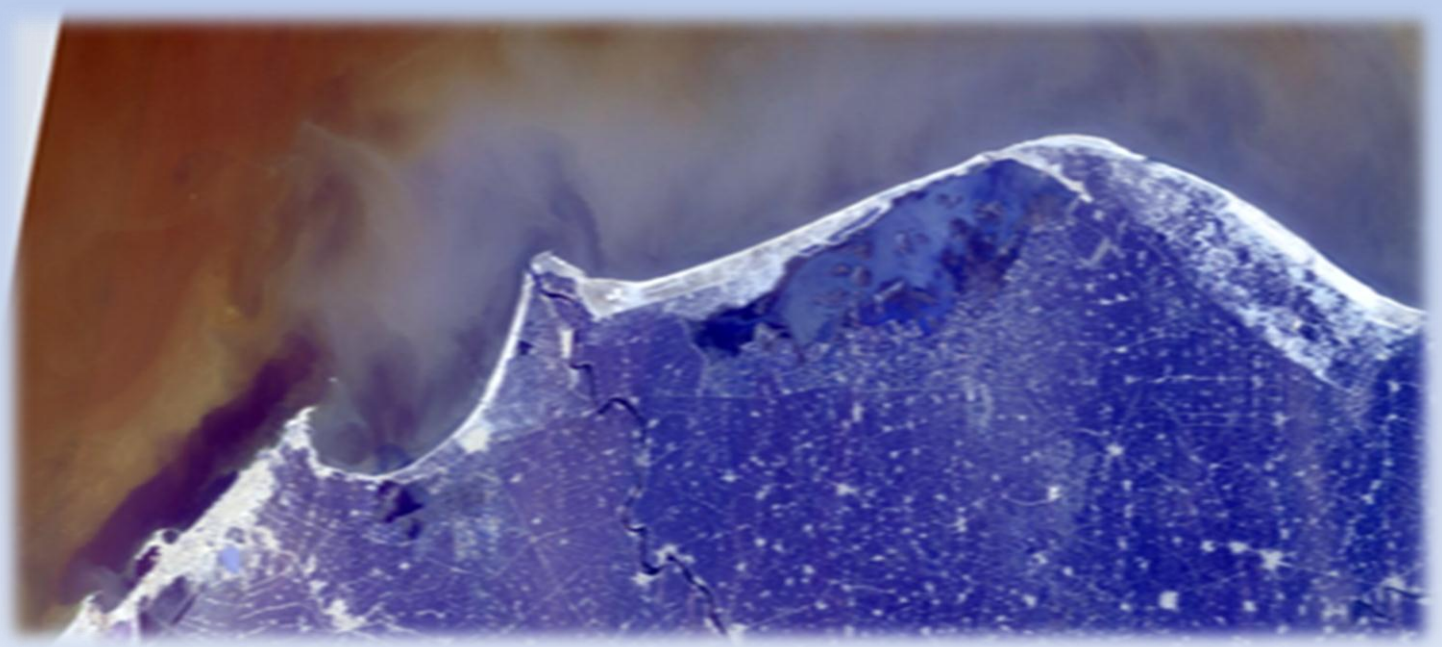
The Question is?

- Can we depend on available satellite images of remote sensing to produce and update high quality nautical charts and to what degrees?

Data Used

Two different data will be used as a source of data for the same study area:

- The first data acquired by Landsat 8 imagery



The second was the raw data of a hydrographic survey process which was collected 14/05/2013 the equipment consisted of:

a - Survey system:

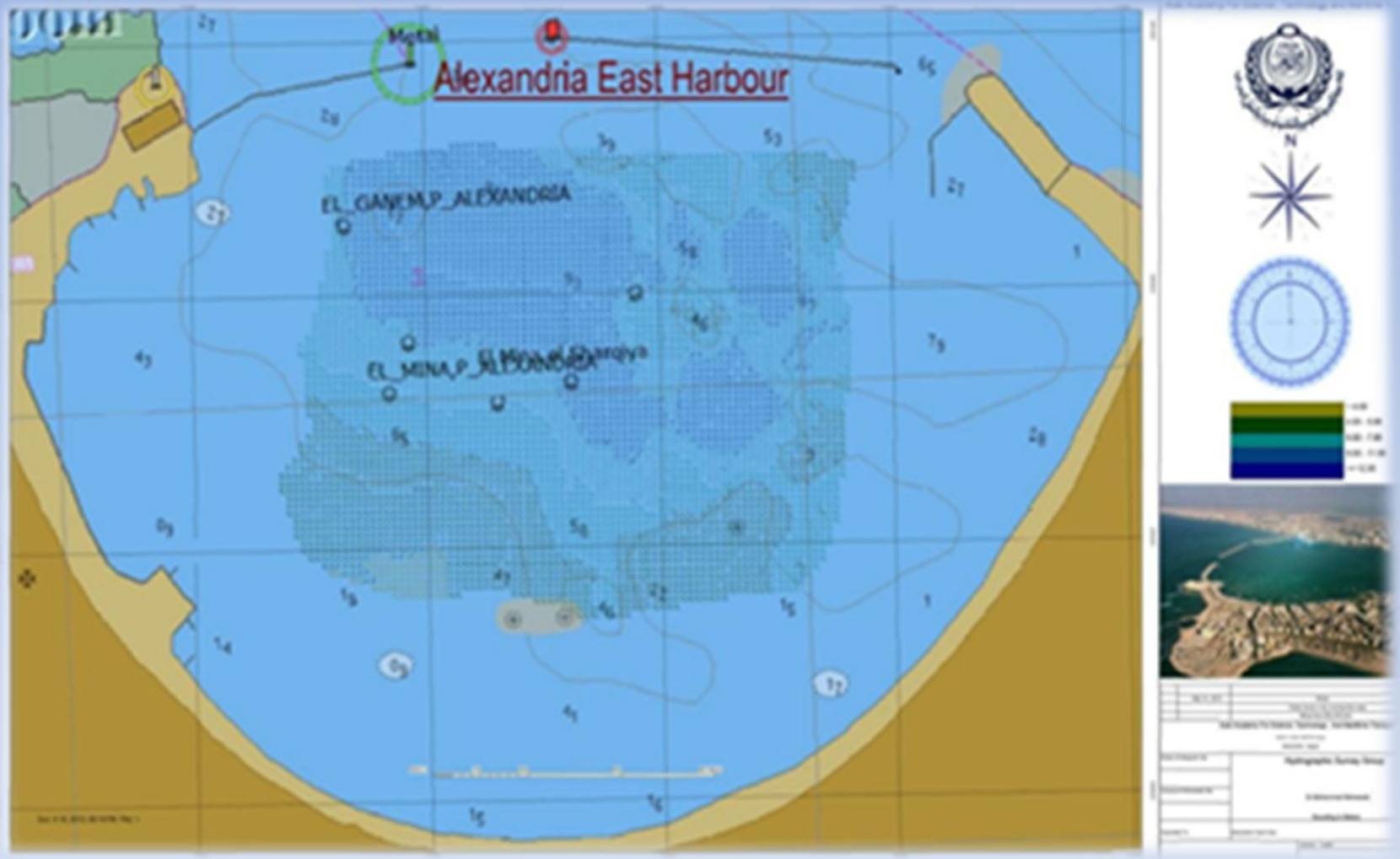
-Echo sounder (navy sound 2010)

-Side scan sonar (Star fish)

-DGPS (GPS Trimble NT 200)

b - Office based equipment:

-HYPACK max 6.2B Hydrographic survey office software.



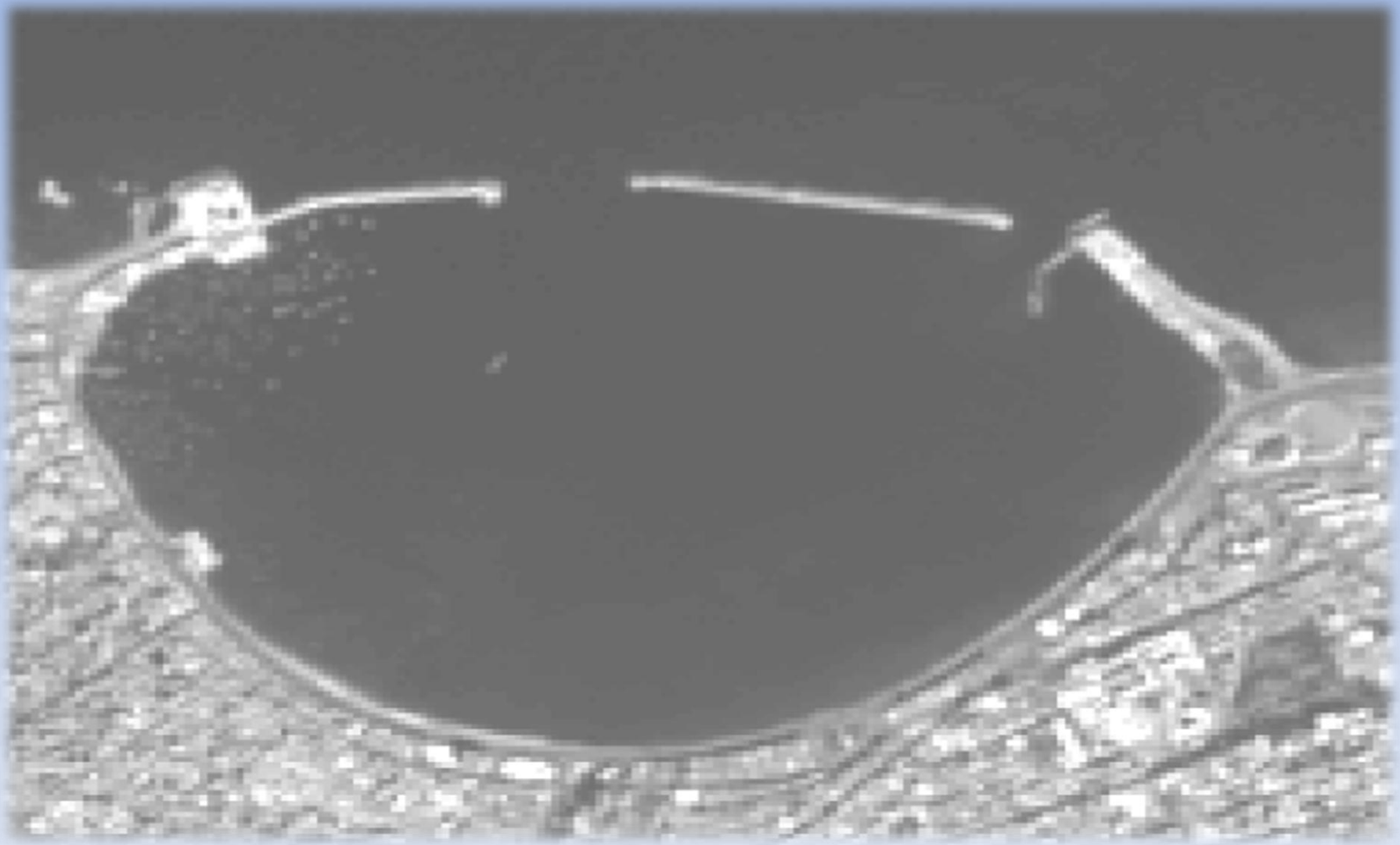
Bathymetric chart of the study area.

Tidal correction

Tide can make a difference in the surface of the sea, so the raw data must add the tide values (-0.44) to adjust the measurements.

X	Y	Z	Tide value	Corrected Z
775245.0	3455985.0	4.36	0.44	4.8
775275.0	3455985.0	4.5	0.44	4.94
775275.0	3455970.0	4.32	0.44	4.76
775260.0	3455985.0	4.42	0.44	4.86
775290.0	3455970.0	4.2	0.44	4.64
775230.0	3456000.0	4.33	0.44	4.77
775245.0	3455985.0	4.36	0.44	4.8

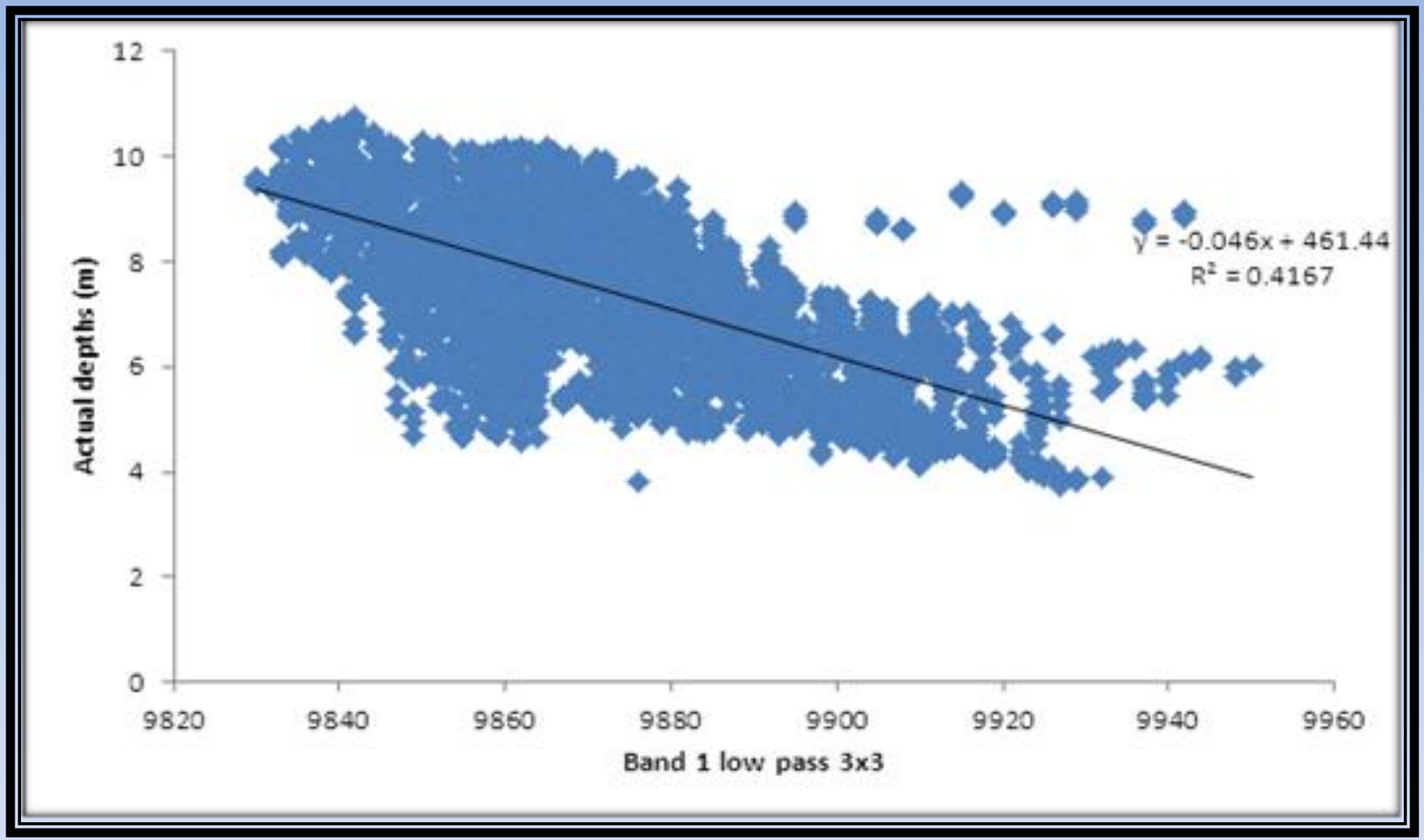
Sub-setting Image:



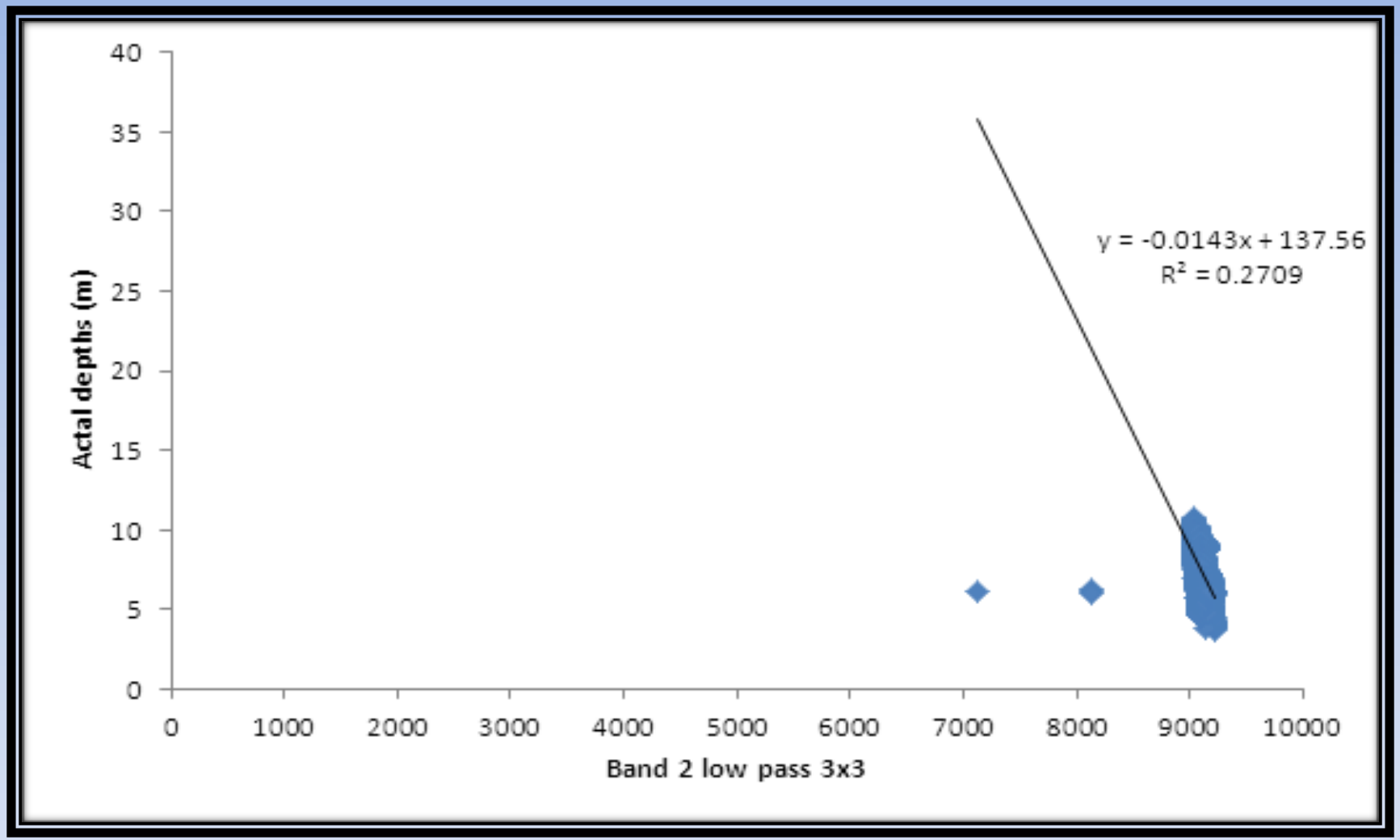
Enhancement of raw DNs:

By low pass filter size 3x3, 5x5, 7x7 and 9x9 .

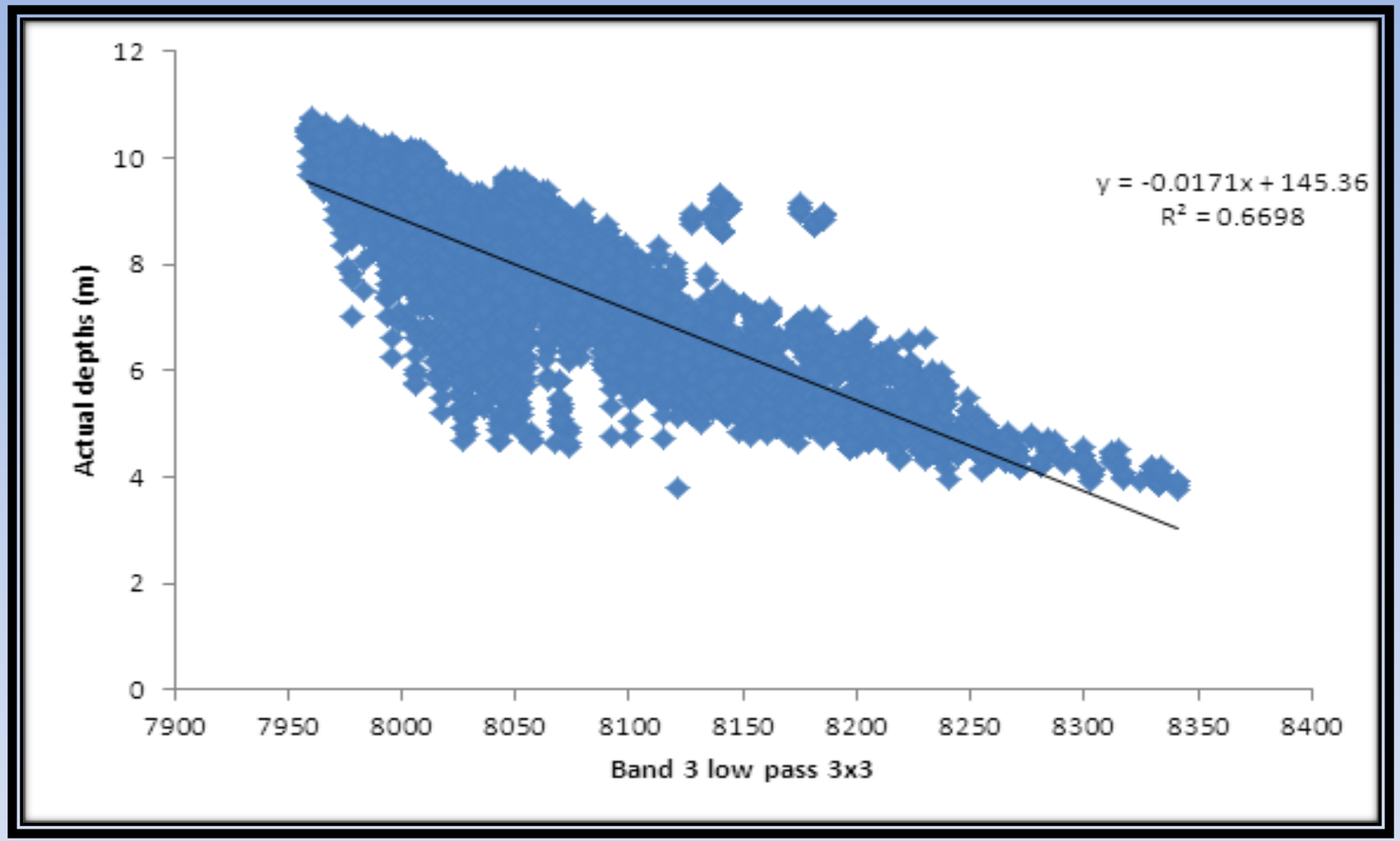
The linear relationship between digital numbers (DNs) low pass filtering and The measured depths.



The linear relationship between digital numbers (DNs) for band 1 by using the low pass filter 3x3and water depth measurements.



The linear relationship between digital numbers (DNs) for band 2 by using the low pass filter 3x3and water depth measurements.

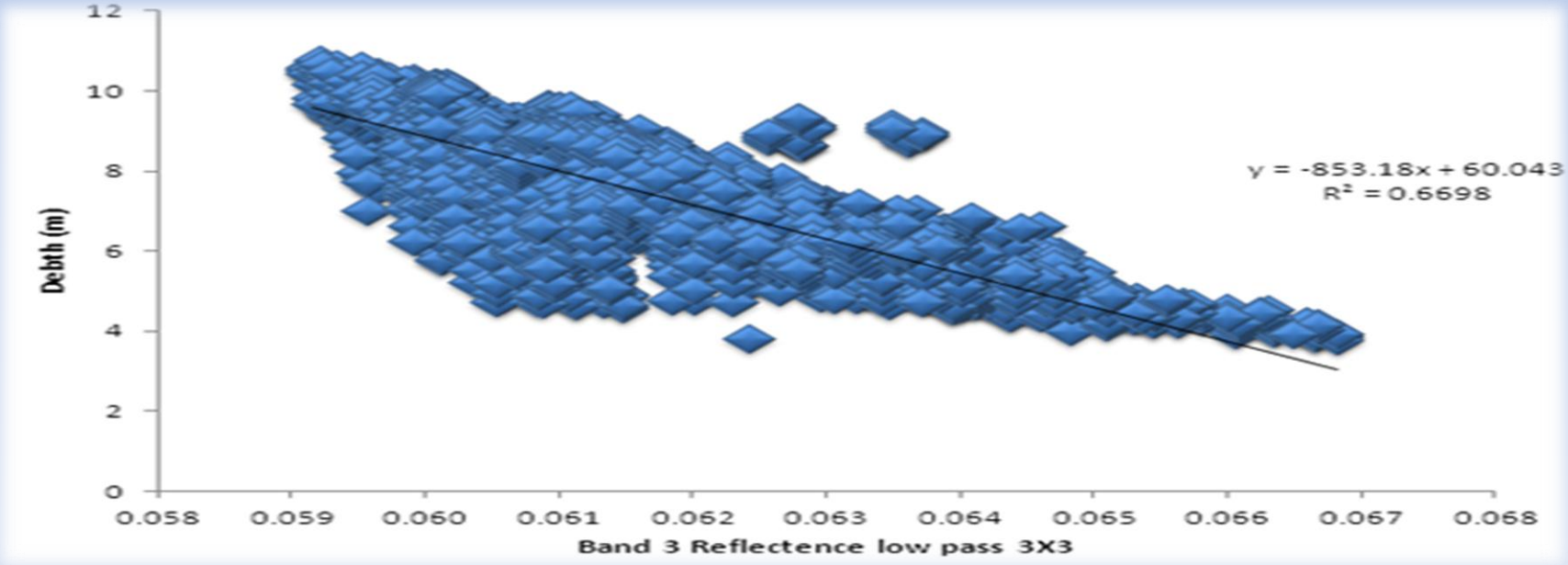


The linear relationship between digital numbers (DNs) for band 3 by using the low pass filter 3x3and water depth measurements.

	Low Pass filter			
	3x3	5x5	7x7	9x9
	Correlations (R)	Correlations (R)	Correlations (R)	Correlations (R)
Band1	0.64553	0.03964	0.03964	0.04890
Band2	0.52046	0.07054	0.33991	0.01552
Band3	**0.81839**	0.81178	0.33992	0.16069

Production of liner regression algorithm (model) to predict water depth:

it based on the correlation between water depths and image reflectance values.



Equations of the models for the three bands.

Band No.	Model equation
1	**D=-2299.3*R+231.51**
2	**D=-714.51*R+66.108**
3	**D=-853.18*R+60.043**

Model Summary of regression analysis.

	Band 1	Band 2	Band 3
R	0.645538	0.520487	0.818298
R Square	0.416719	0.270907	0.669612
Adjusted R Square	0.416597	0.270754	0.669543
Std. Error of the estimate	1.218482	0.000992	0.916881

Field depths and estimated depths and the differences.

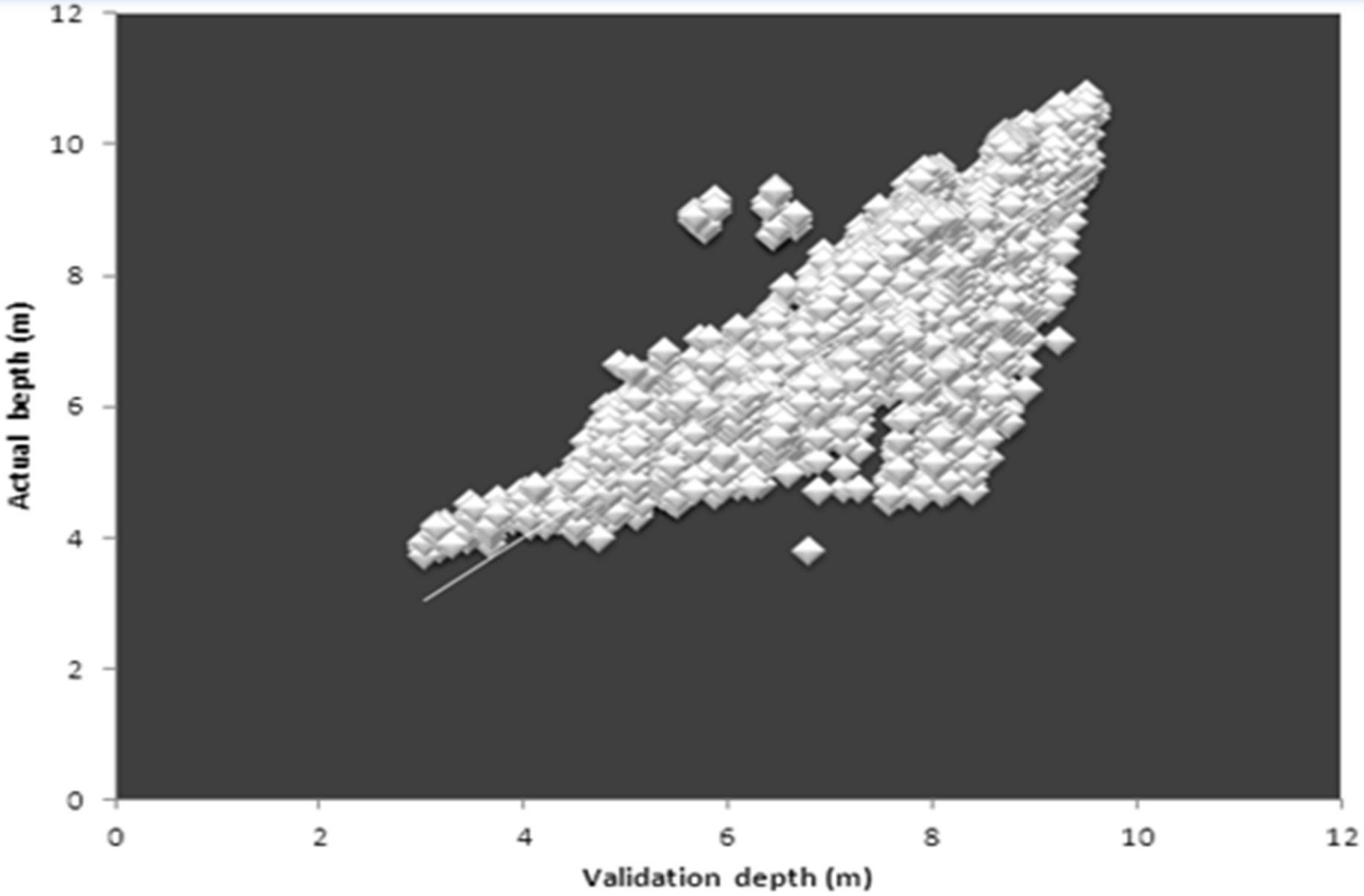
X	Y	Field Depth (m)	Estimated depths (m)	Difference (m)
775665	3456240	6.82	7.27	0.445
775575	3456255	7.14	7.54	0.398
775575	3456270	7.38	7.88	0.5
775545	3456315	7.82	8.10	0.281
775575	3456285	7.62	7.88	0.26
775575	3456315	7.85	8.05	0.2
775575	3456345	8.07	8.17	0.1
775575	3456330	7.96	8.17	0.21
775575	3456300	7.74	8.05	0.31
775605	3456240	6.87	7.50	0.634
775590	3456240	6.88	7.54	0.658

Validity of the model:

At 95% confidence interval and 0.05 significance level the validation results show that p-value equals to (0.986343) .

This means that the difference between the study groups was not statistically significant, where the significant difference between the groups is not a real difference.

As a result of the foregoing the model was accepted for the determination of sea depth.



The validity of model.

Accuracy Assessment:

- The accuracy assessment depends on the following algorithm:

$$ER = \frac{(ED - AD)}{AD} * 100$$

- **Where;**
- *ER* = the error.
- *ED* = the estimated depth.
- *AD* = the actual depth.

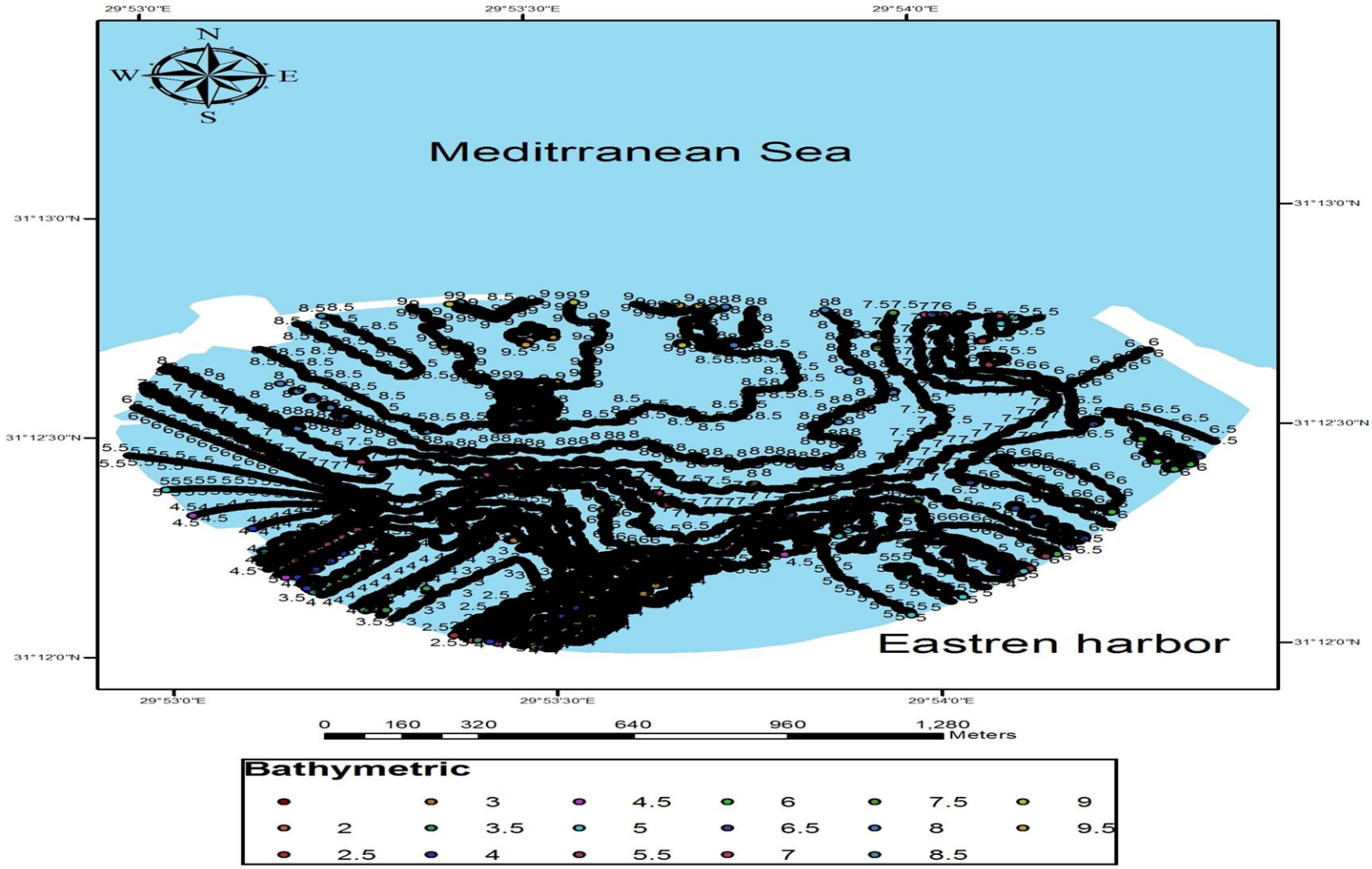
the estimated error was 1.54% this value is due to the clarity of water and the cloud cover that has affected the satellite image.

GIS Application for Navigational purposes:

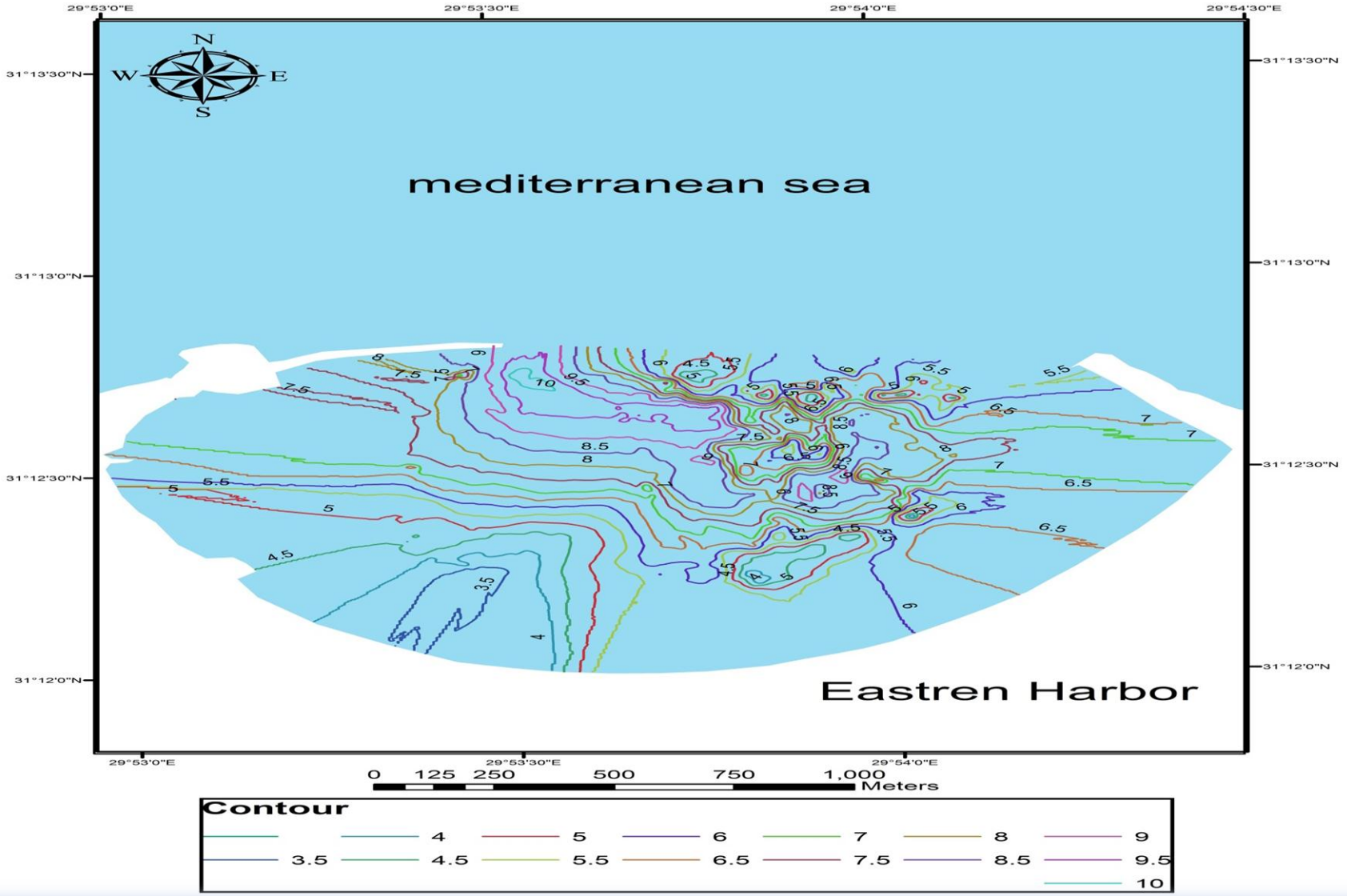
GIS provides the tools (Spatial Analysis) to take advantage of converting the research results (Raster to Vector) to be as a nautical chart which shows the necessary information for Navigation such as depths, contour lines, landmarks, and reference grids.

- **GIS and Data Analysis:**

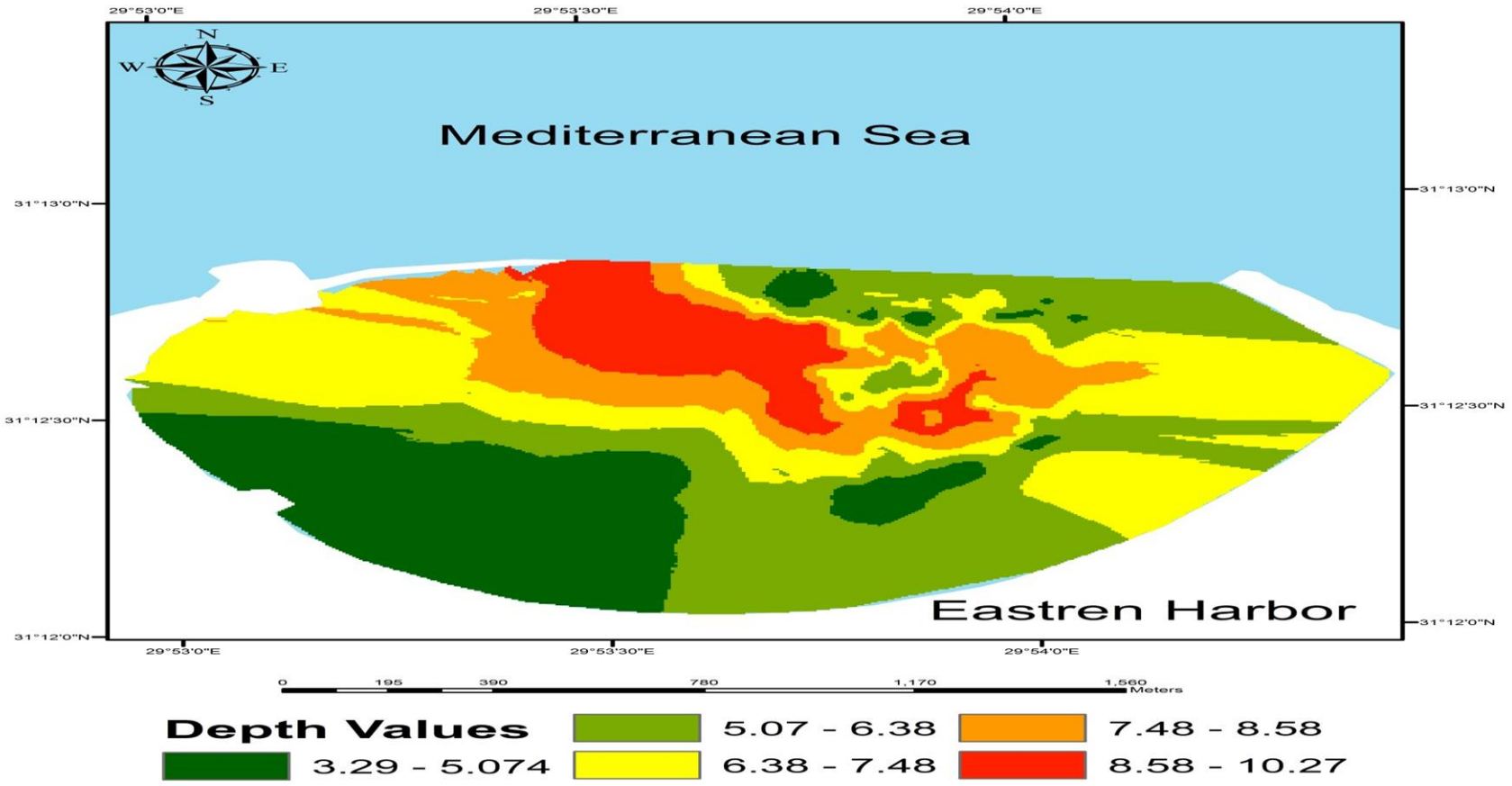
Kriging interpolation technique was used for data analysis, it depends on the statistical relationships or statistical models.



Bathymetric map of the study area.



Contour map of the study area.



Interpolated water depth produced with kriging.

That Mean, the bathymetry chart extracted from the Landsat-8 satellite data show many similitude with the actual depths derived from the field this means Landsat-8 as available and public data has a capability of estimating depths.

Thank you