CAMERI-Coastal and Marine
Engineering Research Institute

המכון הישראלי
לחקר הנדסה ימית בע"מ

Morphological Changes within the Ashdod Port Region

(2011-2012)

Interim Report No.2

P.N.779/13

March 2013

Technion City, Haifa

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Prepared for: ***Israel Ports Development and Assets Company Ltd.***

By:

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March 2013

Technion City, Haifa

Table of Contents

List of Tables

List of Figures

Executive Summary

- The Coastal and Marine Engineering Research Institute (CAMERI) was commissioned by the Israel Ports Development and Assets Company Ltd. (IPC) to carry out an analysis of bathymetric changes in the Ashdod region during 2011-2012. This report is the second interim report issued in the framework of this study.
- The study provides an expert assessment of the morphological changes within the littoral zone in the Ashdod region during the period of 2011-2012.
- During the period of interest (April 2011 – August 2012) the total number of storm events recorded in the Ashdod area was 5, which corresponds to an average annual number of storm events per year. Significant wave height H_{m0}>5.0 m was recorded three times during this period that exceeds an occurrence of such strong storm events in this region. Duration of those three events was longer than average 50 hr (it was 68, 77 and 87.5 hr).
- Since the results considering the 2011- and 2012-surveys reveal significant morphodynamic alterations outside the near shore strip (within the sites deeper than closure depth 10-15 m), they have been suspected to contain some inaccuracy. The obtained significant differences in bathymetric maps cannot be justified by natural processes but can be explained by a systematic error of about 7-8 cm. This report considers only the two latest bathymetry surveys that neither of them has been analyzed previously. In such situation it is unclear which of the maps is prone to mentioned above inaccuracies. Hence, it was at the current stage arbitrarily decided to shift in the further analysis the water depth of the 2012-surveys by -8 cm (i.e. 8 cm is added to water depth measured in 2012). In the future detailed research this issue will be further investigated and more definite decision will be accepted however it cannot affect the conclusions reached in the present report.
- The data analysis is performed for volume, area and average depth variations separately for sand deposition and erosion, which enables us to determine sites of more significant morphodynamic activity.
- It should be bared in mind that during the time period 2011-2012 the natural morphological processes in the study area had been disturbed by human activities such as: (1) sand was dredged from two sites: (i) in between the Blue Marine and the Ashdod Port (98,925 m^3); and (ii) inside the Ashdod Port (214,927 m^3), in total

313,852 m^3 (from May 5 to August 27); (2) all dredged sand was dumped northward the cooling basin of Eshkol Power Station. Therefore, the morphological changes in the area of interest represent a combined effect of the processes, which impact can be hardly separable: the natural phenomena dictated by the climate conditions on one hand and human activity on the other hand.

- The analysis of the ***bathymetric maps differences*** during the last year 2011-2012 reveals:
  (1) Seabed erosion is noticed in the area between the Blue Marine and the Ashdod Port, primarily within lot #1 (for lot location see Fig.1). Insignificant volumetric changes are obtained within lot #3 located in shallow water to the south of the port, active area* is about 35% of total area of this lot. To the north-west of lot#3, remarkable seabed erosion about 1 m is noticed close to the shoreline.
  (2) Northward the port seabed erosion is obtained inside lots #4a-#7, #15 and #16. The most noticeable changes are within littoral lots #5, #7 and #15 indicating that the erosion increases toward the north. Although significant changes in seabed level are recognized inside lot #5, the changes in volume are minor. The reason could be the dumping of 313,852 m^3 of sediment in this lot.
  (3) Changes in seabed level -9 cm on the average are obtained over 13% of lot #8 ("sand storage site"), that corresponds to total erosion ~28,200 m^3 over active area ~333,000 m^2 (total area of the lot is ~2.5 mil.m^2).

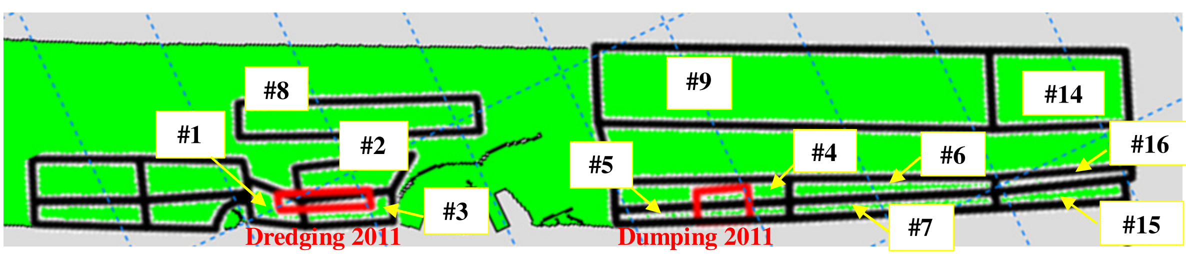


Fig.1. – Plan view of lot' location in the Ashdod region.

- The analysis of ***coastline evolution*** between the Blue Marine and the Ashdod Port during the last year 2011-2012 reveals coastline retreat upstream the port, which in some places reaches the maximum of about 50 m. Coastline retreat diminishes

* **Active area** is the area subject of erosion or accretion

southward and ceases approximately at a distance 0.6 km from the port southern route. Starting from this place only shoreline meandering is revealed, meaning shoreline deviation back and forth (beach retreat and accretion, respectively).

- The main conclusion is that seabed erosion is obtained in the littoral zone northward the Ashdod Port during 2011-2012. The total change of sediment volume in the lots #4a-#7 and #15 and #16 with threshold $|\Delta|=0.3$m is about -244,000 m^3 despite dumping of ~314,000 m^3 of sediment in this region (see Section 5, Table 5.1). The erosion is mainly at 1-3 m water depths.

1. Introduction

CAMERI was commissioned by IPC to conduct regularly an analysis of bathymetric changes in the Ashdod region. The results of the previous studies are described in *CAMERI reports P.N.678/08, P.N.695/09 and P.N.732/11*.

The area around the Ashdod Port was a subject of artificial sand nourishment operations during 2000-2004 years. These works had been carried out so as to ensure the sand bypass seemed to be impaired as a result of the port extension. The annual amount of some 180,000 m^3 of sand was dredged just to the south of the port and disposed northward the Power Station Eshkol. The amount of dredged sand had been chosen to match roughly the expected annual sand drift in the region. These activities were stopped in 2004. However, from time to time maintenance dredging inside the port and entrance channel has been carried out. Moreover, artificial sand nourishment was performed in 2011 year (from May 5 to August 27). Sand was dredged from two sites: (i) in between the Blue Marine and the Ashdod Port (98,925 m^3); and (ii) inside the Ashdod Port (214,927 m^3), in total 313,852 m^3.

This study should represent the analysis of bathymetric changes in the Ashdod region during the period from 2000 to 2012. At the previous (first) stage of this study (*CAMERI report P.N.771/12*) only a preliminary analysis of bathymetric changes within the dredging and dumping sites (lots marked in red in Fig.1.1) during 2011-2012 was conducted. Since at–the previous stage of the current study the maps provided by IPC covered the limited areas (dredging and dumping sites only) rather than the entire Ashdod region and for a very limited time performance, the required assessment of data quality could not been conducted.

At this second stage, the results of bathymetric changes during 2011-2012 are presented within the lots approved by the consultant of the Israeli Ministry of Environmental Protection (MEP) Dr. Dov Zviely (lots marked in yellow in Fig.1.1). The methodology employed is the same as used in the preceding studies (*CAMERI reports P.N.678/08, P.N.695/09* and *P.N.732/11*). Analysis of bathymetric changes all over all lots during the longer period (2000-2012) as well as analysis of the climate conditions during this time will be conducted further and presented in the final report.

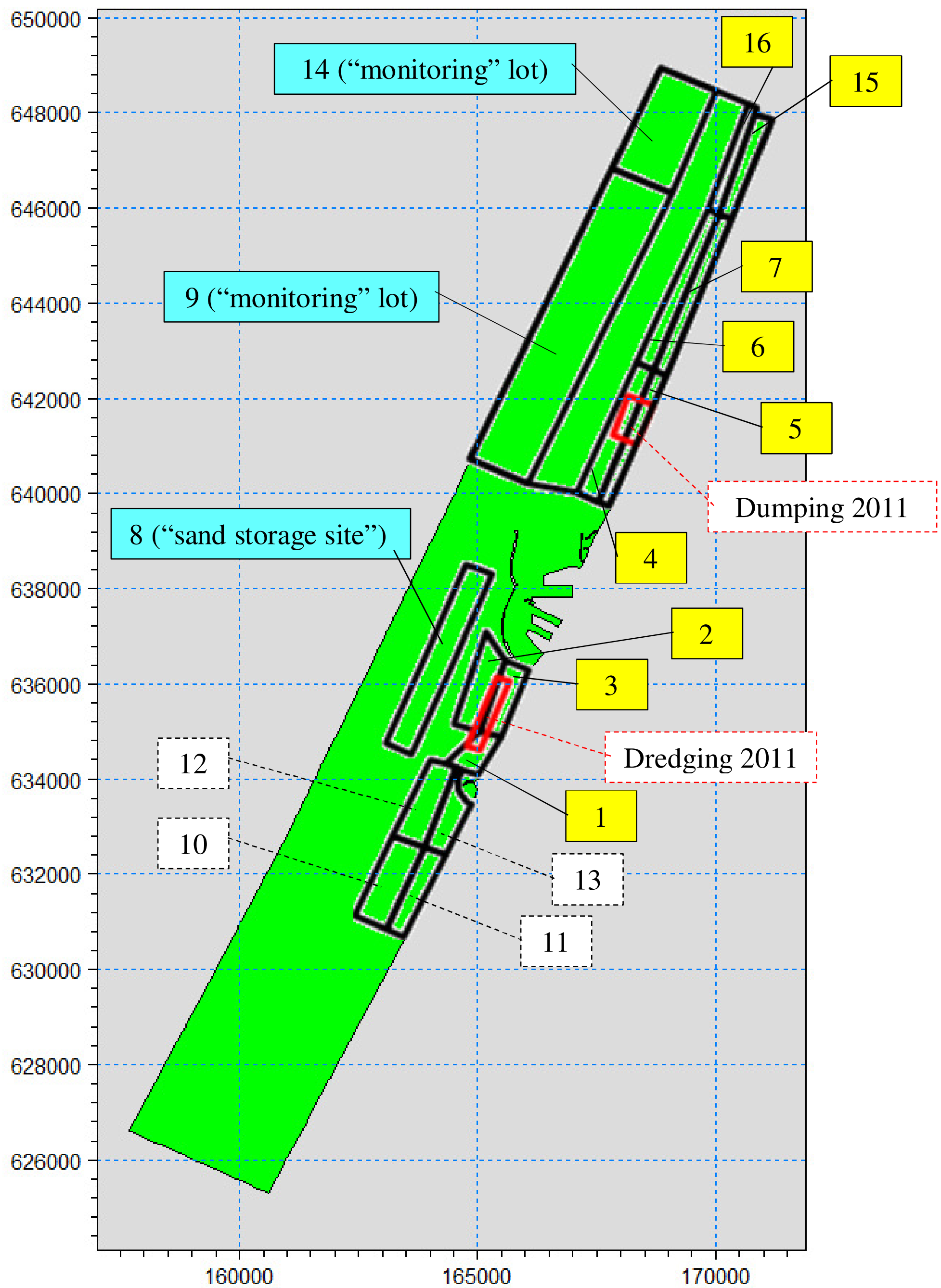


Fig.1.1 – Study area showing the lots used for morphological changes analysis.

2. Data Basis

The data provided by IPC includes:

I. Bathymetry data

1. Bathymetric maps in ACAD format that correspond to the measurements performed relative to the Israel Land Survey Datum (ILSD) in 2011 and 2012 years.
2. Digital bathymetry in ASCII files (xyz-files).

The bathymetry measurement schedule during these years is shown in Table 2.1.

Table 2.1 – Schedule of bathymetry measurements performed in the study area.

No.	Bathymetry measurements conducted			Bathymetry chart
	By	From	To	
1	EDT Marine Construction Ldt	April 2011	September 2011	2011
2		May 2012	August 2012	2012

II. Amount of dredged/dumped materials

During the considered period artificial sand nourishment was performed in 2011 year (from May 5 to August 27). Sand was dredged from two sites: (i) in between the Blue Marine and the Ashdod Port (98,925 m^3); and (ii) inside the Ashdod Port (214,927 m^3), in total 313,852 m^3.

All dredged sand was dumped northward the cooling basin of Eshkol Power Station.

III. Wave data

Parameters of storm events and their duration that occurred in between bathymetric surveys of 2011 and 2012 are given in Table 2.2. During this period 5 storm events with significant wave height larger than 3.5 m were recorded. The number of storms corresponds to an average annual number of storm events per year. Significant wave height H_{m0}>5.0 m was recorded three times during this period that exceeds an occurrence of such strong storm events in this region. Duration of those three events was longer than average 50 hr (it was 68, 77 and 87.5 hr).

Table 2.2 –Statistical analysis of storm events in deep water at Ashdod.

No.	Date of storm	Maximum wave			Storm duration (hour) with H_{m0} larger than:							
		H_{m0} (m)	T_p (sec)	Dir	2.0m	2.5m	3.0m	3.5m	4.0m	4.5m	5.0m	5.5m
April - September 2011												
1	2011-12-25, 19:21	3.84	10.5	299	68	46	14	5				
2	2012-01-22, 19:20	5.03	11.8	284	30.5	24	18	16	7	4.5	0.5	
3	2012-01-27, 16:51	3.74	10.0	292	36.5	24	10.5	0.5				
4	2012-02-18, 06:51	5.65	11.1	298	87.5	63.5	37	28.5	23	9.5	3.5	1
5	2012-02-29, 21:21	5.55	13.3	299	77	68	51.5	41	35	16	5	0.5
May - August 2012												

3. Methodology of the Study

In this study MIKE 21 model developed by DHI is used for the assessment of bathymetric changes.

It should be noted that the large size of the surveyed area in the Ashdod region and very high measurement resolution do not allow raw bathymetric data interpolation (as is) to the MIKE model mesh with the required resolution. Therefore, the measured values of water depths were interpolated separately to each lot. The procedure uses the method of triangular interpolation. The area of mesh' cells is not larger than 100 m^2 that ensures the length of the triangle edges ~15 m or less.

It is turned out that a trench was dug in between 2001- and 2012-surveys (Fig.3.1). The trench route starts at ~5-7 m water depth and goes outside the considered area to deeper waters. The trench depth is approximately 1.5 m at water depths 11 m and lower, but at deeper locations its depth reaches ~3 m. The trench crosses the southern sections of lots #4 and #9. Therefore, the analysis of seabed changes within these lots excludes their southern sections and is presented only inside northern parts of lots #4a and #9a that were designated.

The analysis is carried out within the eight littoral zone lots shown in Fig.2.1 (marked in yellow) as well as in so called "sand storage site" (lot#8) and monitoring lots #9a and #14. The area of the chosen lots is listed in Table 3.1.

Table 3.1 – Area of the lots selected for sand balance analysis.

Lot #	1	2	3	4a	5	6	7	15	16	8	9a	14
Area, km^2	0.52	1.10	0.73	0.90	0.83	1.10	1.03	0.75	0.50	2.49	6.28	3.07

Data analysis is performed for volume, area and average depth variations separately for sand deposition and erosion, which enables one to determine sites of more significant morphological activity within the study area. These parameters (volume, area and depth) are computed with no threshold Δ=0.0 m and with threshold $|\Delta|$=0.3m. The threshold (if any) is subtracted from all depth differences (for example, see Fig.3.2), i.e. only the depth differences above the threshold for the positive depth differences and below the threshold for the negative depth differences are considered as suggested by *Manual on Hydrography published by International Hydrographic Bureau* (2005).

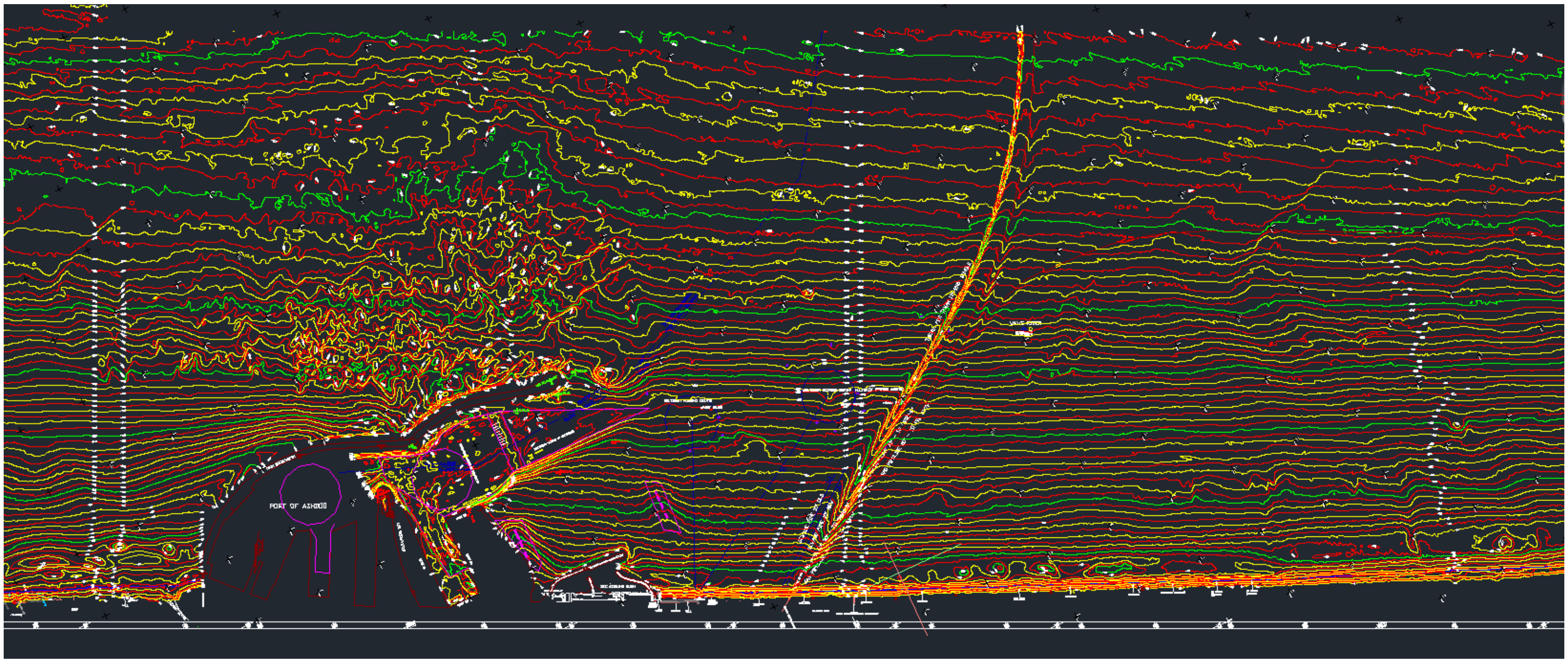
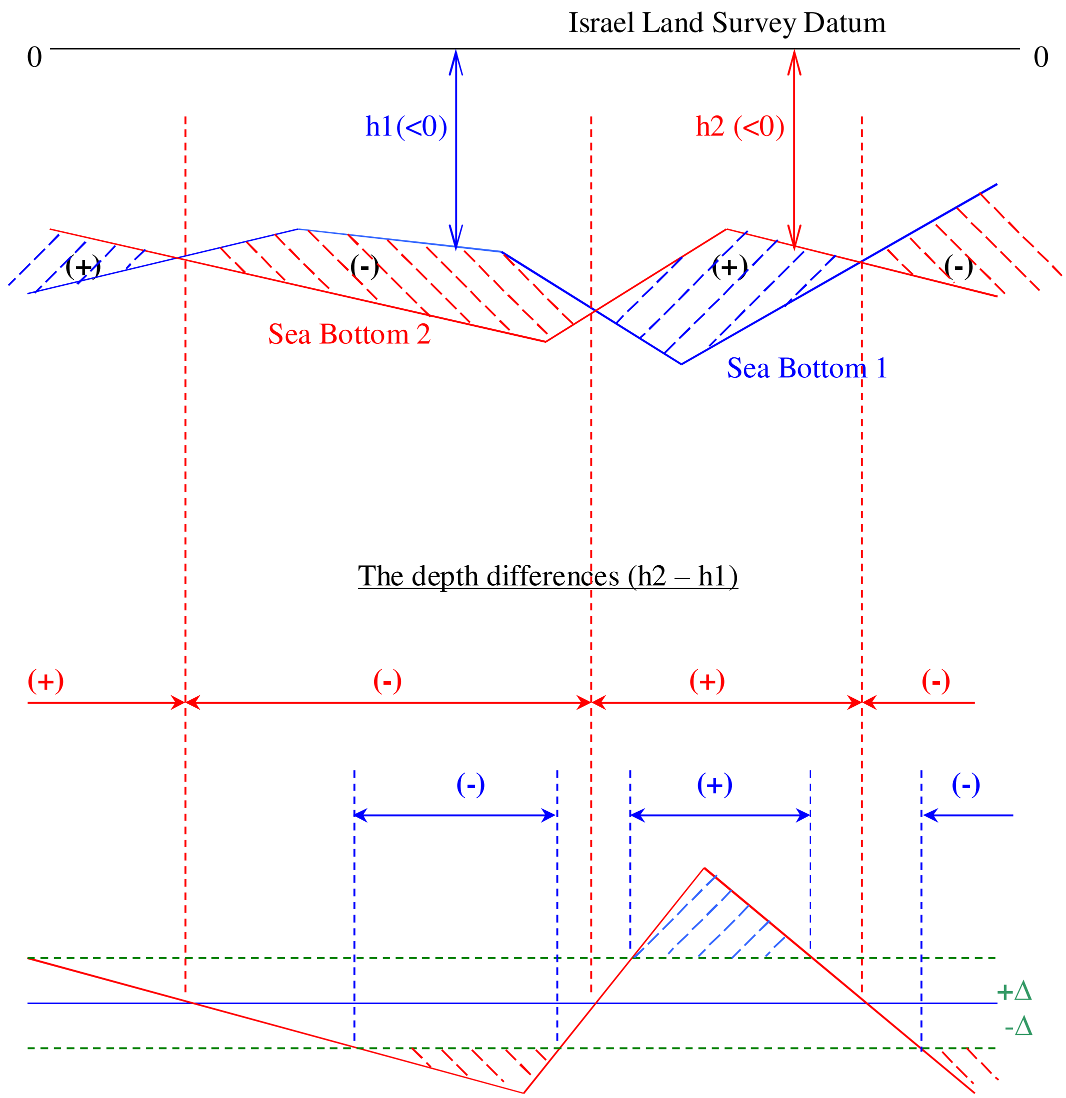


Fig.3.1 – Bathymetric map based on 2012-survey (“map-all-12.dwg”).



(+), (-) - with no threshold Δ=0.0 m
(+), (-) - with threshold |Δ|=0.3 m

Fig.3.2. – Scheme of negative/positive volumes calculations.

The average depth difference Δh_i within the lot $\boldsymbol{i}$ is calculated utilizing the following relationship:

$$\Delta h_i = {V_i}/{S_i}, \qquad (1)$$

where V_i and S_i are the sand volume and active area* of the i^{th} lot, respectively. The negative values of the sand volumes as well as depth differences indicate lot (sediment) erosion, while the positive – correspond to lot (sediment) accretion.

It should be noted that when the sand balance is calculated within considerable areas, even relatively small systematic error in depth measurements causes noticeable error in volume computations. For instance, for a lot of area 1 km^2 a depth measurement uncertainty of 30 cm brings about an error in volume computations of about 0.3 $mil.m^3$. At the same time, in the dredging sites with noticeable local changes in water depths the results obtained are believed to be more reliable.

* **active area** is the area subject of erosion or accretion

4. Verification of Bathymetric Maps Quality

As already noted in the previous reports (*CAMERI reports P.N.678/08, P.N.732/11*), according to our knowledge about marine sedimentological processes along the Israeli coast, the changes in bathymetry at water depths of 20-30 m should be small. Therefore, it is believed that the considerable changes in bathymetry in these depths indicate the systematic error in the measurements. The following verification of the recent 2011- and 2012-maps is performed based on this conclusion.

The average depth differences obtained during the verification periods (2011-2012) within lot #9a and lot #14 indicate significant "accretion" (see Table 4.1). The changes in the average depth differences with threshold $|\Delta|$=0.3m are about 7-8 cm. Since the results considering the 2011- and 2012-surveys reveal significant morphodynamic alterations outside the near shore strip (within the sites deeper than closure depth 10-15 m), they have been suspected to be doubtful. These high values of apparent sand "accretion" cannot be justified by natural processes but can be explained by a systematic error of about 7-8 cm. This report considers only the two latest bathymetry surveys that neither of them has been analyzed previously. In such situation it is unclear which of the maps is doubtful. Hence, it was decided to shift in the further analysis the water depth of the 2012-surveys by -8 cm (i.e. 8 cm are added to water depth measured in 2012).

Table 4.1 – Volume, area and average depth differences obtained within lot #9a and lot #14.

Period	$|\Delta|$	**Lot #9a**			**Lot #14**		
	Threshold, m	Volume, mil. m^3	Active area, km^2	Average depth, cm	Volume, mil. m^3	Active area, km^2	Average depth, cm
2011-2012	no shift						
	0	1.081	6.284	17.0	0.369	3.073	12
	0.3	0.143	1.485	9.7	0.039	0.505	7.9
	with 8 cm shift						
	0	0.578	6.2845	9.2	0.123	3.073	4.0
	0.3	**0.056**	**0.754**	**7.5**	**0.010**	**0.268**	**3.7**

5. Sand Balance Analysis

The differential maps for thresholds |Δ|=0.0 m and |Δ|=0.3 m are shown in Figs.5.1-5.12. The sediment volumes, active area of the lots (absolute and normalized) and water depth differences over the overlapping areas are given in Figs.5.13-5.15 as well as in Tables 5.1-5.4. The main conclusions are based on the results obtained using threshold |Δ|=0.3 m.

It should be reminded that the presented results are obtained after shifting the 2012 bathymetric map by -8 cm (i.e. 8 cm are added to water depth measured in 2012)**.** Introduction of such a shift is based on the analysis of bathymetric changes outside littoral strip inherent in sediment activity, namely at lots #9a and #14. More detailed discussion about the necessity of this shift and its value will be given in the final report. It is worth noting that this methodology of correcting systematic errors in bathymetric measurements had been developed and applied in the CAMERI previous studies, e.g. see *CAMERI reports P.N.695/09 and 732/11.*

Area between the Blue Marine and the Ashdod Port (lots #1-#3)

Some erosion (~23,000 m^3) is noticed in this area, mainly close to the Blue Marine within lot #1, where the amount of sediment lost is ~22,000 m^3. Approximately half of the total area of this lot was involved in morphological processes, while the active area of lot #3 is ~35% and of lot#2 only ~3%. Changes inside lot#1 located to the north of the marina are very uneven, which is typical for the shallow water areas located downstream the marine facilities. Average value of changes in seabed level is ~8.5 cm (erosion ~22,000 m^3) while the appropriate average seabed level rise is ~36 cm (~16,000 m^3) and average seabed level lowering is ~18 cm (~38,000 m^3). Erosion within lot #2 is ~1,500 m^3 with 4 cm change in seabed level over the active area of this lot. Along shore lot #3 reveals a large heterogeneity of seabed level changes while keeping sediment volume in this lot unchangeable that indicates local redistribution of sediment. The changes are noticed primarily in the northern part of this lot, i.e. close to the port facilities. Average value of changes in seabed level is ±30 cm (accumulation and erosion about ±41,000 m^3). The along shore strip and the bar at ~3-4 m water depth are subject to erosion, whereas some sand accretion is obtained closer to the coast.

Area northward the Ashdod Port (lots #4a-#7, #15 and #16)

In general, during the considered period (2011-2012), the area located northward the port was subject to erosion. At the same time, some sand accretion (about 2,700 m^3 obtained using $|\Delta|=0.3$ m) is noticed within lot #4a. The total change of sediment volume in the lots #4a-#7 and #15 and #16 with threshold $|\Delta|=0.3$m is about -244,000 m^3 despite dumping of ~314,000 m^3 of sediment in this region (see Table 5.1).

As mentioned earlier, a new trench crosses the entire lot#4 (e.g. see Fig.5.4). When no threshold is used an accretion is recognized northward this trench, which could be associated with dumping of dredged sediment. This sediment accumulation disappears when threshold $|\Delta|=0.3$ m is applied.

At water depths 5.5 m and deeper (lots #4a, #6 and #16) morphological activity is significantly less than inside the along shore lots #5, #7 and #15. The most notable changes occurred within lots #15 and #7. Average value of seabed level change in lot #15 revealed over 64% area (active area) of the lot is -0.24 m (~114,000 m^3). Average negative value of seabed level change is -0.59 m (erosion ~185,000 m^3) and average positive value is 0.43 m (accumulation ~71,000 m^3). Average value of seabed level change in lot #7 is somewhat less, i.e. -0.18 m (~87,000 m^3), and active area is 47% of total lot area. Average negative and positive values of seabed level change are -0.35 m (erosion ~118,000 m^3) and 0.20 m (accumulation ~31,000 m^3), respectively. Significant morphological activity is noticed inside lot #5. More than half of the lot area (57%) was involved in this activity. Although average negative and positive values of seabed level change are relatively high, i.e. -0.51 m and 0.33 m, respectively, no significant changes in sediment volume are obtained. Erosion of 95,900 m^3 and accretion of 94,500 m^3 yield erosion of 1,400 m^3 all over the active area 474,000 m^2 (total area of this lot is 826,000 m^2). It turned out that erosion along the coast increases northward from 1,400 m^3 at lot #5 to 113,800 m^3 at lot #15. This tendency and lack of erosion within lot #5 inherent in high morphological activity could be related to artificial sand nourishment (dumping of 313,852 m^3) carried out in this area in 2011 year (from May 5 to August 27). Maximal erosion within lot #5 took place at 2-3 m water depths. Inside lot #7 eroded areas are located closer to the coastline and within lot #15 an alternation of areas of accumulation and erosion of sand is noticed.

Sand storage site (lot #8)

During the considered period the active area of this lot is 333,000 m^2, which comprises 13% of the total lot area 2.5 mil.m^2. Average value of seabed level change in lot #8 is -9 cm that corresponds to approximately 28,000 m^3 of sand loss.

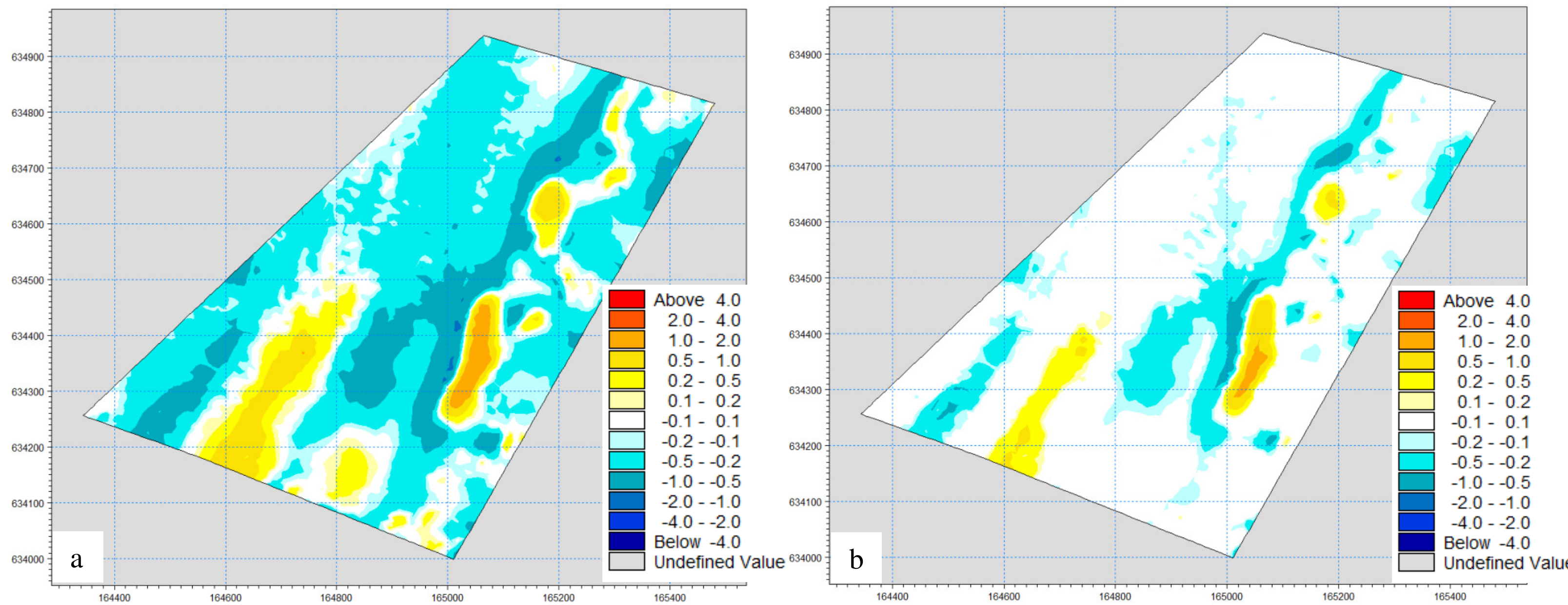


Fig.5.1. – Differential maps of lot #1 (shift = 0.08 m): (a) threshold |Δ|=0.0 m and (b) threshold |Δ|=0.3 m.

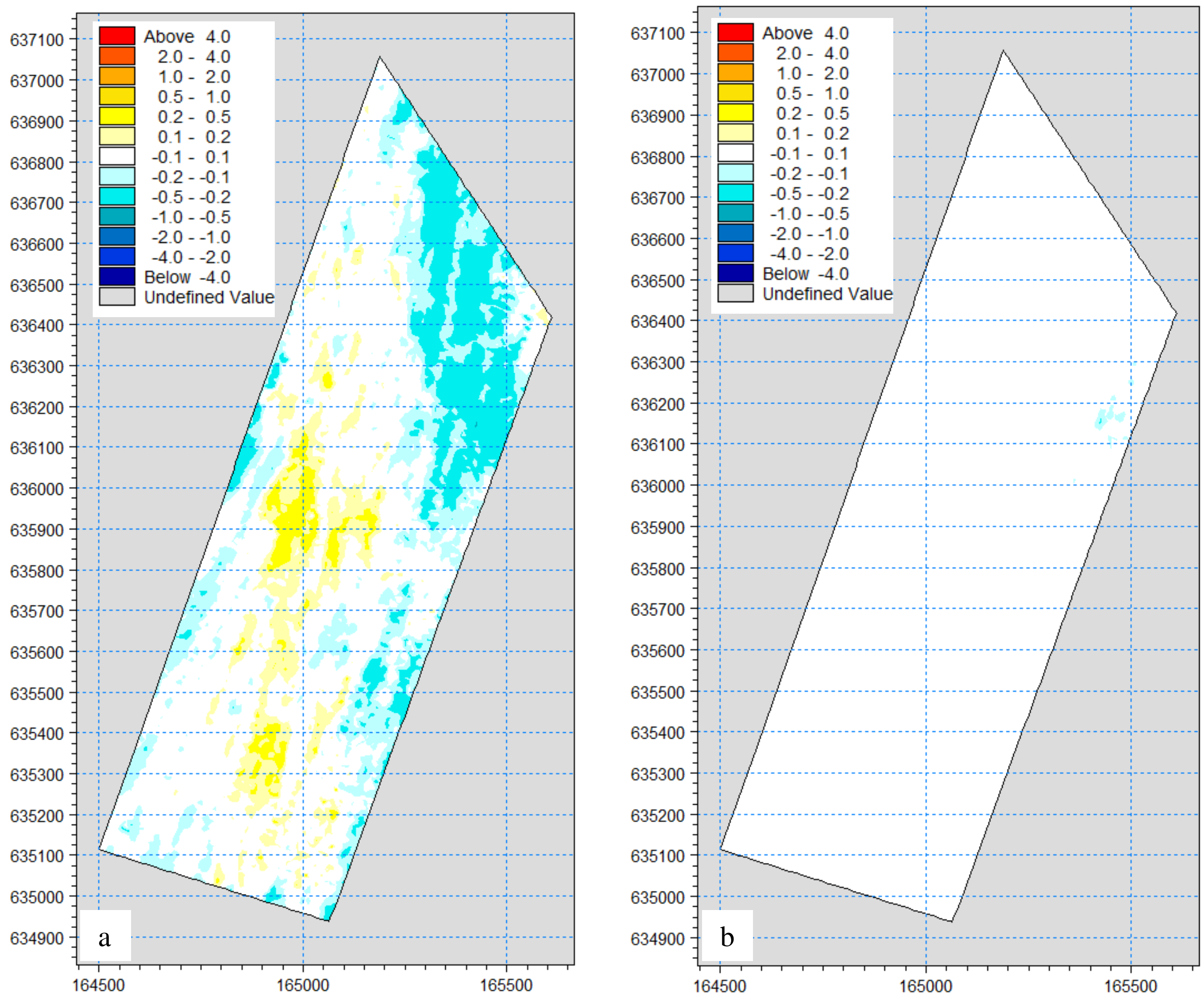


Fig.5.2. – Differential maps of lot #2 (shift = 0.08 m): (a) threshold |Δ|=0.0 m and (b) threshold |Δ|=0.3 m.

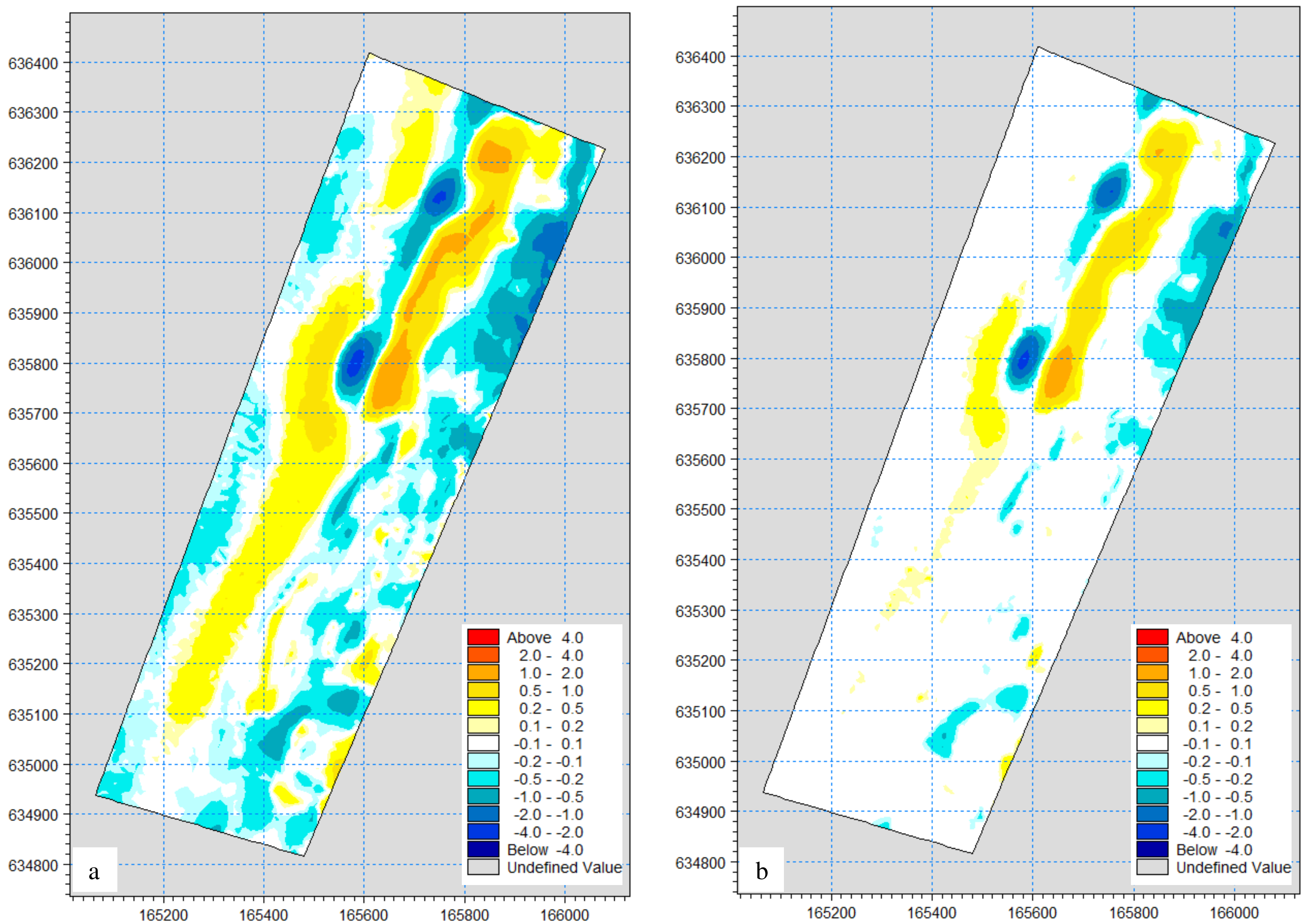


Fig.5.3. – Differential maps of lot #3 (shift = 0.08 m): (a) threshold |Δ|=0.0 m and (b) threshold |Δ|=0.3 m.

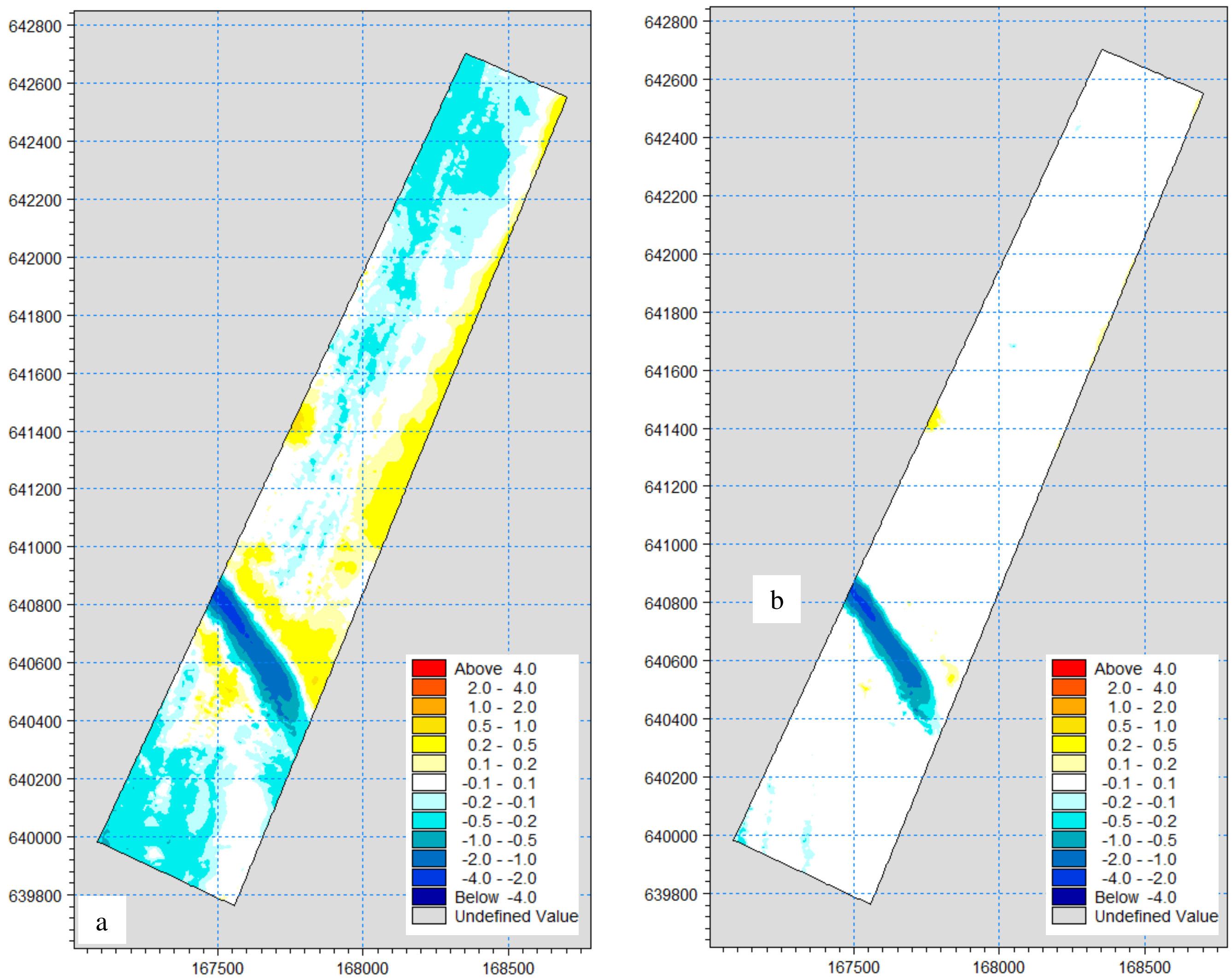


Fig.5.4. – Differential maps of lot #4 (shift = 0.08 m): (a) threshold |Δ|=0.0 m and (b) threshold |Δ|=0.3 m.

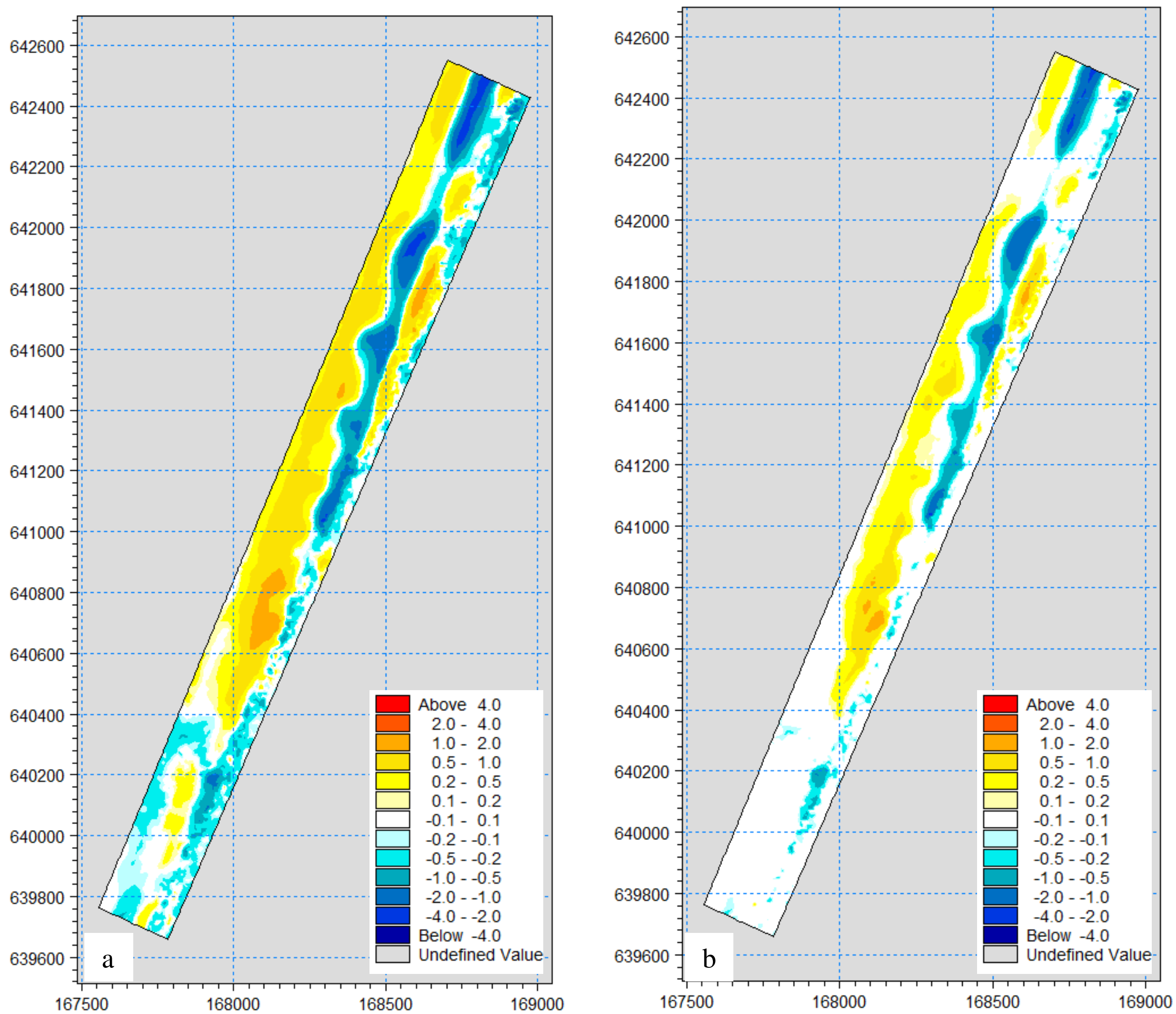


Fig.5.5. – Differential maps of lot #5 (shift = 0.08 m): (a) threshold |Δ|=0.0 m and (b) threshold |Δ|=0.3 m.

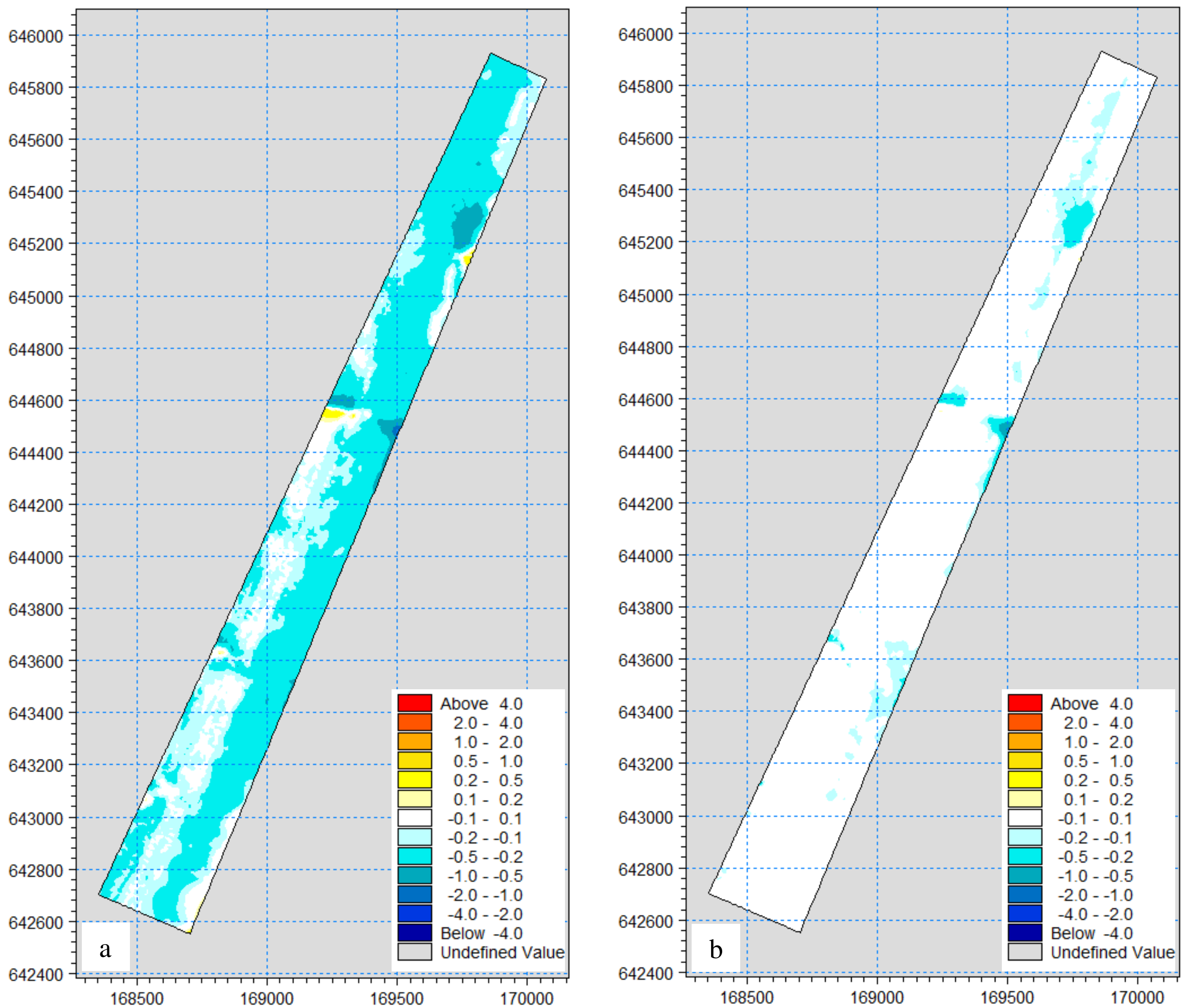


Fig.5.6. – Differential maps of lot #6 (shift = 0.08 m): (a) threshold |Δ|=0.0 m and (b) threshold |Δ|=0.3 m.

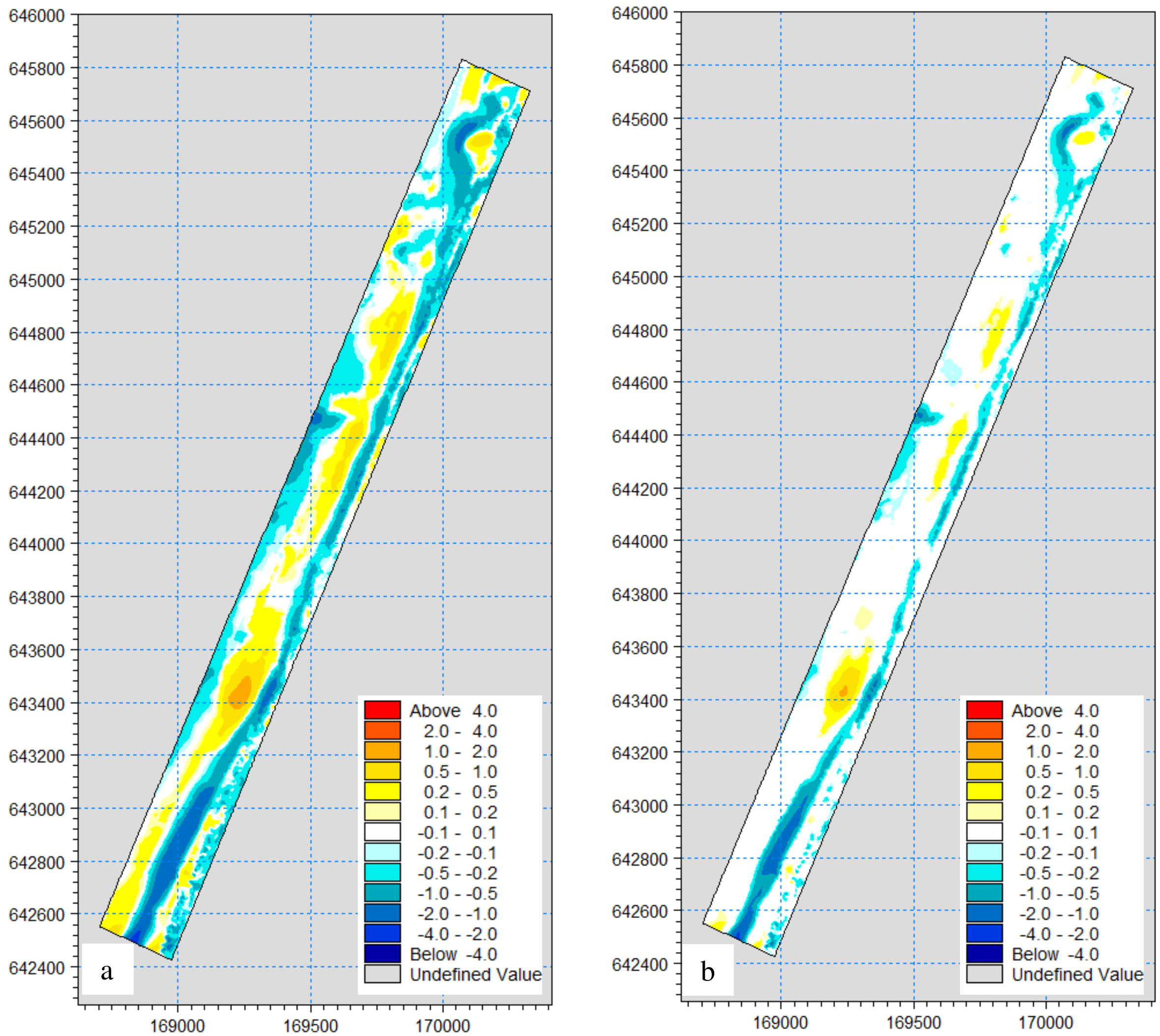


Fig.5.7. – Differential maps of lot #7 (shift = 0.08 m): (a) threshold |Δ|=0.0 m and (b) threshold |Δ|=0.3 m.

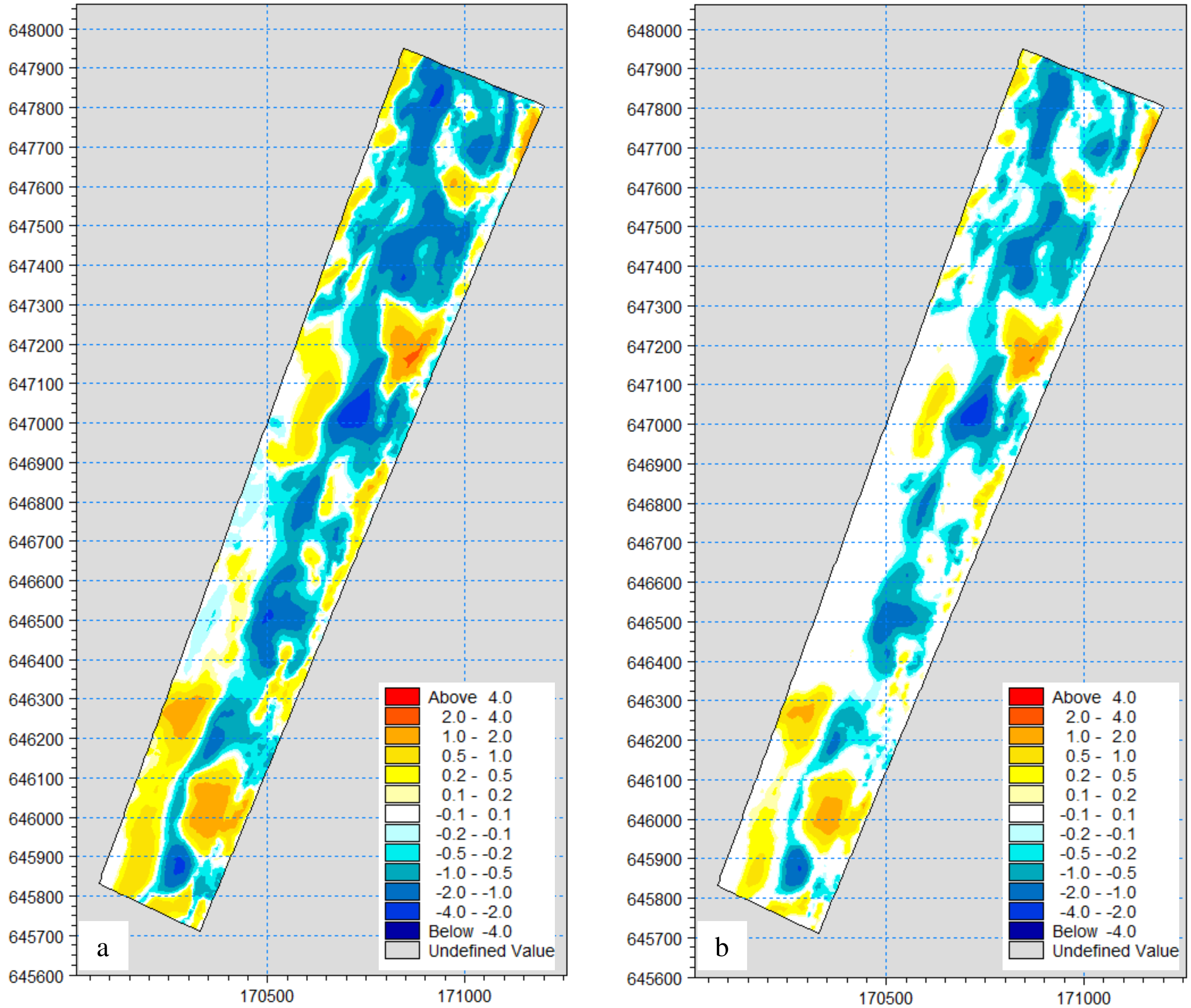


Fig.5.8. – Differential maps of lot #15 (shift = 0.08 m): (a) threshold |Δ|=0.0 m and (b) threshold |Δ|=0.3 m.

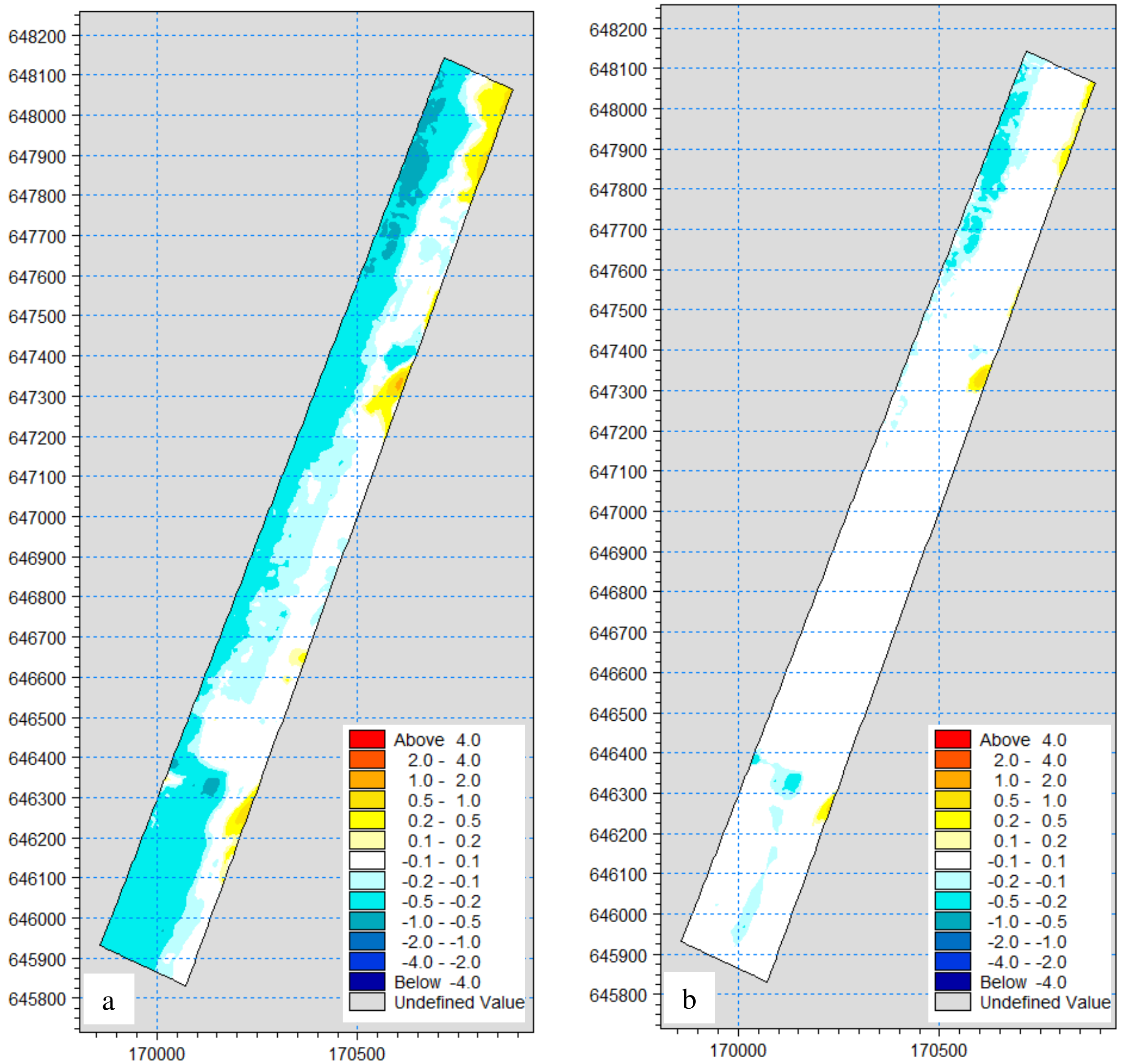


Fig.5.9. – Differential maps of lot #16 (shift = 0.08 m): (a) threshold |Δ|=0.0 m and (b) threshold |Δ|=0.3 m.

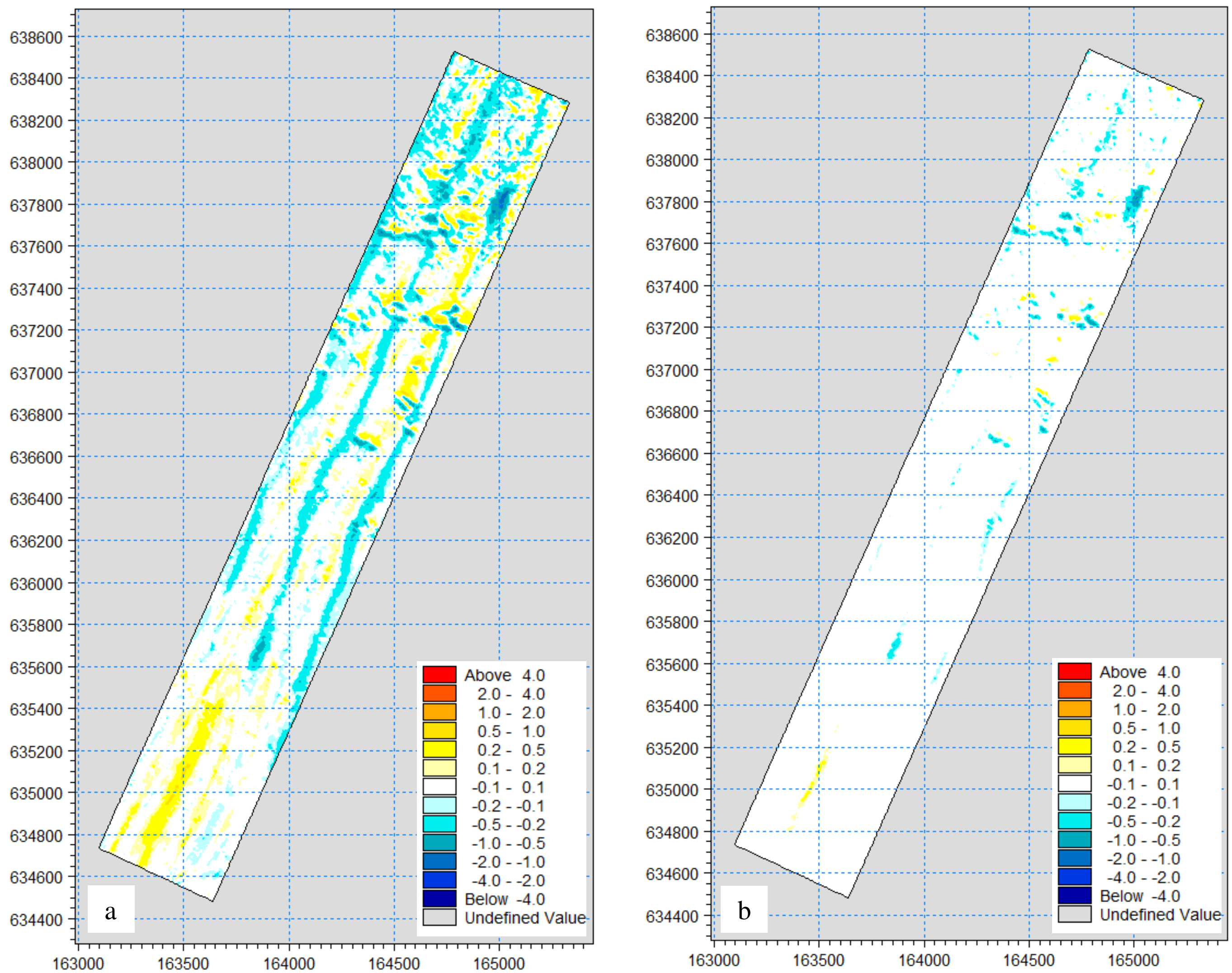


Fig.5.10. – Differential maps of lot #8 (shift = 0.08 m): (a) threshold |Δ|=0.0 m and (b) threshold |Δ|=0.3 m.

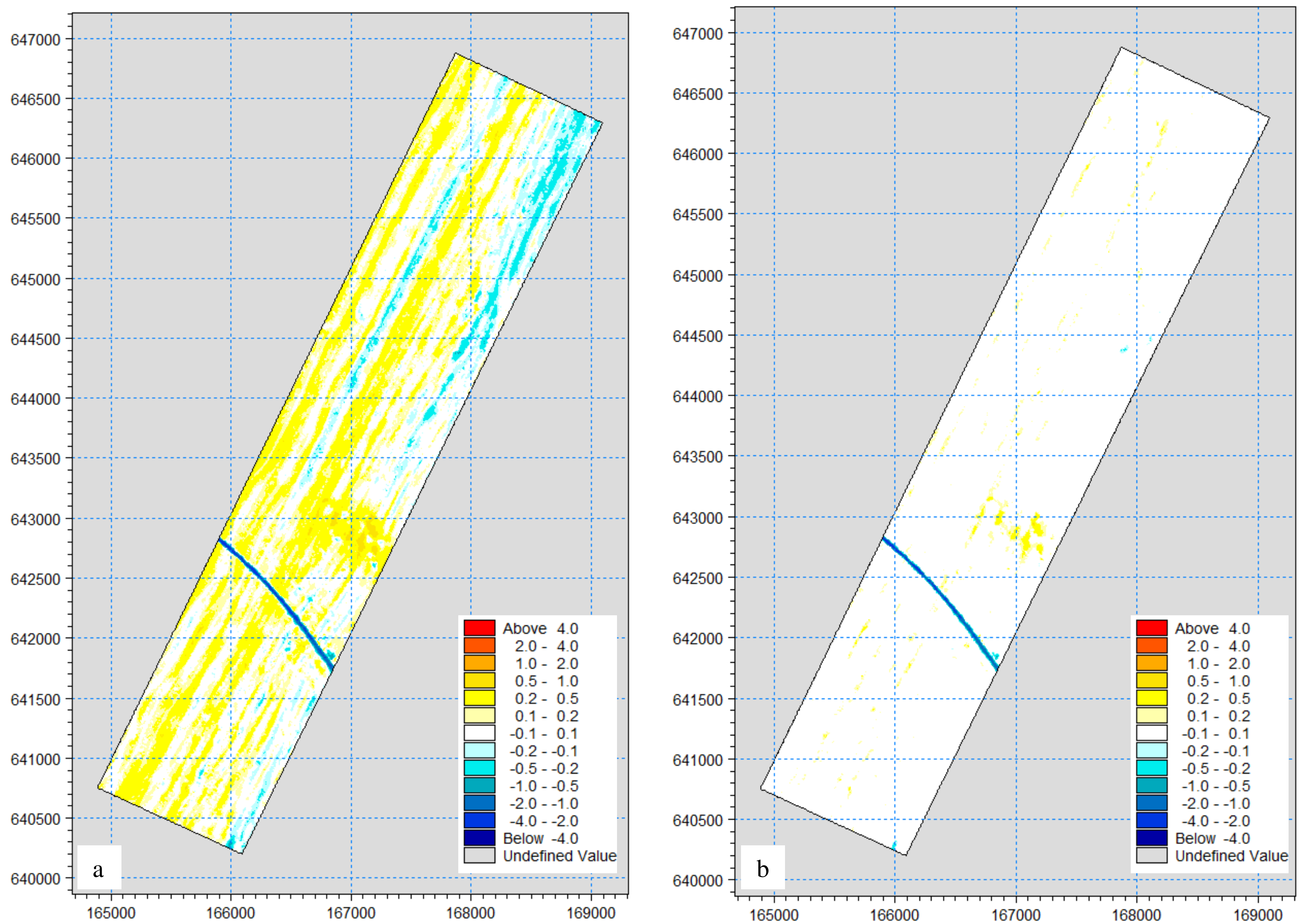


Fig.5.11. – Differential maps of lot #9 (shift = 0.08 m): (a) threshold |Δ|=0.0 m and (b) threshold |Δ|=0.3 m.

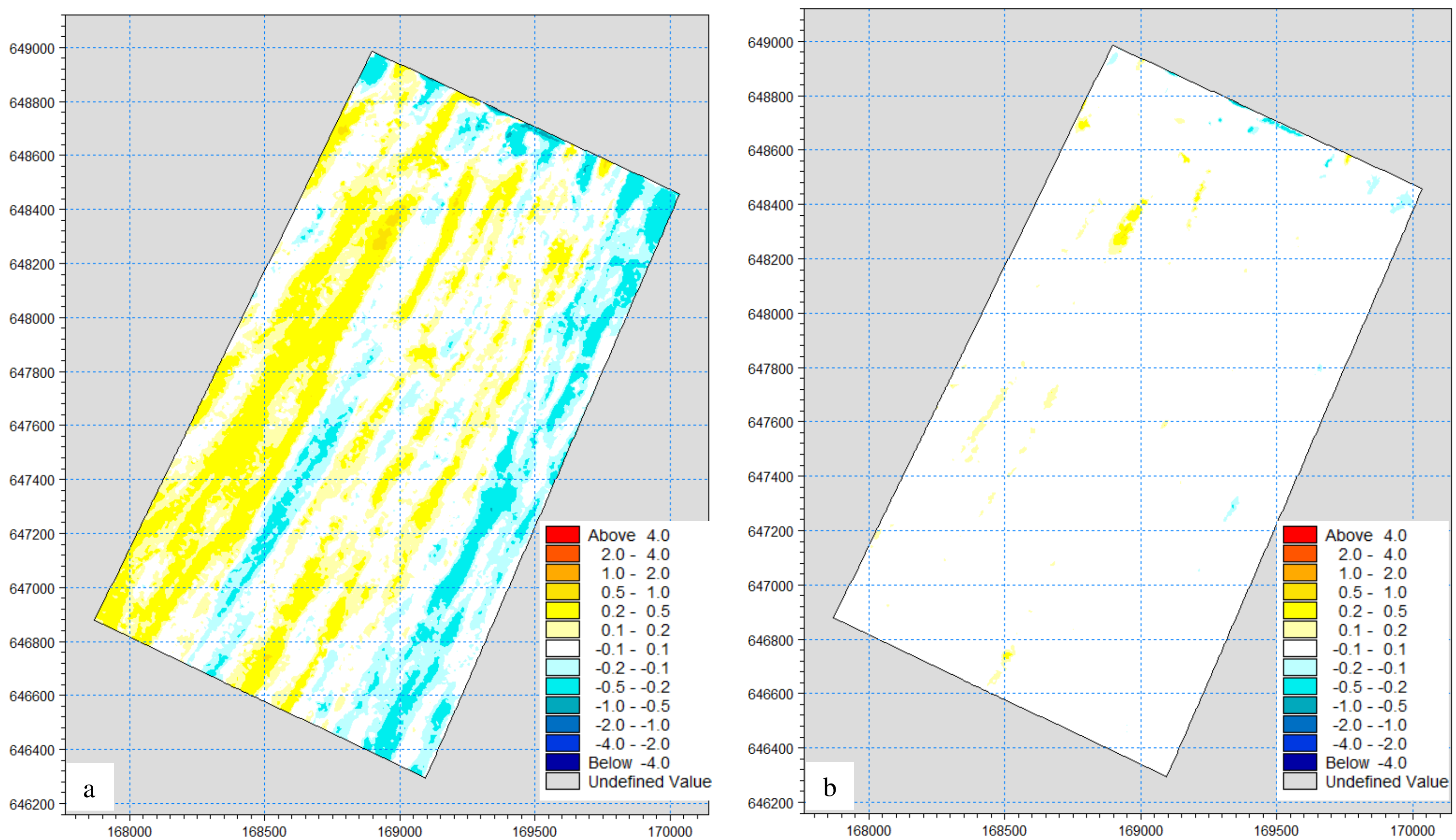


Fig.5.12. – Differential maps of lot #14 (shift = 0.08 m): (a) threshold |Δ|=0.0 m and (b) threshold |Δ|=0.3 m.

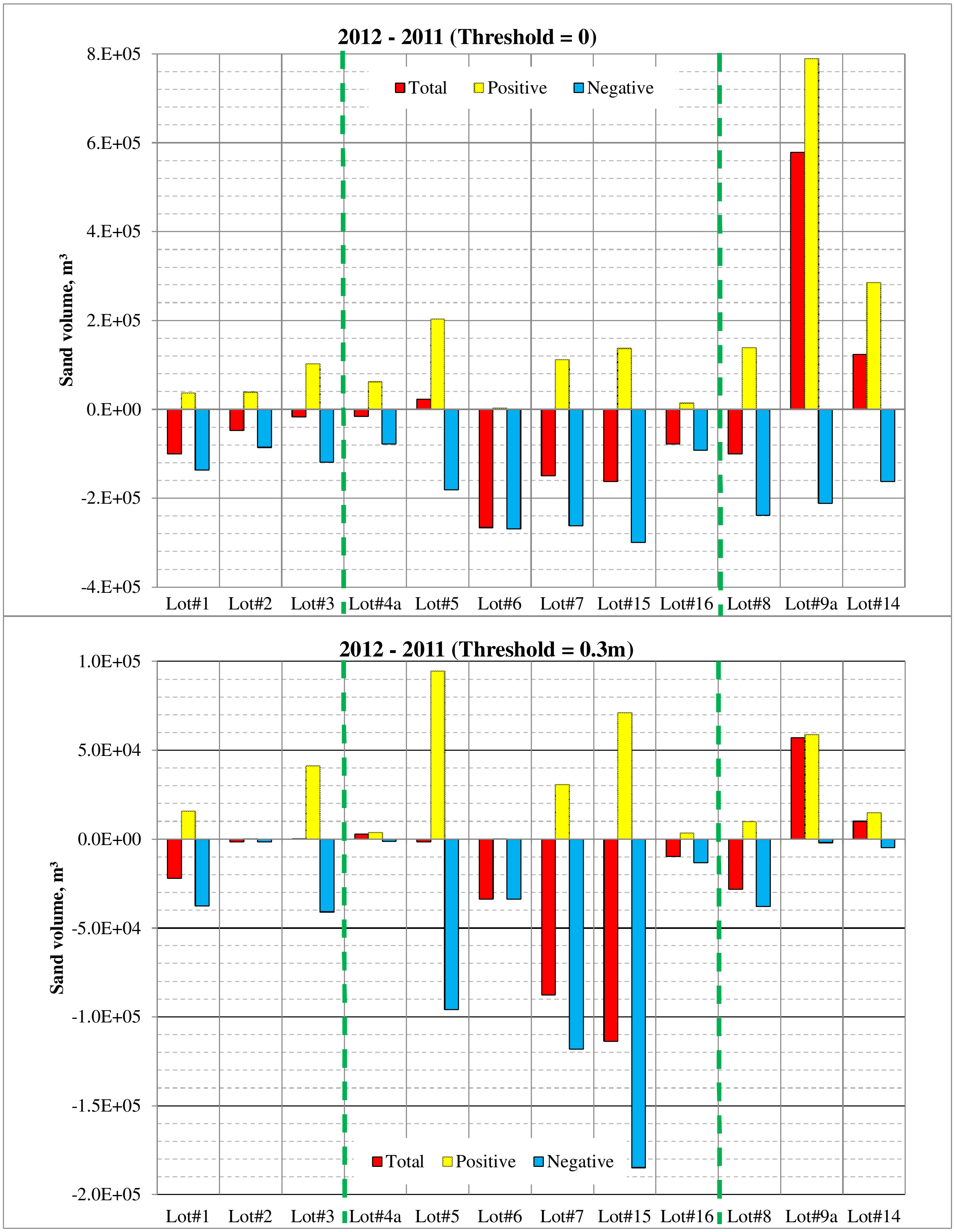


Fig.5.13. – Differences in sand volumes during 2011-2012 (with shift 0.08m).

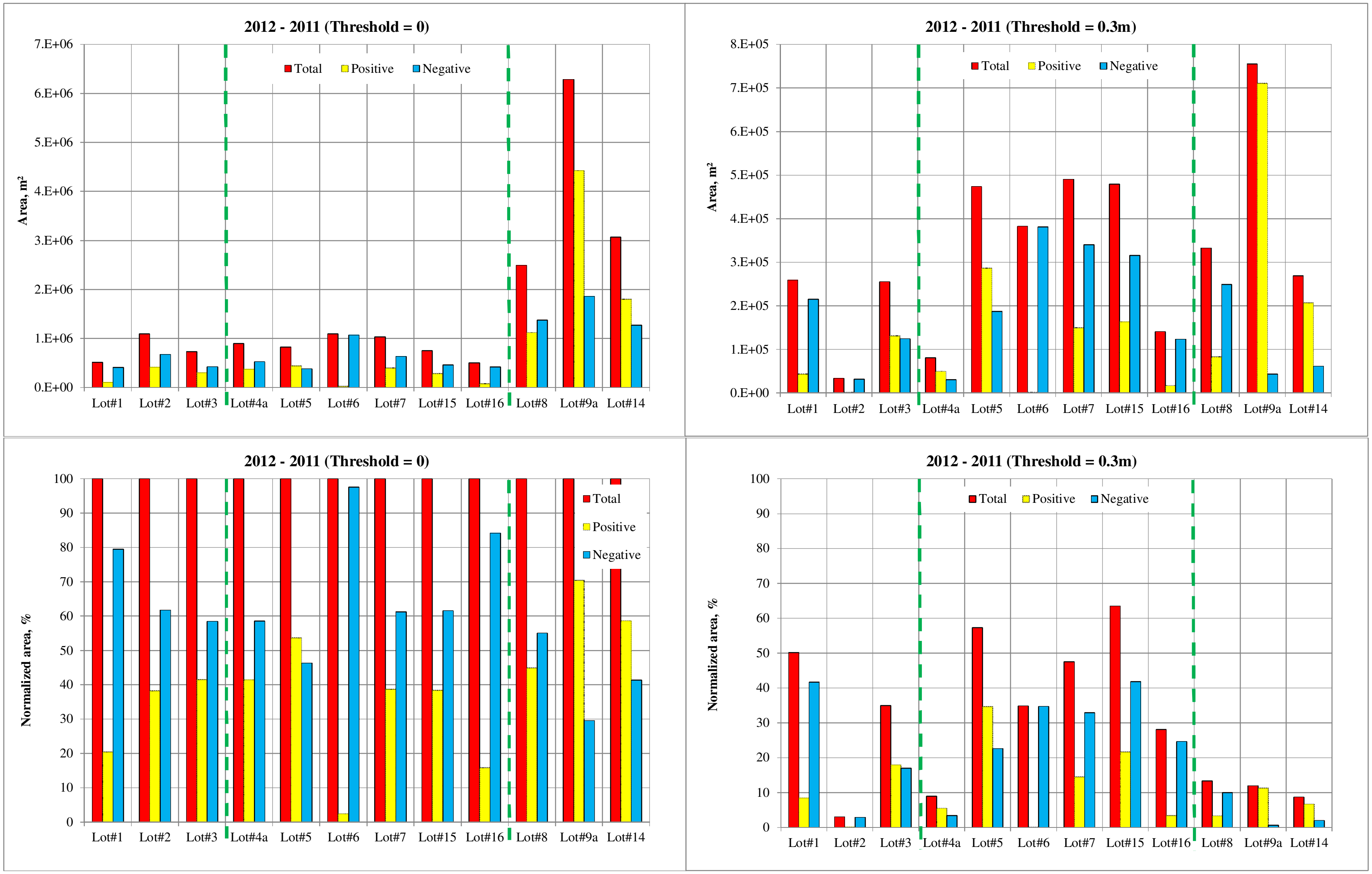


Fig.5.14. – Active areas of considered lots during 2011-2012: absolute values are shown on the left and normalized overlapping areas are plotted on the right (with shift 0.08m).

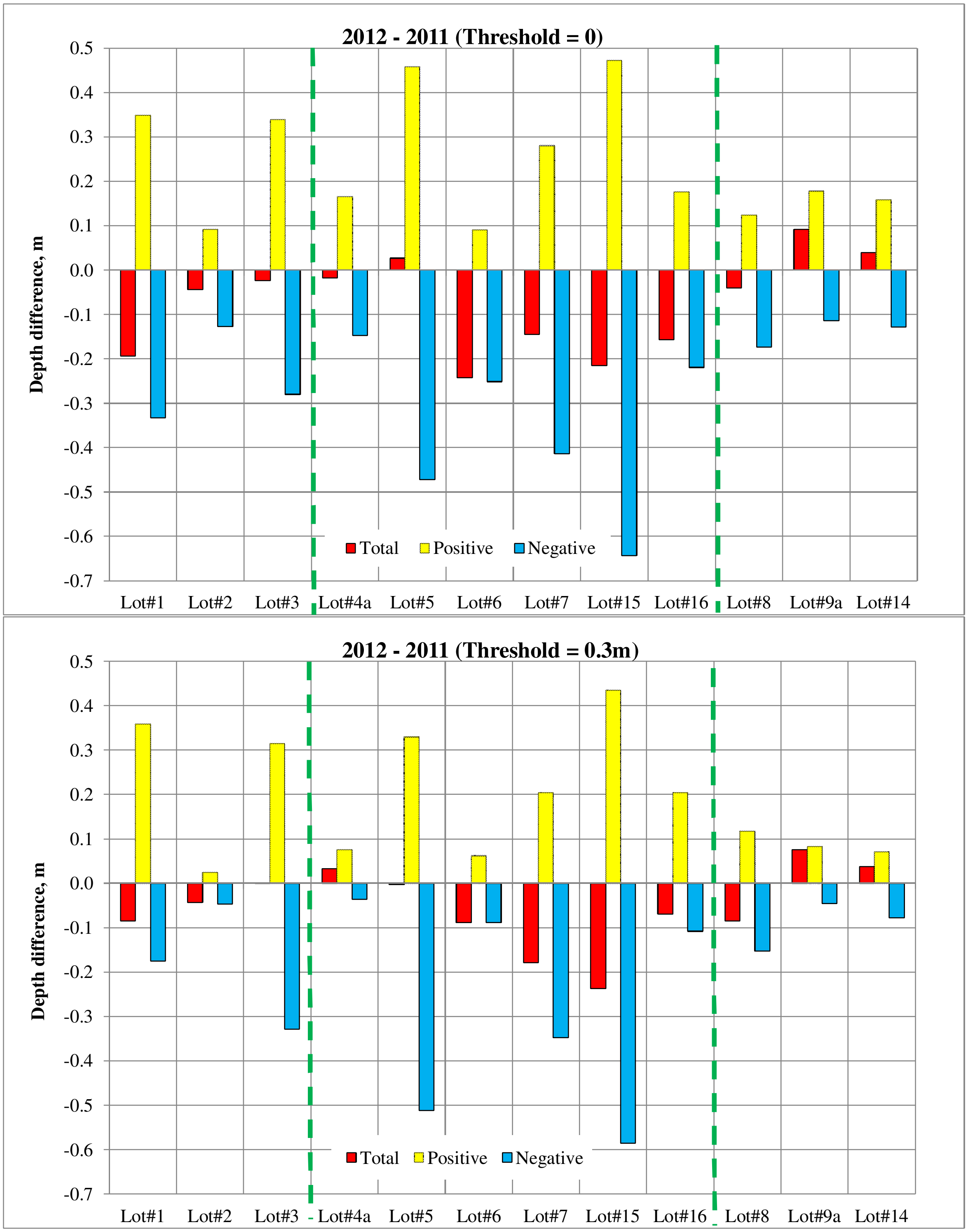


Fig.5.15. – Water depth variations averaged over the active area within the considered lots during 2011-2012 (with shift 0.08m).

Table 5.1 – Sand balance within the selected lots during 2011-2012.

Volume, m³												
Threshold, m	**Lot**											
	#1	**#2**	**#3**	**#4a**	**#5**	**#6**	**#7**	**#15**	**#16**	**#8**	**#9a**	**#14**
-0	-136647.5	-85770	-119529	-77951	-180754	-268746	-262159	-299097	-92464	-238616	-210944	-162248
+0	36852	38564	102761	61950	203333	2426	112238	136985	13951	138888	789392	285792
Total 0.00	**-99,796**	**-47,206**	**-16,768**	**-16,002**	**22,579**	**-266,318**	**-149,921**	**-162,112**	**-78,513**	**-99,736**	**578,448**	**123,544**
-0.30	-37,676	-1,494	-40,937	-1,111	-95,921	-33,852	-118,237	-184,907	-13,345	-37,952	-2,000	-4,808
+0.30	15,729	42	41,203	3,793	94,484	88	30,587	71,075	3,524	9,800	58,960	14,768
Total 0.30	**-21,948**	**-1,450**	**265**	**2,681**	**-1,437**	**-33,764**	**-87,651**	**-113,831**	**-9,821**	**-28,152**	**56,960**	**9,968**

Table 5.2 – Active areas within the selected lots during 2011-2012.

Area, m²												
Threshold, m	**Lot**											
	#1	**#2**	**#3**	**#4a**	**#5**	**#6**	**#7**	**#15**	**#16**	**#8**	**#9a**	**#14**
-0	410,551	676,945	426,922	527,981	383,091	1,070,109	632,879	464,680	422,042	1,372,945	1,859,716	1,270,372
+0	105,669	418,843	303,042	374,056	443,215	26,752	399,750	289,628	79,138	1,120,480	4,424,980	1,803,065
Total 0.00	**516,220**	**1,095,788**	**729,964**	**902,037**	**826,305**	**1,096,861**	**1,032,629**	**754,308**	**501,180**	**2,493,425**	**6,284,695**	**3,073,438**
-0.30	215,214	31,982	124,563	31,021	187,295	381,285	340,209	315,922	123,677	249,436	43,938	61,753
+0.30	43,825	1,735	131,051	49,976	286,610	1,421	150,203	163,586	17,211	83,622	710,805	206,999
Total 0.30	**259,039**	**33,717**	**255,614**	**80,997**	**473,905**	**382,707**	**490,412**	**479,509**	**140,888**	**333,058**	**754,742**	**268,752**
Lot Area	**516,220**	**1,095,788**	**729,964**	**902,037**	**826,305**	**1,096,861**	**1,032,629**	**754,308**	**501,180**	**2,493,425**	**6,284,695**	**3,073,438**

Table 5.3 – Normalized active areas within the selected lots during 2011-2012.

Normalized Area, %												
Threshold, m	**Lot**											
	#1	**#2**	**#3**	**#4a**	**#5**	**#6**	**#7**	**#15**	**#16**	**#8**	**#9a**	**#14**
-0	79.53	61.78	58.49	58.53	46.36	97.56	61.29	61.60	84.21	55.06	29.59	41.33
+0	20.47	38.22	41.51	41.47	53.64	2.44	38.71	38.40	15.79	44.94	70.41	58.67
Total 0.00	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
-0.30	41.69	2.92	17.06	3.44	22.67	34.76	32.95	41.88	24.68	10.00	0.70	2.01
+0.30	8.49	0.16	17.95	5.54	34.69	0.13	14.55	21.69	3.43	3.35	11.31	6.74
Total 0.30	**50.18**	**3.08**	**35.02**	**8.98**	**57.35**	**34.89**	**47.49**	**63.57**	**28.11**	**13.36**	**12.01**	**8.74**

Table 5.4 – Depth differences within the selected lots during 2011-2012.

Depth difference, m												
Threshold, m	**Lot**											
	#1	**#2**	**#3**	**#4a**	**#5**	**#6**	**#7**	**#15**	**#16**	**#8**	**#9a**	**#14**
-0	-0.333	-0.127	-0.280	-0.148	-0.472	-0.251	-0.414	-0.644	-0.219	-0.174	-0.113	-0.128
+0	0.349	0.092	0.339	0.166	0.459	0.091	0.281	0.473	0.176	0.124	0.178	0.159
Total 0.00	**-0.193**	**-0.043**	**-0.023**	**-0.018**	**0.027**	**-0.243**	**-0.145**	**-0.215**	**-0.157**	**-0.040**	**0.092**	**0.040**
-0.30	-0.175	-0.047	-0.329	-0.036	-0.512	-0.089	-0.348	-0.585	-0.108	-0.152	-0.046	-0.078
+0.30	0.359	0.024	0.314	0.076	0.330	0.062	0.204	0.434	0.205	0.117	0.083	0.071
Total 0.30	**-0.085**	**-0.043**	**0.001**	**0.033**	**-0.003**	**-0.088**	**-0.179**	**-0.237**	**-0.070**	**-0.085**	**0.075**	**0.037**

6. Coastline Evolution

In this interim report coastline changes are presented only for limited area, which stretches from the northern route of the Blue Marina to the southern route of the Ashdod Port.

The ACAD-drawing are used for analysis of coastline changes during the last one-year period (2011-2012).

Coastline alignment for both years (2011 and 2012) is plotted in Fig.6.1. Coastline retreat is recognized upstream the port, which in some places reaches the maximum of about 50 m. Coastline retreat diminishes southward and ceases approximately at a distance 0.6 km from the port southern route. Starting from this place only shoreline meandering is revealed, meaning shoreline deviation back and forth (beach retreat and accretion, respectively).

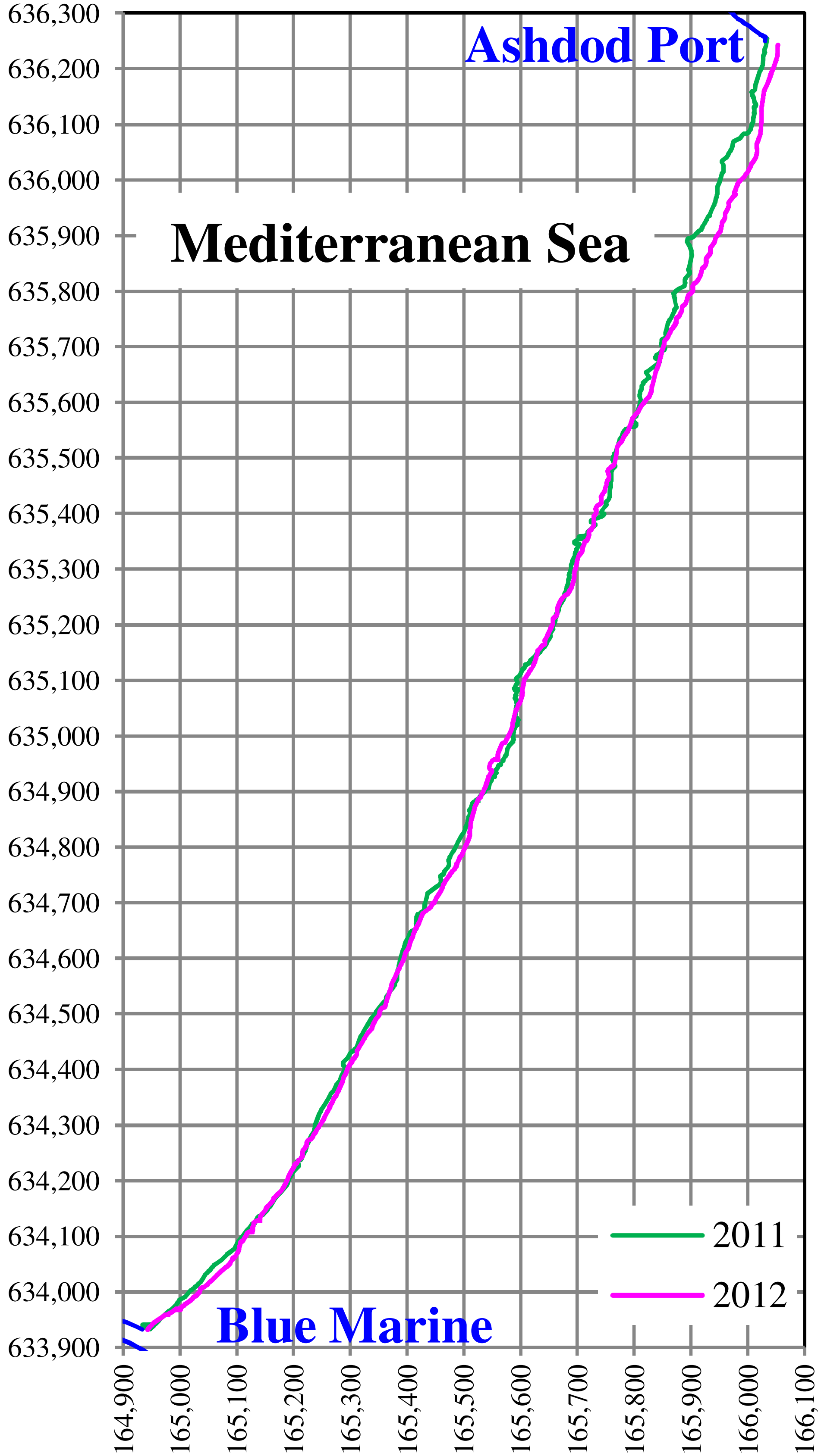


Fig.6.1. – Coastline evolution during 2011-2012.

7. Summary and Conclusions

The analysis of the ***bathymetric maps differences*** during the last year 2011-2012 reveals:

1. Seabed erosion is noticed in the area between the Blue Marine and the Ashdod Port, primarily within lot #1. Insignificant volumetric changes are obtained within lot #3 located in shallow water to the south of the port, active area is about 35% of total area of this lot. To the north-west of this lot, remarkable seabed erosion about 1 m is noticed close to the coast.
2. Northward the port seabed erosion is obtained inside lots #4a-#7, #15 and #16. The most noticeable changes are within littoral lots #5, #7 and #15, at that the erosion increases toward the north. Although significant changes in seabed level are recognized inside lot #5, the changes in volume are minor. The reason could be the dumping of 313,852 m^3 of sediment in this area.
3. Changes in seabed level -9 cm on the average are obtained over 13% of lot #8 ("sand storage site"), that corresponds to total erosion ~28,200 m^3 over active area ~333,000 m^2 (total area of the lot is ~2.5 mil.m^2).

The analysis of ***coastline evolution*** between the Blue Marine and the Ashdod Port during the last year 2011-2012 reveals coastline retreat upstream the port, which in some places reaches the maximum of about 50 m. Coastline retreat diminishes southward and ceases approximately at a distance 0.6 km from the port southern route. Starting from this place only shoreline meandering is revealed, meaning shoreline deviation back and forth (beach retreat and accretion, respectively).

The main conclusion is that seabed erosion is obtained in the littoral zone northward the Ashdod Port during 2011-2012. The total change of sediment volume in the lots #4a-#7 and #15 and #16 with threshold $|\Delta|=0.3$m is about -244,000 m^3 despite dumping of ~314,000 m^3 of sediment in this region (see Section 5, Table 5.1). The erosion is mainly at 1-3 m water depths.

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1. **International Hydrographic Bureau**, *2005*: "Manual on Hydrography", Publication M-13, Monaco.
2. **Sladkevich M., Levin A., and Kit E.,** *2008*: "Artificial Sand Nourishment Impact on Morphological Changes within the Ashdod Port Region", CAMERI report P.N.678/08, Technion City, Haifa.
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4. **Sladkevich M., Levin A., and Kit E.,** *2012*: "Preliminary Assessment of Bathymetric Changes within the Dredging and Dumping Sites Due to Nourishment Operation in the Ashdod Region in 2011", CAMERI interim report P.N.771/12, Technion City, Haifa.
5. **Sladkevich M., Tokarev D., Levin A., Kit E., and Drimer N.,** *2011*: "Morphological Changes within the Ashdod Port Region", CAMERI report P.N.732/11, Technion City, Haifa.