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CHAPTER 259

STUDY OF 50 YEARS COASTAL CHANGES AT HADERA, ISRAEL

by Dov S. Rosen[1], MASCE, MIAHR

Abstract

An investigation regarding the coastal changes over a period of about 50 years, as depicted from waterline and beach bluff fluctuations was conducted at Hadera-Sdot Yam beach, located at the central sector of the Southeastern Mediterranean coast of Israel. The study was conducted to assess the sedimentological impact of the breakwaters of a neighboring cooling basin, recently built. Processing and analysis methods used, as well as the main findings and conclusions are presented.

Introduction

A study of the coastal changes over a period of about 50 years (1937-1989), as depicted from waterline and beach bluff fluctuations measured from bathymetric charts and large scale air photographs was conducted by the author at Hadera-Sdot Yam beach, located at the central sector of the Southeastern Mediterranean coast of Israel (Fig.1). This coast represents a sedimentary unit within the Nile littoral cell extending from the Nile delta to the Haifa Bay. Hence it may serve as a long-term example of the morphodynamics of this littoral cell.

The purpose of the investigation was to assess the sedimentological impact of a cooling basin, built between

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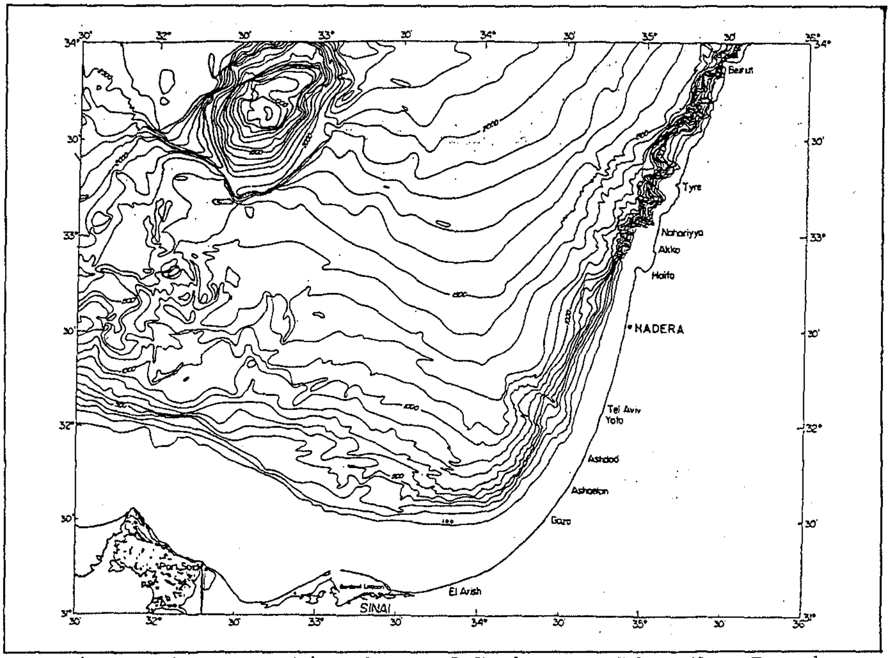

Figure 1. Location Map of Hadera - Sdot-Yam Beach

1977-1980 for a power plant located at Hadera shore, on its northward neighboring beach, downstream of the general net longshore transport .It was initiated due to claims of progressive erosion at the neighboring Sdot-Yam beach, made by local residents. The claims were supported by apparently significant erosion and beach bluff recession at several places along that beach. The erosion was attributed to be due to the recent construction of the cooling basin breakwaters, which were considered to have stopped the longshore sand transport, inducing progressive erosion to the supposedly "starved" neighboring beach some 1800 m to 2500 m away (Fig. 2). The breakwaters creating the cooling basin cover 700 m of coastline, protruding about 600 m into the sea (to -6 m).

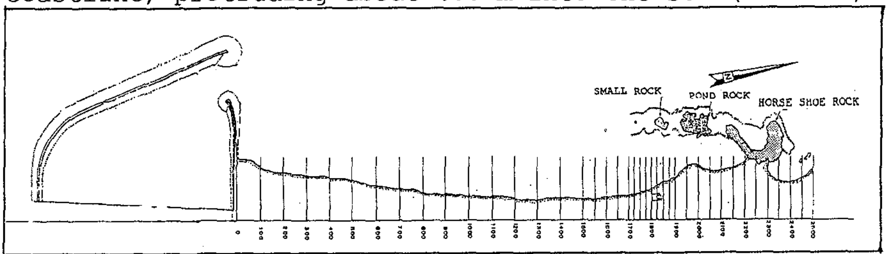

Figure 2. Hadera-Sdot-Yam Coast with Baseline & Sections

Data Processing and Results

The study was based mainly on the analysis of some 90 aerial photographs of 45 flights and 24 maps and correlation with the wave climate history. The correct determination of the bluff and waterline positions in the various charts and aerial photographs, relative to a fix baseline, parallel to the coastline, represented an important item of the study. In view of the suggestions of other investigators (Lueder-1977, Striem-1965), the prevailing (mean) waterline in the air-photographs at the time they were taken, was marked in the middle of the wet area of beach (dark area - see Fig. 3) and bounded by the visible water line.

The methods employed for the determination of the corrected waterline position (+0.0 m relative to Mean Sea Level - MSL) and of the bluff line position (+2 m above MSL), included:

(a) Analysis of relatively large scale enlargements of the pictures and maps (all at a scale of 1:2500) and marking of the water and bluff lines,

(b) Preparation of a mylar (polyester, i.e. non-shrinking) transparent base map of the area at a scale of 1:2500, on which all present beach features (structures, rocks, etc.) and the baseline and control sections were included (see Fig. 2)

(c) Measurement of the distances from the base line to the bluff and waterline at each section, by superposing the transparent map on the various maps and air-photographs, using the presence of land marks, or structures and beach rocks.

(d) Assessment of the tide and wave induced super-elevation from wave records and tide records or tide prediction and

(e) Correction of the waterline position line taken from the charts or aerial photograph, due to tide and waves' contributions. Wave set-up correction was based on the Shore Protection Manual (U.S. Army CERC-1984), while for tide correction use was made of the foreshore mean slope at each coastal sector.

The waterline distances measured on the base map were also corrected for varying camera angles and elevations in different air-photographs, by a relatively simple but efficient method. By this method, applicable elsewhere in similar cases, advantage was taken of the presence of beach rocks on the foreshore, near the waterline, with tops at about 0 m to 0.5 m elevation above MSL. By superposing the rocks on the base map with

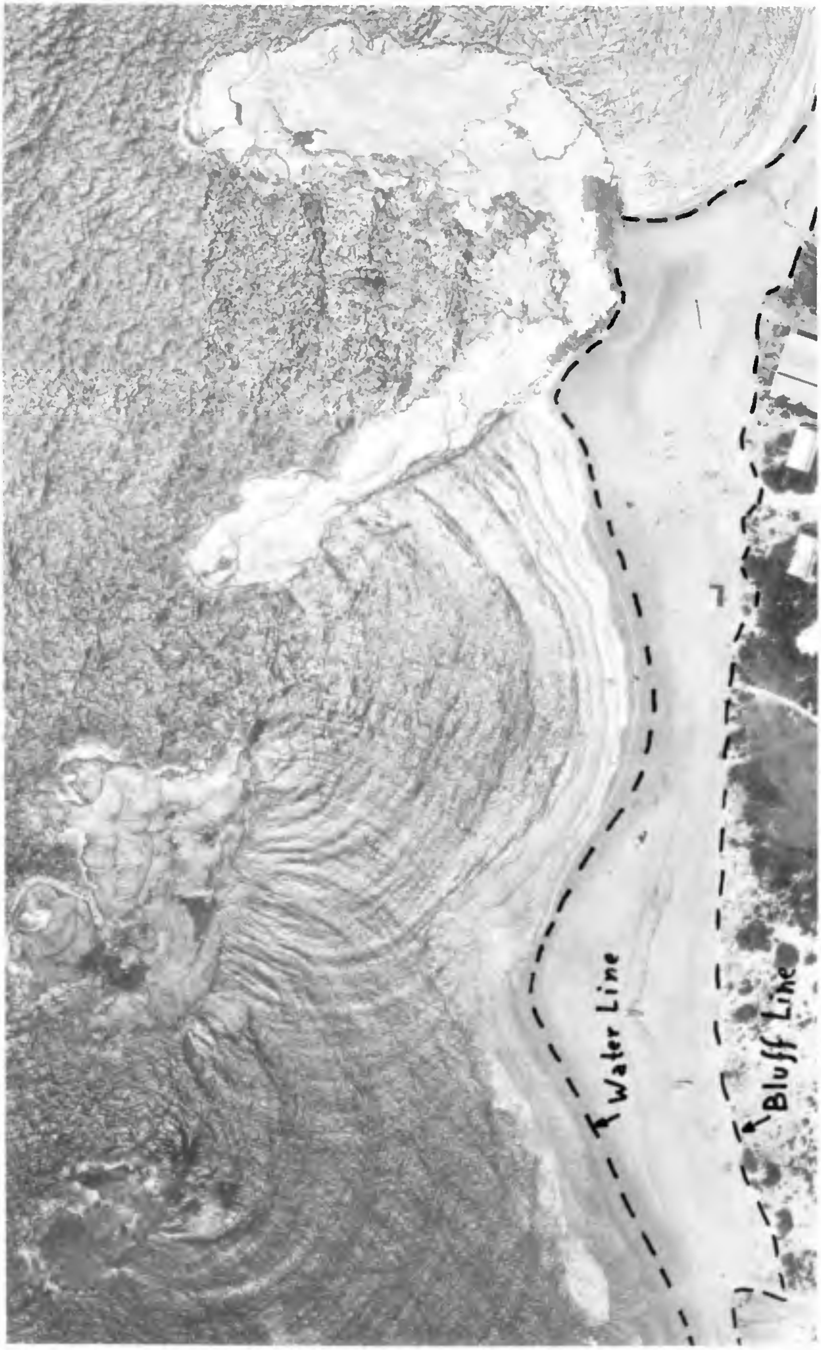

Figure 3 Example of marking of waterline and bluffline on an aerial photograph (Sdot-Yam 31.07.1970)

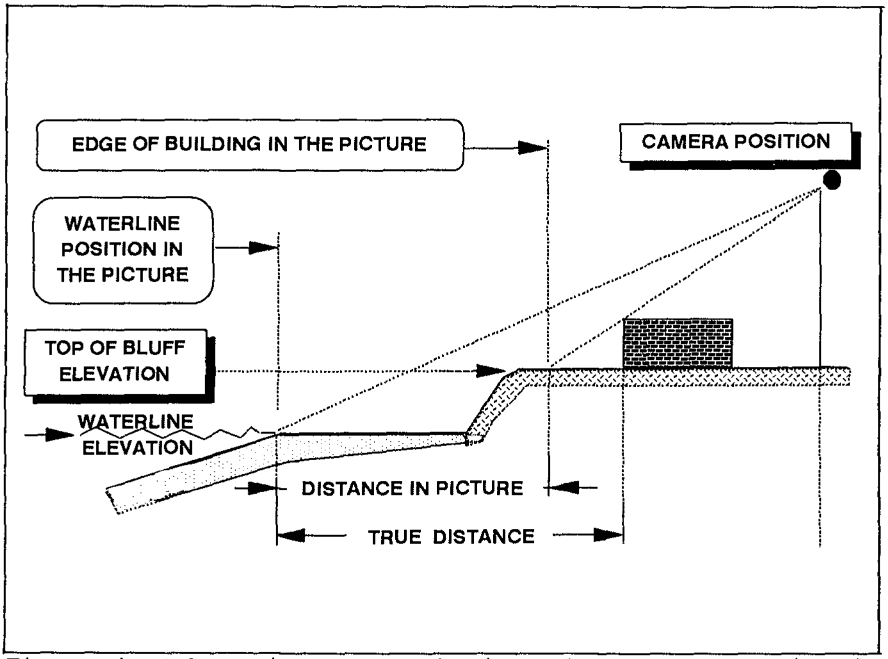

Figure 4 Schematic representation of error source in air photographs due to camera angle and elevation differences

those on the pictures, the distances between the base line and the waterline position at nearby sections could be accurately measured (with very little distortion), since the waterline and rock tops were at about the same elevation (Fig. 4). For correct interpretation of the fluctuating positions of the waterline and bluff with time and along the beach, an evaluation of the errors associated with the values computed for their positions due to various factors like paper shrinkage, drafting accuracy, scaling, positioning, etc., was also performed. The overall errors assessed were 5 m for the maps and 10 m for the air-photographs. Then, the waterline and beach bluff fluctuations prior, during and after the construction of the cooling basin breakwaters were analyzed at constant control sections along the base line (Fig. 2). The distance along the base line between control sections was 100 m, except at certain recently eroded sectors, where the distances were shortened to 25 m. Furthermore, the morphologic features of the coastal sector studied (bars, cusps, rip currents, spits, breakwaters, groins, sea walls and antique coastal structures) were also observed. Time histories of the corrected positions of the bluff and waterlines were plotted for each control section. Results at representative control sections are presented in Figs. 5 through 16. They were compared to the time histories of the yearly maxima of deep water significant wave heights and of the yearly rain volume (Figs. 17 and 18). The whole waterline and bluffline fluctuations for the whole coastal sector are represented in Figs. 19 and 20 respectively. A isolines map of the waterline fluctuation in time and space was prepared from the data of the waterline position during 50 years along the whole sector of coast studied (Fig.21). This map facilitates to depict the location and duration of erosion or accretion in time along the whole coast. A tri-dimensional view of this fluctuations map in time and space is also presented in Fig. 22.

Analysis of the Results and Conclusions

The results obtained show that this coastal sector was relatively stable until the beginning of the sixties, when a coastal erosion pattern was observed. The observed erosion seems to have occurred due to extensive quarrying of beach sand for construction purposes, forbidden by law since 1966. By the end of the sixties that erosion ceased, but reappeared for a short period at the beginning of the seventies, after an extreme storm in January 1968 and heavy rain 1969 year, which removed the beach sand, probably to the offshore bar. It disappeared from the mid-seventies, but reappeared in limited locations since 1982 due to local reasons. Beach bluff erosion, which encountered at a location remote 1800 m from the cooling basin was assessed to be due to local land reclamation from the sea without adequate scouring protection. At another sector (2100 m to 2300 m remote from the cooling basin), a 3 m recesses in bluff position was measured in 1988. The erosion occurred after the cooling basin construction, but was induced by the construction of two groins that stopped longshore sand transport within a local pocket beach. A rather surprising result was that although the ending (northern) sector of that coast suffered from a recent small bluff erosion, it accreted some 15 m within the 1956-1964 period. The outcome indicated that the longshore influence of the cooling basin (accretion) extends for about 1500 m of the neighboring beach and nulls at about 1600 m from the lee breakwater (2.5 times its protrusion into the sea) and that a dynamic sedimentologic equilibrium state was reached after about 8 years from the cooling basin construction. Though some recent

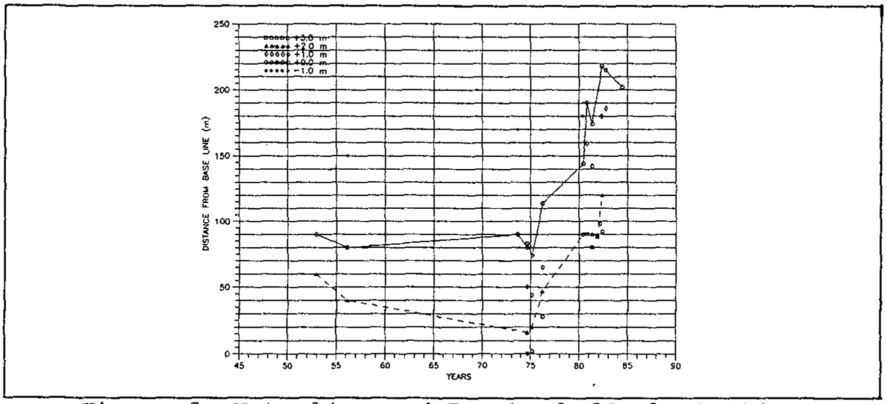

Figure 5. Waterline and Beach Bluff Fluctuations
Hadera - Sdot Yam Shore 1945-1990 - Control Section 0m

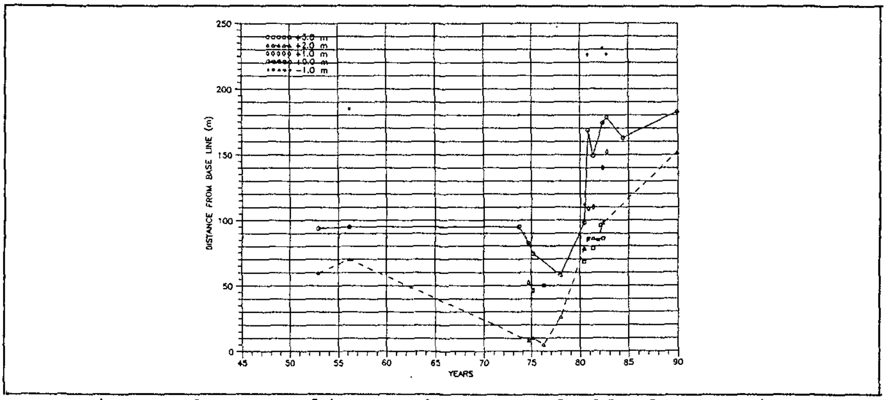

Figure 6. Waterline and Beach Bluff Fluctuations
Hadera - Sdot Yam Shore 1945-1990 - Control Section 100m

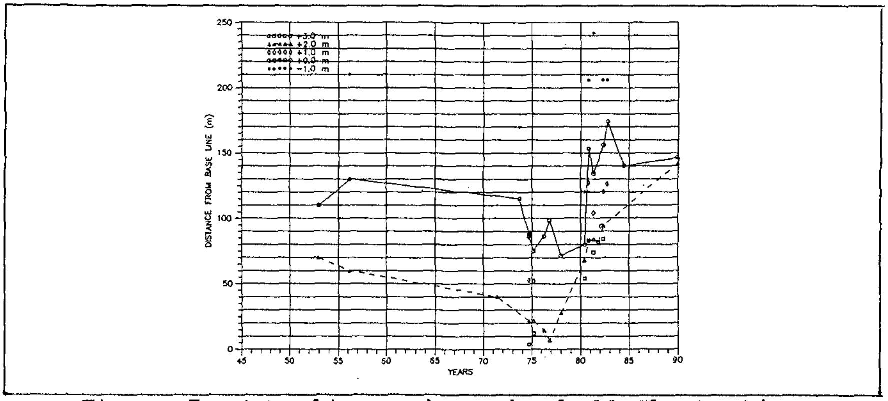

Figure 7. Waterline and Beach Bluff Fluctuations
Hadera - Sdot Yam Shore 1945-1990 - Control Section 200m

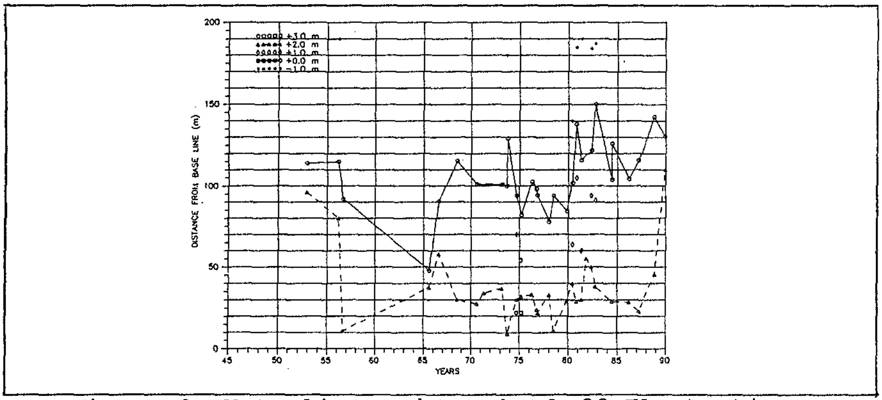

Figure 8. Waterline and Beach Bluff Fluctuations
Hadera - Sdot Yam Shore 1945-1990 - Control Section 500m

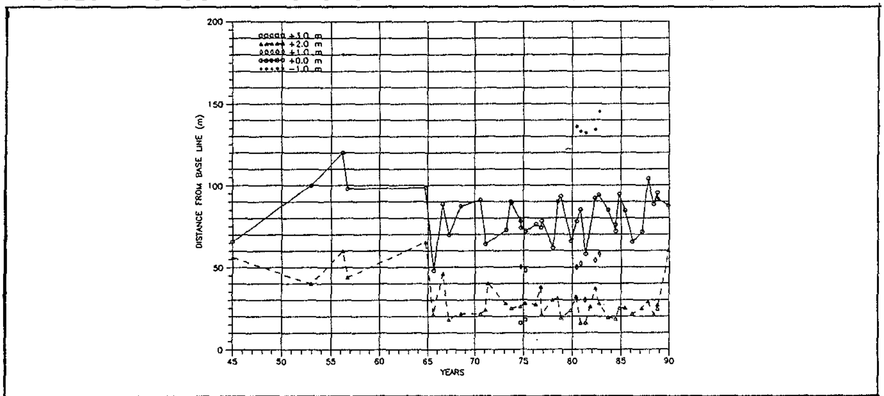

Figure 9. Waterline and Beach Bluff Fluctuations
Hadera - Sdot Yam Shore 1945-1990 - Control Section 1000m

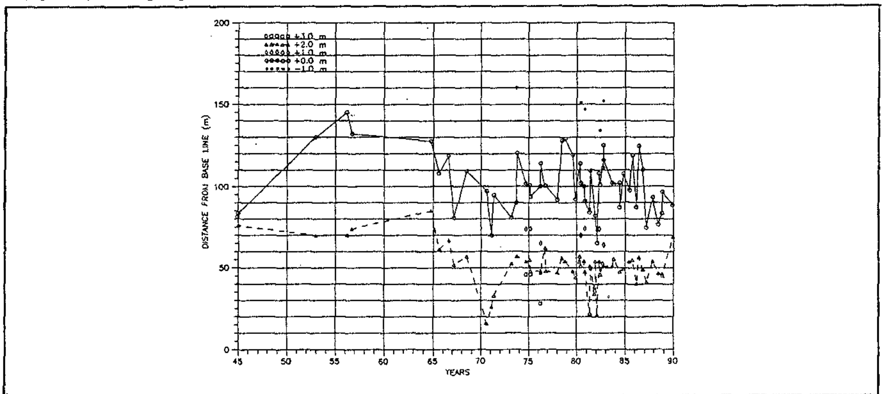

Figure 10. Waterline and Beach Bluff Fluctuations
Hadera - Sdot Yam Shore 1945-1990 - Control Section 1500m

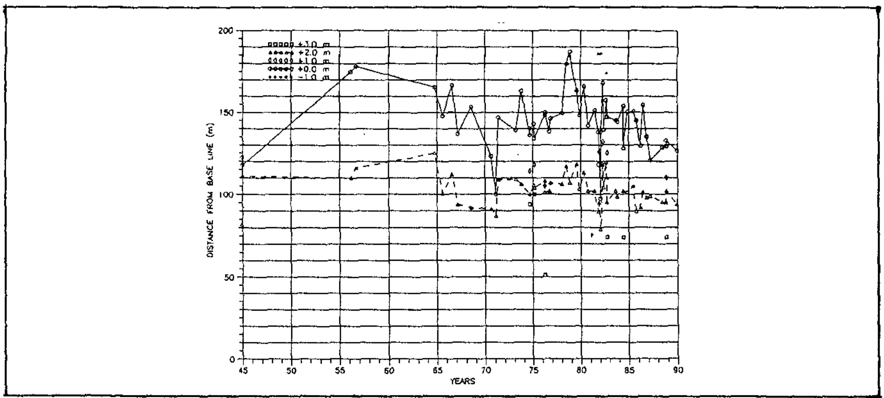

Figure 11. Waterline and Beach Bluff Fluctuations
Hadera - Sdot Yam Shore 1945-1990 - Control Section 1750m

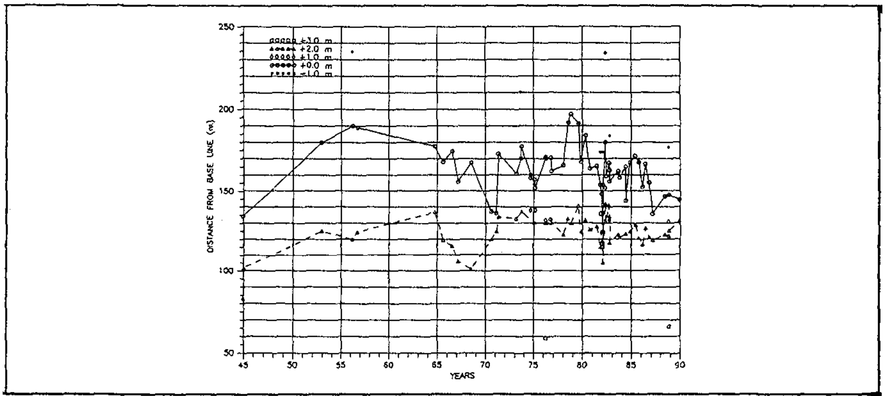

Figure 12. Waterline and Beach Bluff Fluctuations
Hadera - Sdot Yam Shore 1945-1990 - Control Section 1800m

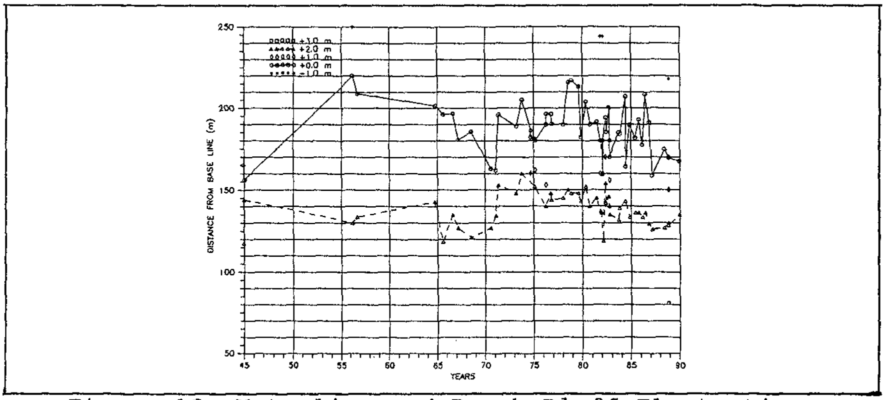

Figure 13. Waterline and Beach Bluff Fluctuations
Hadera - Sdot Yam Shore 1945-1990 - Control Section 1850m

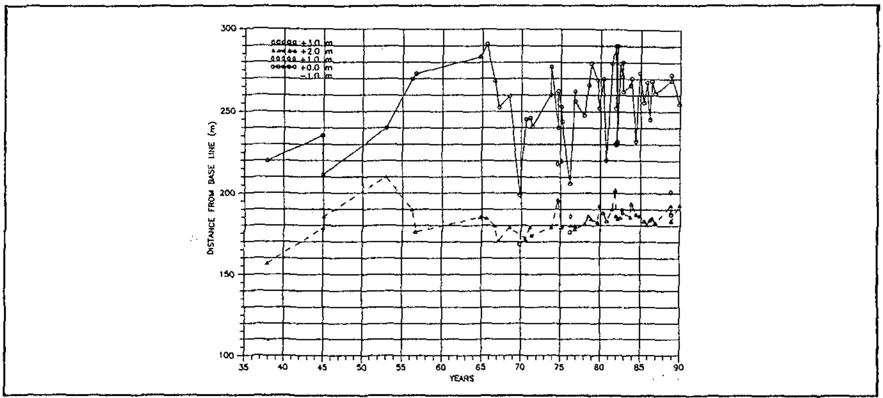

Figure 14. Waterline and Beach Bluff Fluctuations
Hadera - Sdot Yam Shore 1937-1990 - Control Section 2200m

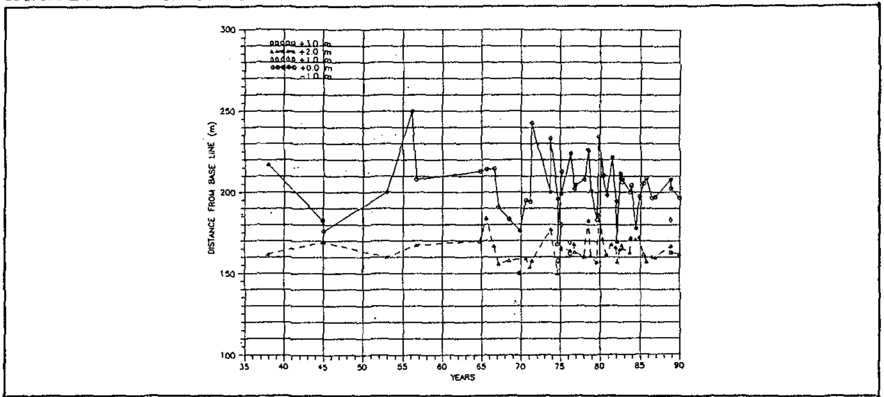

Figure 15. Waterline and Beach Bluff Fluctuations
Hadera - Sdot Yam Shore 1937-1990 - Control Section 2300m

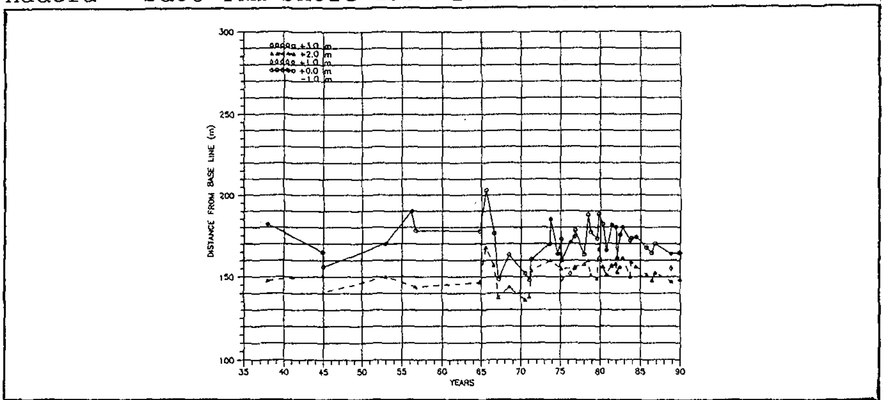

Figure 16. Waterline and Beach Bluff Fluctuations
Hadera - Sdot Yam Shore 1937-1990 - Control Section 2400m

erosion was found at a few points as mentioned above, the general waterline and bluff fluctuations remained all within the natural long-term range of fluctuation. No sedimentological impacts were found for the rest of the beach.

Acknowledgments

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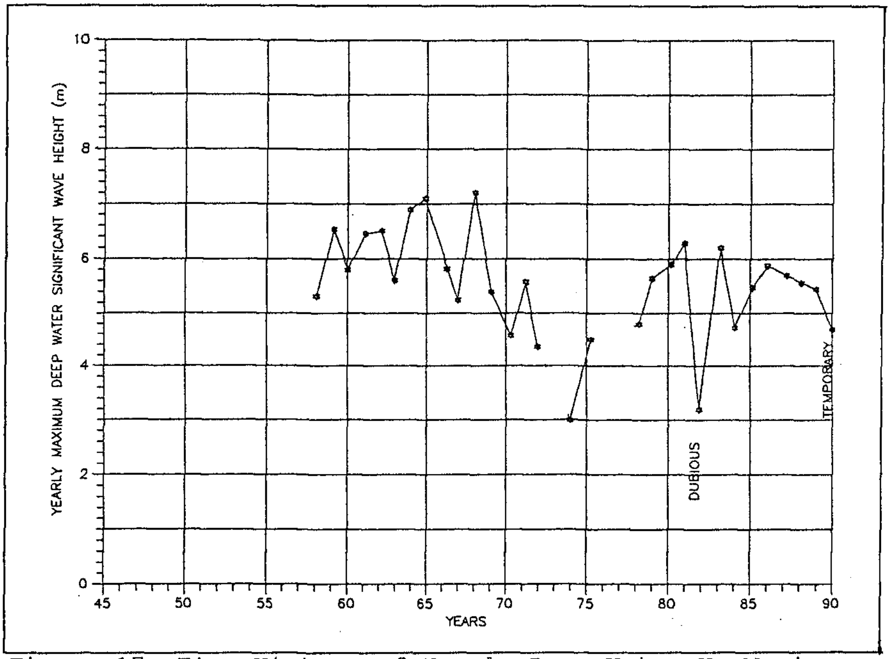

Figure 17 Time History of Yearly Deep Water Hs Maxima

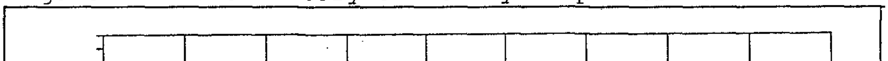

Figure 18 Time History of Yearly Rainfall Volume

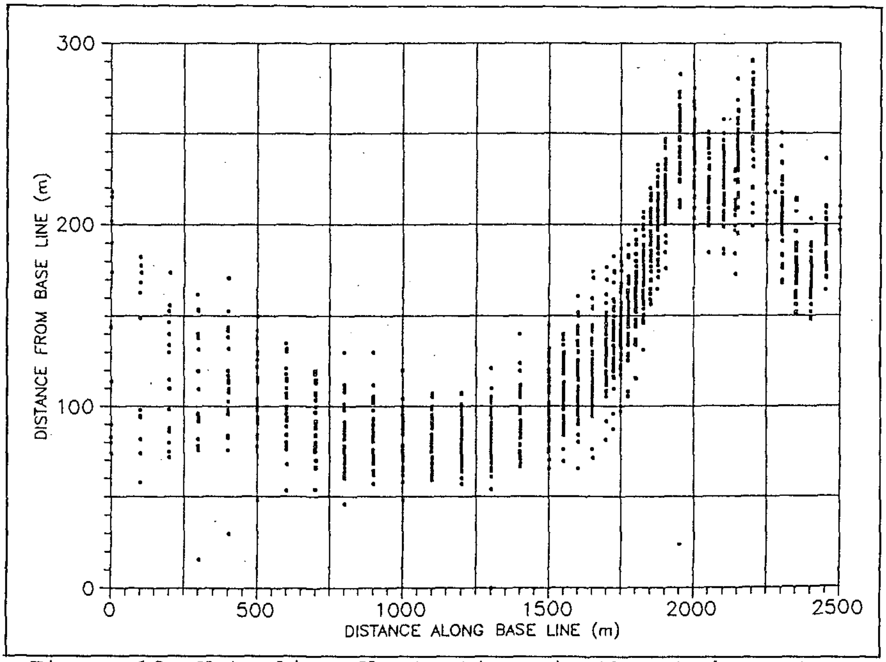

Figure 19 Waterline Fluctuations in the Study Sector

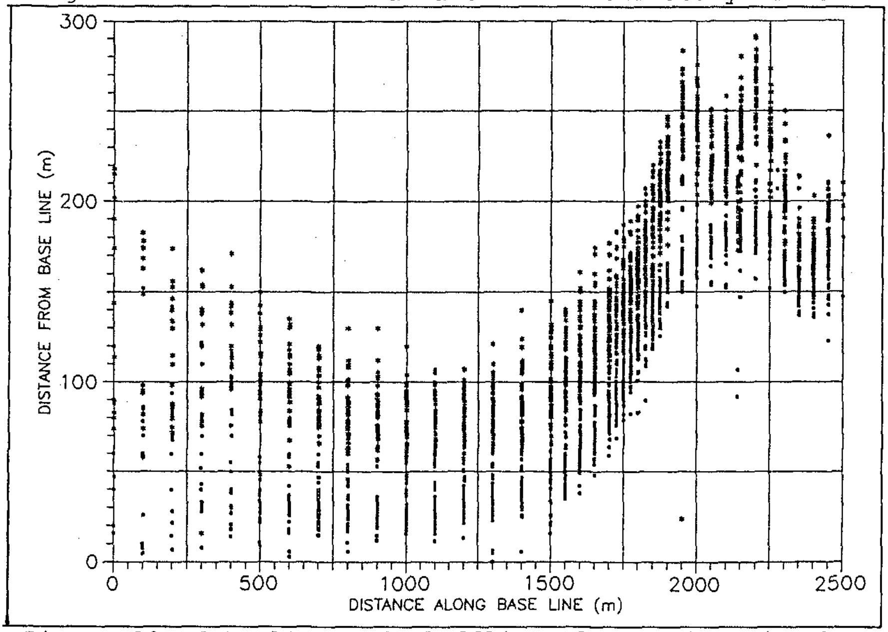

Figure 20 Waterline and Bluffline Fluctuations in the Study Sector (* -waterline ; O - bluffline)

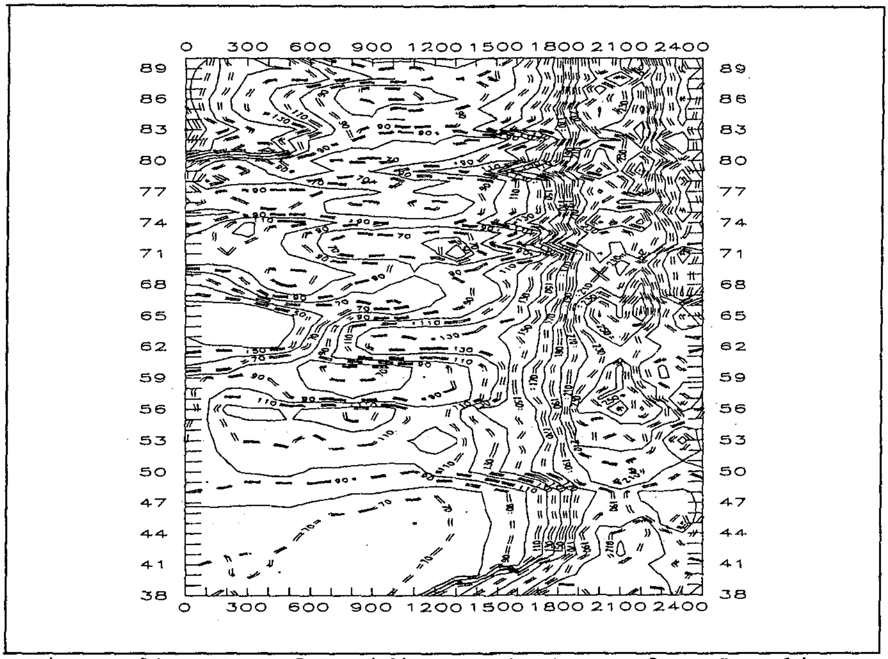

Figure 21. Map of Equidistant Contours from Baseline Hadera Sdot-Yam Coast Waterline (1937-1989)

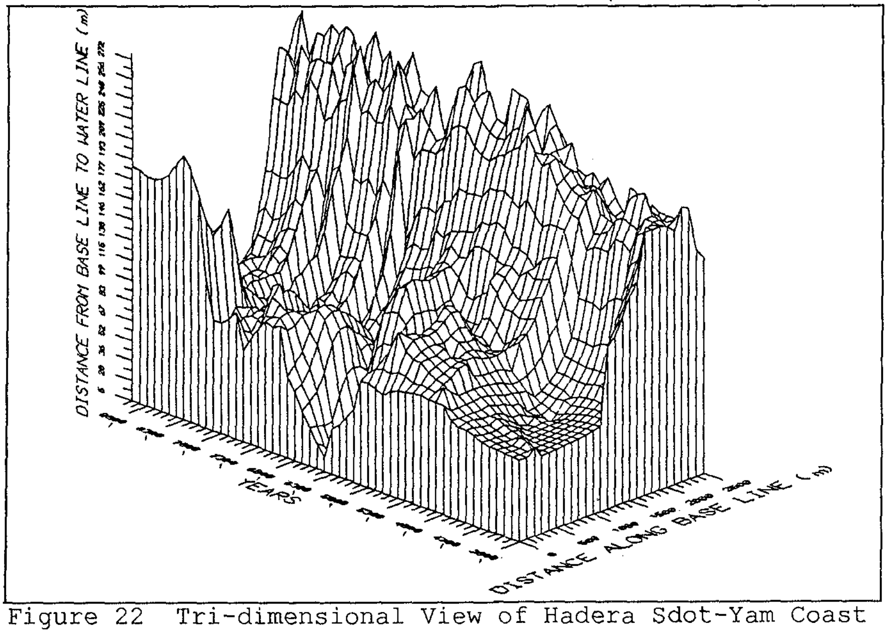

Figure 22 Tri-dimensional View of Hadera Sdot-Yam Coast Waterline Fluctuation in the period 1937-1989