



**UNITED NATIONS ENVIRONMENT PROGRAMME
MEDITERRANEAN ACTION PLAN**



**PRIORITY
ACTIONS
PROGRAMME**



MAP CAMP PROJECT "ISRAEL"
FINAL INTEGRATED REPORT AND SELECTED DOCUMENTS

MAP Technical Reports Series No. 134

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The thematic structure of the MAP Technical Series is as follows:

- Curbing Pollution
- Safeguarding Natural and Cultural Resources
- Managing Coastal Areas
- Integrating the Environment and Development

This series contains selected reports resulting from the various activities performed within the framework of the components of the Mediterranean Action Plan: Pollution Monitoring and Research Programme (MED POL), Blue Plan (BP), Priority Actions Programme (PAP), Specially Protected Areas (SPA), Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), Environment Remote Sensing Centre (ERS), and Cleaner Production Centre (CP).

MAP CAMP PROJECT "ISRAEL"
FINAL INTEGRATED REPORT AND SELECTED DOCUMENTS

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Annex I. Coastal Zone Management in Israel

Annex II. The Mediterranean Coast in Israel: Social and Economic Evaluation

Annex III. Management of Israeli Coastal Sand Resources

List of MTS Technical Reports

Technical Note

This issue of MAP Technical Reports Series presents a selected set of documents prepared within the MAP CAMP "Israel" project. Each CAMP project includes a number of individual project activities, prepared by national experts and/or institutions with the assistance and guidance of respective MAP Centres. The outputs of these activities are usually presented by final documents or final activity reports, each report containing 80 – 200 pages, and sometimes even more, including a number of maps, figures and technical annexes.

The selection of the documents to be included in this issue was made by PAP/RAC, under the supervision of the MAP Co-ordinating Unit.

The issue contains the Final Integrated Report of the project and the Report of the Final Presentation Conference, both documents presenting the synthesis of all project results, and, as annexes, the final documents of the activities related to Coastal Zone Management in Israel, Social and Economic Evaluation of the Mediterranean Coast in Israel, and Management of Israeli Coastal Sand Resources.

In addition, the document contains a preface, introduction, and the list of all final outputs of the project.

All documents are presented in their original form.

PREFACE

The MAP Coastal Area Management Programme (further on referred to as CAMP or Programme) has been approved by the Sixth Ordinary Meeting of the Contracting Parties, held in Athens, in 1989. Its adoption was preceded by four coastal management pilot projects, implemented by PAP/RAC, in the 1987-1989 period.

During the 1989-2001 period, eight CAMP projects were implemented in: Albania (the Albanian Coast), Croatia (the Kastela Bay), Egypt (the Fuka-Matrouh Coastal Area), Greece (the Island of Rhodes), Israel (the Israeli Coast), Syria (the Syrian Coastal Area), Tunisia (the Sfax Coastal Zone), and Turkey (the Izmir Bay). Presently, the CAMP "Malta" project is in implementation (since early 2000), the project for Lebanon started in 2001, and the project for Algeria in preparation, likely to start in the year 2001, or early 2002. Finally, projects for Morocco and Slovenia are in preparation, to start in 2002, or later on.

Within the initial phase of CAMP, the MAP Co-ordinating Unit in Athens was responsible for the Programme as a whole and for the implementation of its individual projects. Since 1996, PAP/RAC has been the MAP Centre responsible for the co-ordination of the CAMP, under the supervision and guidance of the Co-ordinating Unit.

The conceptual framework of MAP CAMP is based on the principles of sustainable development and on Integrated Coastal Area Management (ICAM). The Programme performs practical coastal management projects in areas selected in accordance with the Programme objectives and defined criteria. The projects are implemented by MAP in co-operation with the responsible national and local authorities and institutions, by selected national teams or institutions, with the assistance of respective MAP Centres and MED POL.

The objectives of the Programme are:

- a) to develop strategies and procedures at local and national levels for sustainable development, environment protection, and rational utilization of coastal and marine resources, to be also used as inputs for the formulation of Mediterranean strategies of sustainable development,
- b) to identify, adapt, and test, in a realistic operational context, methodologies, tools and practices of sustainable coastal management in the region,
- c) to contribute to the upgrading of relevant national/local institutional and human capacities, and
- d) to secure a wider use, at national and regional levels, of experience achieved by the Programme and by its individual projects, and create conditions for follow-up activities.

The Programme is of a multilevel nature, being oriented at local/project area level by dealing with area-specific priority problems, and at national and regional levels by applying the project results and experience as pilot ones.

Individual CAMP projects are structured into project units defined as individual project activities, each activity dedicated to a specific issue or to an interrelated multi-sectoral group of issues. Integration and co-ordination, data management, sustainability analysis, and a public participation programme are considered as mandatory activities of each CAMP project.

INTRODUCTION

The CAMP "Israel" project has been approved by the Eighth Ordinary Meeting of the Contracting Parties to the Barcelona Convention, held in 1993, in Antalya. After a preparatory phase, the Agreement on the development and implementation of the project was signed in 1996, and the implementation of project activities started in 1997. The project was implemented during the 1997-1999 period, and the Final Presentation Conference held in May 2000, in Jerusalem.

The project area included the 188 km long coastal strip of Israel, populated by about 70% of Israel's 6 million residents. Due to a high population growth, expansion of built-up areas and intensive development of all kind of activities, this area is subject to ever-growing pressures and user conflicts.

Such intensive development resulted in increased pollution, high pressures on coastal and marine resources, loss of habitats and scenic beauties and worsening of the quality of life of the resident population. Heavy pollution and almost total degradation of rivers, the Kishon River in particular, might be added to this picture. In addition, a number of specific conservation and development-related issues were emerging, such as the problem of cliffs instability and retreat, the management of coastal sand resources, and the impact of climate change on coastal resources, calling for in-depth studies needed for a rational approach and management.

It should be noted that since 1970s the national authorities were applying land-use planning and marine pollution prevention as major tools to cope with emerging threats, but the classical sectoral approach proved as not capable to solve or mitigate the problems of coastal management. The result was a growing recognition of the need for a better definition of sustainability of future development and for strengthening and improving the integration of the decision-making system. Finally, the need was felt for implementation of an ICZM programme, to provide for re-evaluation of present development concepts and practices and for new ideas aiming at a better integration of environmental concerns into national development policies. This resulted, among other initiatives, with the proposal for the formulation and implementation of the MAP CAMP "Israel" project.

The conceptual framework of the "Israel" project was built up on the MAP/UNEP methodology and practices of Integrated Coastal Area Management (ICAM), and on proved national capacities for land-use planning, scientific research, and pollution monitoring and prevention.

The activities selected for the project responded to issues relevant to developed countries and to specific national priorities. Some of traditional activities of CAMP projects were not included since they were undertaken in the country for a long time. At the same time, the project focused at issues related to sustainable development of priority sectoral activities and at coastal zone levels. Finally, the project was expected to provide inputs for the decision-making process at national level.

New ideas and concepts, generating changes of policies and inducing impacts towards a sustainable and environmentally sound integrated coastal management were the major expected benefits of the project, in addition to expected contributions related to selected priority issues.

Accordingly, the main objectives of the project were to incorporate environmental considerations into decision-making processes, and to improve the professional basis for policy making on selected priority issues, in particular related to integrated coastal zone management. After preliminary studies and discussions held at national and MAP levels, the Project Agreement envisaged the implementation of the following individual project activities:

- First National Strategy for Sustainable Development, including issues of national strategy, and sectoral issues related to agriculture, industry, energy, tourism, transport, sustainable human settlement development, and open space and biodiversity,
- Management of Coastal Resources and Hazards: management of coastal sand resources, implications of climate change, and cliffs instability and retreat,
- Socio-economic Valuation of Coastal Resources,
- Remote Sensing Support to Decision Making and Sustainable Development (approved as an EC project), and
- Integrated Coastal Area Management.

During the implementation of the project, the activities related to biodiversity protection and to the pollution assessment and rehabilitation of the Kishon River were included in the project.

Finally, the preparation of a Final Integrated Report and organization of a Final Project Presentation Conference were envisaged.

The institutional arrangements at MAP level included the involvement of MAP Co-ordinating Unit as the overall project co-ordinator and supervisor, PAP/RAC as the operational co-ordinator and PAP/RAC, BP/RAC, SPA/RAC and ERS/RAC as Centres responsible for the implementation of individual activities within their mandate.

The arrangements at host-country level included the involvement of the Ministry of the Environment as the national agency responsible for the co-ordination and implementation of the project, the Institute for Oceanographic and Limnological Research (IOLR), and a number of other authorities and institutions. Ms. V. Brachya acted as the National Project Co-ordinator, with co-ordinators for each individual activity and six Sustainable Development Sectoral Target Groups, responsible for the implementation of sectoral actions within the activity on sustainable development (see Appendix B of the Final Integrated Report).

Among the major project results, the following ones of a policy nature might be mentioned:

- Management of sand resources

The study provided a better understanding of processes affecting sand distribution along the shore and the implications of man's intervention, i.e. by building coastal structures. It emphasized the need for national sand management at the governmental level and the need for a more thorough consideration of sand nourishment and sand bypassing as protective measures.

- Cliff instability

The study showed that cliff instability has to be recognized as an integral part of the natural shore dynamics. However, it is still not clear what should be the planning policy of urban cliff shores.

- Climate change

The study did not indicate any significant changes.

- Biodiversity

The issues of biodiversity were previously only discussed by scientists. The study within the CAMP project brought the issues onto the table of decision makers.

- Kishon River

The study within the CAMP project indicated the major significant pollutants from industrial discharge at the most severe hotspot of land-based pollution along the Israel coast.

- Remote sensing

Remote sensing for coastal management was investigated and tested as a possible new tool, and the respective data processing and modelling were analyzed.

- Socio-economic study

Socio-economic valuation was performed based on interpretation of pressures on coastal resources in economic terms and analysis of effectiveness of possible use of economic instruments for coastal management.

- Coastal zone management

The study indicated that Israel had well established systems and tools for integrated coastal zone management but that there was a need for better co-ordination between those dealing with marine pollution prevention and those dealing with coastal land-use regulation. It also indicated that though the systems and tools had been improved over the years, they were still insufficient and that further measures were necessary to protect the coastline, especially for the benefit of the public as a whole. It indicated that most work had been done at the national level and that further work was needed at the local level.

- Sustainable development

The study within CAMP put sustainable development on the table in Israel. It was previously an academic discussion, but CAMP turned it into a discussion of the practical application of changes in consumer and producer behaviour and concepts of ecoefficiency in economic sectors. It was the stimulus to co-operation between a wide range of stakeholders to find mutually acceptable lines of future policy. The final papers have not yet been issued in Hebrew and will be made available shortly on CD and on the Ministry of Environment's internet site.

The activity on coastal zone management, using as inputs, among others, the results of all other activities of the project, presented an integrated assessment and analysis of coastal resources, pressures on the coastal environment, and current and proposed policies and tools for integrated coastal zone management in the country. Focusing on major coastal issues and institutions involved, and on tools available presently and in the future, elaborating sensitive issues as impacts of marine structures, public access to the coast, beach and cliff protection, and pollution prevention, the document presents new initiatives and policies towards a sustainable development of national coastal areas.

From an overall point of view, the set of documents related to national and sectoral aspects of sustainable development, and the results of the project as a whole, contributed to generation of new ideas and approaches, to advancement of ICAM practices in the country, and to a change in thinking, in line with the activities of the UNCSD and of the MCSD.

Finally, it should be emphasized that, despite the fact that the project was concluded only one year prior to printing of this issue of MAP TRS, follow-up activities are being implemented or in preparation, such as:

- Management of sand resources

Understanding of the processes enabled the Territorial Waters Committee to take a decision to require sand bypassing as a condition on the approval of an extension to Ashdod port. This decision set a precedent and is being implemented. One hundred and eighty thousand cubic metres of sand was bypassed around the port, from south to north during the last year and will be repeated annually for the lifetime of the port structures. It also brought all relevant authorities to recognize that undersea sand within 30 metres depth is a part of the coastal sand system and should not be dredged for any purpose other than beach nourishment. There is still a need for formulating a national sand management policy.

- Cliff instability

The CAMP study will be followed up by an additional study on formulating policy for the planning of urban cliffshores, to be prepared by the NGO SPNI and the Ministry of Environment. A recent decision by the National Board for Planning and Building required a proposal for building on a cliff shore to find an acceptable solution without measures at the base of the cliff which would reduce the width of the beach available for public use.

- Climate change

Although the CAMP study did not indicate any significant changes, other researches have concluded that while average temperatures and precipitation may not change significantly but their distribution may change and more frequent extreme events should be expected. This raises the need for further consideration of extreme storms on coastal erosion (loss of sand, cliff instability) and on flooding along lower river channels.

- Biodiversity

There is now a wider discussion among decision makers of the implications of issues of biodiversity.

- Kishon River

The study undertaken within CAMP was the forerunner of several processes currently in hand to stop the pollution from the industrial land-based sources, including:

- Ministry of Environment has issued discharge permits which include stringent controls of pollution and require the industries to take significant measures at source.
- Industries have agreed to implement pollution prevention and treatment measures during 2001.
- NGOs are opposing the construction of a marine outfall for the industrial effluent unless it is proven that the effluent is only composed of salts which cannot be safely disposed on land.
- A conflict assessment is now indicating the interests and positions of the various stakeholders and how to build consensus between them.

- Remote sensing

The tools developed during CAMP are being applied to detect land-use changes and will provide an important ongoing database.

- Socio-economic study

There is considerable doubt as to the usefulness of finding economic values to represent the public value of the coast. The CAMP study, as well as another study which sought to attach an economic value to recreational use of open spaces, including the seashore, found that economic values for public use do not compete with the property values of private residences.

- Coastal zone management

Following the CAMP study, the Ministry of Environment has been strengthening the connections between the coastal and marine department and the land-use planning staff. A major follow-up is the discussion of a coastal law, both a private member's bill currently in Parliament and a proposed law by the Ministry of Environment. The NGOs continue to be most active in promoting public awareness of the importance of coastal protection.

- Sustainable development

Participation of individuals in discussions and in the target groups is now being reflected in documents in various decision-making systems. Examples include the National land-use masterplan for building and conservation, the policy document of the Ministry of Transportation on land transport, and documents of the Ministry of Tourism on tourism policy. Discussion is now widening among professional groups and will bring sustainable development onto the public agenda in the future. Attempts will be made to bring concepts of sustainable development into policy formulation in local authorities, based on examples elsewhere of local Agenda 21. The CAMP documents provided the initial working basis for the newly established Israel Commission for Sustainable Development, which should become a public forum for wider discussions of the issues and the need for a government strategy.



**UNITED NATIONS ENVIRONMENT PROGRAMME
MEDITERRANEAN ACTION PLAN**



**PRIORITY
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COASTAL AREA MANAGEMENT PROGRAMME (CAMP) ISRAEL

Final Integrated Report

**Priority Actions Programme
Regional Activity Centre
Split, 2000**

Note:

This final report was prepared by Ms. Shoshama Gabbay within the framework of the UNEP/MAP Coastal Area Management Programme for Israel. Acknowledgements are due to many professionals and academic experts who have contributed to every part of this document. References to the documents which formed the basis for this report are listed in the appendix. Special thanks are due to Mr. Ivica Trumbic, MAP Co-ordinator for CAMP Israel and Ms Valerie Brachya, Israel Co-ordinator for CAMP Israel. Ms Branka Baric edited the document, and Mr Mario Brzic and Mr Slobodan Pavasovic provided technical support in putting the document in its present form.

The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the United Nations Environment Programme, the Mediterranean Action Plan or the Ministry of the Environment of Israel concerning the legal status of any State, Territory, city or area, or their authorities, or concerning the delimitation of its frontiers and boundaries. The views expressed in this document do not necessarily represent the views of the Mediterranean Action Plan or the Ministry of the Environment of Israel.

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1. Introduction

About 70% of Israel's 6 million residents live along its 188-kilometer coastal strip. Integrated planning and management of coastal and marine areas is therefore a crucial area of government activity.

Israel has been a very active member of the Mediterranean Action Plan (MAP) since its inception in Barcelona in 1975, and it has played an active role in all of its components. In 1993, Israel submitted a proposal for a Coastal Area Management Programme (CAMP). This report summarizes most of the activities which have been carried out within this program.

The activities selected for CAMP Israel responded to issues relevant to developed countries and to new directions in MAP Phase II. Some of the more traditional components of CAMP were not included since they have been undertaken in Israel for many years (e.g., specially protected areas, oil pollution prevention, environmental impact assessment). On the other hand, new components, especially those related to sustainable development, comprised a primary element in the program. The intent of CAMP Israel was to help translate the new concepts included in Agenda 21 and Med Agenda 21 into practical applications in a Mediterranean coastal area. Furthermore, the program focused on issues of acute concern in the local context, such as beach erosion and coastal sand supply, which, to date, have not received sufficient attention within MAP.

Since the coastal area is the main center of economic activity where urban settlements, industry, energy, and a large portion of tourism and transport activities are physically concentrated, changes in coastal area activities are likely to affect the country as a whole. Consequently, both the sustainable development strategy and other CAMP activities are relevant not only to the coastal area but to policy and decision making at the national level.

1.1. Objectives of CAMP Israel

CAMP Israel was conceived as a catalyst for new ideas and concepts which could generate changes in the directions of policy making in the country. While the program itself could not implement changes, its results are likely to bring about revisions of policies toward a more environmentally integrated approach.

The program had two main objectives:

- To encourage policy makers of economic development sectors to take responsibility for the environmental impacts of their decisions and to incorporate environmental considerations in their decision making processes (sustainable development, capacity building, economic instruments); and
- To improve the professional basis for policy making on issues not sufficiently covered in current coastal zone management (pollution control, beach erosion, cliff stability, climate change, biodiversity).

1.2. Phases of the Program

Following a year of preliminary preparation, CAMP Israel was officially launched in November 1996 with the first meeting of the Steering Committee at which the program was finalized. The Agreement between Israel and UNEP-MAP was signed by the Minister of the Environment for the Government of Israel and by the Coordinator of MAP for UNEP-MAP. The activities were undertaken in parallel during a three-year period and are to be presented at a final presentation Conference in Jerusalem in May 2000, with the participation of the Israel Minister of the Environment and the Coordinator of UNEP-MAP.

1.3. Summary of Activities

Few countries worldwide face the twin problems of high rates of population growth together with high rates of economic growth. Moreover, when the powerhouse of economic growth is in the coastal area, coastal management must contend with an acute concern: intense pressure for urban development.

This is well reflected in the first section of this report which aims to give an overall view of coastal area management in Israel. Whilst many successful efforts have been made over recent decades to prevent marine pollution and conserve on- and offshore natural and cultural resources, coastal area management has not dealt adequately with such issues as the impacts of marine construction and marinas, prevention of beach and cliff erosion and protection of public access to the shore. During CAMP, an appraisal was made of current coastal area management in Israel. It concluded that while new policies, such as a new document on planning for the coastal waters, have adopted a more environmentally-oriented approach to coastal management within the physical planning process, new coastal legislation is needed to assure coastal area protection in the face of development pressures.

The second section of the report focuses on a crucial local issue in Israel, beach erosion and sand supply. Israel is not the only Mediterranean country concerned with the natural movement of sand along the shoreline, the impacts of human interference on sand flow and the need to manage sand supply to beaches, but this issue has not received sufficient attention to date within the MAP framework. Sand is an essential national commodity for beach maintenance and for the prevention of coastal erosion. Although sand mining for building material was outlawed in the early 1960s, its impacts are still felt and are multiplied by the additional impacts of shore and marine structures, resulting in changes of sand distribution along the beaches. Management of coastal sand resources requires accurate data on sand sources, their characteristics, the processes affecting sand movement and means of nourishing eroded beaches by sand bypassing or sand from more distant sources.

Cliff recession is a natural, dynamic process affecting some 40 kilometers along the Israel Mediterranean coastline. Retreating cliff coastlines are not unique to Israel, and where they occur along natural open coastlines, there is no reason to interfere with the process. However, where slumping and cliff erosion occur along a highly developed urban coastline, the question of treat or retreat requires serious consideration within coastal area management. The third section of this document analyses the processes and risks of cliff retreat along the Sharon Escarpment and suggests guidelines for its management.

The fourth section of the report reviews available data and predictions concerning climate change. It concentrates on present climatic conditions prevalent in the Israeli coastal area and suggests that, on the basis of the model used by the University of East Anglia, no major climatic changes are foreseen. It should be noted that this is only a preliminary study and that other experts in Israel do not necessarily accept this conclusion. Moreover, climate changes at the global level are likely to affect the coastal area of Israel as a result of a predicted rise in global sea level.

The fifth section was added by the Israel Ministry of the Environment during the course of the program, when it was felt that insufficient attention has been paid to biodiversity. Although the report summarized in this document was prepared as part of the "Sustainable Development" activity, its relevance is much wider in scope and it is therefore presented as an independent section. It emphasizes the importance of considering processes affecting biodiversity within all relevant aspects of decision making.

The sixth section focuses on a specific "hotspot" along the coast, at Haifa Bay. While many measures have been successful in reducing and preventing marine pollution from different sources, the Kishon River has remained a major conduit of domestic and industrial effluents. The study undertaken during CAMP identified the major polluters of the Kishon River and focused on measures to reduce pollution from industrial effluents entering the river.

The seventh section discusses the role of information management for decision making. Geographical Information System (GIS) techniques are well established in Israel, but there is a lack of systematically collected coastal data relevant to coastal area management. Remote sensing techniques using satellite imagery were investigated and tested to see where satellite imagery could provide adequate data, where future developments in satellite imagery (particularly concerning the level of resolution) are likely to provide important data sources and how data processing and modelling could provide new tools for land use planning in coastal areas.

The eighth section presents a first attempt to understand pressures for coastal development in economic terms and to indicate whether economic instruments could be effective in the management of coastal resources. The study revealed the intensity of competition and pressure to transform coastal locations in the center of the country to residential property and raised some questions as to the ability of any economic assessment of the public value of the coastline to serve as a relevant tool for coastal management in Israel.

The final section of this document summarizes some elements in the preparation of a first strategy for sustainable development in Israel. While an initial document on sustainable development had been prepared within the Israel 2020 Masterplan, CAMP generated a major move towards a change in thinking, in line with the activities of the United Nations Commission on Sustainable Development (UNCSD) and the Mediterranean Commission on Sustainable Development (MCSD), and according to the new directions of thought incorporated in MAP Phase II. As part of the process, experts prepared reviews of current and anticipated environmental resources (air, water, space) and wastes (sewage, solid waste, hazardous wastes). Their papers provided background material for the facilitators of the six target groups (industry, energy, transport, tourism, urban sector, agriculture). The facilitators then prepared initial papers for discussion within their groups and summarized the discussions in the final papers presented in this document. During the course of the process, the Ministry of the Environment commissioned an additional study on the social aspects of sustainable development, which is now nearing completion. The final results will be published fully in Hebrew in the near future.

1.4. Linkages Between CAMP Activities

Although each of the activities undertaken within CAMP has a value of its own and each has contributed to furthering the specific subject under study, their synergistic contribution has significantly advanced coastal area management in Israel. It is not reasonable to discuss coastal area management in Israel without an understanding of how the economic dynamics of the country generate development pressures in the central coastal strip. Similarly, it is not reasonable to discuss coastal management without an understanding of how the natural dynamic process and anthropomorphic intervention cause beach accretion, sand loss and cliff retreat.

Policies for effective coastal management attempt to present a holistic approach, based on specific expertise in a wide variety of disciplines, backed up by effective information processing and by investigations of potential regulative and economic instruments for implementation.

The activities in CAMP Israel should therefore not be considered in isolation but within the overall context of coastal zone management activities in Israel. Over the past three years, these activities investigated areas of concern which were in need of more detailed consideration, and, together with existing knowledge and expertise, contributed to improving the basis for policy formulation both in the coastal area and at a national level.

2. Integrated Coastal Area Management

2.1. Introduction

Israel's 188-kilometer long coastal strip has been subject to ever-growing pressures and conflicts. Emerging issues include impact of marine structures, public access to the coast, beach and cliff protection, and pollution prevention. Several institutions are involved in tackling these issues and in developing tools and policies for coastal management. In recent years, recognition of the growing value of the coastal environment and of its natural and cultural resources has led to several new initiatives designed to bring about integrated coastal management.

2.1.1. Coastal Landscape and Natural Values

The coastal landscape is for the most part characterized by sandy shores, backed by sand dunes in the south, a low escarpment in the center and narrow beaches to the north with the exception of the wide Haifa Bay. A few sections have rocky shores with abrasion platforms, reefs and islets and are rich in natural species. The low topography is broken at two sections where mountain ranges reach the coast at Rosh Hanikra and Mt. Carmel.

The natural landscapes of the coast are enhanced by cultural landscapes including ancient cities and many on- and offshore archaeological sites and remains, from shipwrecks to submerged prehistoric settlements.

2.2. Current Coastal Issues

2.2.1. Development Pressures on Coastal Resources

The combination of urban and economic pressures for development, coupled with the attraction of the coastline for tourism and recreation, has exacerbated the conflicts along the Mediterranean coastline. Moreover, reduced profits in the agricultural sector have triggered further pressures for the conversion of agricultural lands along the coastline into built-up areas, especially in the central section of the coastline where population and industrial activity are concentrated.

Roughly 70% of the population, which reached 6 million in 1999, lives within 15 kilometers of the Mediterranean coastline. This narrow coastal strip is the focus of the country's economic and commercial activity, and the main transportation arteries run very close to the coastline for much of its length, particularly from Tel Aviv northwards. Haifa Bay offers protected water for an international port, and is the primary center of heavy industry including oil refining and a power plant. Tel Aviv, with an expanding metropolitan area, is the major commercial center and the focus of the country's transportation networks. Ashdod, further south, competes with Haifa Port for international shipping and handles container shipments, citrus exports, phosphates from the Dead Sea and other bulk cargo. The second oil refinery is located at Ashdod, and the city is the second major center of heavy industry along the coast.

The coastal strip also contains the most fertile agricultural land of Israel, especially for citrus production. There is severe conflict between the expansion of urban settlements along the coastline and the protection of open space.

2.2.2. Protection of Coastal Resources

In a country with high density urban development and scarce land resources, the coast and seashore serve a vital role as open spaces. However, growing urban and development pressures have led to encroachment on and loss of scenic landscapes, nature and agricultural land. Today, coastal agricultural lands serve to break up stretches of built areas and prevent the formation of a megalopolis throughout the coastal plain.

Out of the 188-kilometer shoreline, 50 kilometers are used for national infrastructures and defense uses and are closed to the public. The remaining coastline has been designated as follows: 59 kilometers as urban shores, 43 kilometers as nature reserves and national parks, and 36 kilometers for open space (free of all infrastructures and facilities).

Areas of particularly high natural value, such as river mouths and rocky shores, have been designated as coastal nature reserves while offshore rocky areas rich in marine flora and fauna and offshore rocks and sections of sandy shores important for sea turtles have been proposed for marine reserves. Along the Mediterranean, 14 marine reserves, 20 coastal reserves, two islet reserves, and two protected natural asset belts have been proposed or declared. Beaches of high value for recreation in natural surroundings and sites of archaeological interest for visitors have been designated as national parks. The coastal strip includes 14 parks and ten river mouths.

2.2.3. Marine Pollution

Major resources are invested in protecting the coastal and marine area from all forms of pollution: accidental and emergency oil and chemical spills from ships or terminals; polluting discharges from industrial or municipal land-based sources; dumping of waste at sea; airborne pollution into the marine environment; and litter in the sea or on beaches.

Land-based sources of marine pollution represent the most serious risk. A few coastal municipalities and a number of industries continue to sporadically discharge partly treated sewage into the sea. In recent years, as a result of increased supervision and enforcement of the Prevention of Marine Pollution (Land-Based Sources) Law and its regulations coupled with better information and guidelines to industrial plants and municipalities, substantial progress has been made in preventing pollution from land-based sources. Special efforts have been made to prohibit indirect marine pollution through coastal streams, especially in the Haifa Bay area which has been identified as one of Israel's pollution "hot spots" (see chapter on Identification of Main Sources of Pollution of the Kishon River).

Prevention and treatment of marine and coastal pollution, purchase of equipment, law enforcement, inspection, monitoring and research, and beach and shore cleanups are initiated and financed through the Marine Pollution Prevention Fund. Income is derived from fees collected from all oil terminals and ships calling at Israeli ports and from fines collected from individuals and bodies convicted of transgressing marine legislation. In addition, a Cleanliness Fund helps finance a wide array of environmental activities, including beach cleanups, from income derived from fees imposed on manufacturers and importers of disposable beverage containers and fines imposed on violators of environmental laws.

2.2.4. Impacts of Marine Structures

Fifty-five seaward-projecting and offshore structures, including harbors, marinas and anchorages, intake and cooling ponds for power plants, and groins and detached breakwaters were identified in a coastal study conducted about a decade ago. More recent structures include the coal terminal at the Ashkelon power plant and the marinas at Ashkelon, Ashdod and Herzliya. Studies confirm that these marine structures intercept the longshore sand transport, causing sand accumulation on the upstream side of the structure and beach erosion downstream (see chapter on Management of Coastal Sand Resources).

2.2.5. Loss of Areas for Tourism, Recreation and Public Access

Existing institutions and legal instruments have been successful in protecting the Mediterranean coastline outside urban areas but have not succeeded in preserving urban coastal stretches from persistent and powerful development pressures, particularly for exclusive residential development. Massive pressures by both developers and municipalities for coastal sites have led to repeated breaches of the coastal masterplan, particularly in relation to the prohibition of construction within 100 meters of the coastline.

In such urban centers as Tel Aviv, Haifa, Herzliya, Ashdod, Ashkelon, Netanya and Nahariya, private developers together with municipalities, economic development companies and the Israel Lands Administration have transformed coastal resources into real estate destined for high-income residential development. Many buildings were constructed in areas allocated for tourism under the guise of “apartment hotels” or “resort apartments”. Such development blocks sea views and sea breezes and interferes with public access to the shore. The value of such apartments is significantly higher than similar properties inland without a sea view (see chapter on Social and Economic Evaluation of the Mediterranean Coast).

The Society for the Protection of Nature in Israel (SPNI) and the Israel Union for Environmental Defense (IUED), two of the country’s foremost non-governmental environmental organizations, published a position paper on this subject in 1998. It maintains that areas with high landscape and environmental value, which are designated for tourism and recreation in the national tourism and other masterplans, should be preserved exclusively for such uses. They should be protected from over-development and clear guidelines are needed to prevent their transformation to residential uses.

In March 1999, the SPNI published a special booklet entitled “Principles for Sustainable Development of Urban Shores”. The document presents planning principles collected from policy documents on integrated coastal zone management in various countries and from international conventions on coastal protection and biodiversity.

Alternatives to Urban Coastal Development

The high demand for residential development in the densely populated coastal strip could be met in a number of ways: *building up* by means of high-rise buildings to allow for more building on less space; *building out* into open landscapes which would lead to urban encroachment; *building underground* which is not yet well accepted; and *dispersion* to the periphery, to the north and south of the country, which has not been very successful. Yet another possibility raised for discussion is sea reclamation since coastal conditions could be potentially suitable for artificial islands. Experts have argued that artificial islands off Israel’s shores would help alleviate land pressures in the central coastal strip.

The possibility of artificially islands is currently being investigated by a joint Israeli-Dutch team. Two main subjects were targeted for evaluation during the first phase of a feasibility research and development study which was initiated in mid-1997:

1. Effects of artificial islands on the coastline: environmental and morphological changes.
2. Appropriate fill material: availability, quantities, costs and environmental effects.

The studies so far show that artificial islands are technically feasible, possibly for infrastructures, but not as a solution for non-exclusive residential development.

2.3. Existing Policies and Tools for Integrated Coastal Management

2.3.1. Coastal Legislation

Most of the land along the coast is under public management by the Israel Lands Authority. The Lands Law of 1969 includes the seashore in the framework of “designated land” which is “public land designated for public use”. However, the Israel Lands Authority has not to date recognized its role in coastal land management. No coastal conservation law exists as yet, but a proposed new law is currently in discussion (see last section of this chapter).

Marine and coastal issues are included in a wide variety of legislation. A list of major laws which relate to coastal protection appears in the appendix.

2.3.2. National Masterplans

A short review of masterplans which affect coastal zone management is presented in the appendix. Of foremost importance are the National Masterplan for the Mediterranean Coast (NOS 13) and the National Masterplan for Tourism (NOS 12).

The Mediterranean Coast Masterplan, approved in 1983, determines land use along the coastal strip for beaches, recreation and sport; tourist facilities; protection of antiquities, nature reserves, national parks, forests and coastal reserves; ports and other infrastructures for which a coastal location is essential. The plan aims to prevent development for which a coastal location is not essential and to resolve conflicts of interest among land uses which require a coastal location. A most important clause prohibits development within 100 meters of the coastline and requires environmental assessments as prerequisites for considering coastal projects. The masterplan, however, allocates sites for fourteen marinas which are now considered to be unnecessary and damaging.

A further National Masterplan for the Resource Management of the Mediterranean Coastline for Tourism and Recreation (NOS 13C) was commissioned by the National Planning and Building Board in 1983. This coastal management plan, prepared by the Environment Ministry and approved in principle by the National Board, bases development policies on principles of suitability and sensitivity of coastal resources. Suitability for tourist and recreation development was assessed on the basis of geological, vegetation, landscape and archaeological surveys, and levels of development were then defined for each site along the Mediterranean coastline in relation to resource sensitivity. Multidisciplinary teams of land use planners, geologists and ecologists prepared surveys of coastal resources and guidelines for some of the main resource management issues.

The overall national policies proposed for resource management of the coast include:

- development other than for essential coastal uses should not be permitted along the coast and its immediate hinterland;
- policies for recreation and tourist development should ensure that opportunities for a variety of daytime activity and overnight accommodation experiences are made available to the entire population;
- recreation and tourist development of the hinterland should be confined to centers. In order to protect as much open space as possible, linear development along the coastline should not be permitted;
- highly intensive uses should be confined to existing urban centers;
- sites not previously developed, where resources were identified as having recreation potential, could be designated for low intensity levels of development;
- offshore construction for recreation and water sport activities should be restricted to urban centers;
- a public footpath should be designated along the coastline to ensure public access by foot to and along the coastline.

Significantly, many of these principles were also incorporated into the newly revised National Masterplan for Tourism (NOS 12). Prepared by the Tourism and Interior Ministries, in close cooperation with green organizations, the masterplan recognizes the importance of maintaining sufficient land reserves along the coastal strip for tourist accommodation and services in order to help realize the country's long-term tourism potential, but stringent regulations are needed to prevent their loss to residential development.

2.3.3. Coastal Waters Policy

In recent years, as a result of ever-growing development pressures and conflicts along the coastline and coastal waters, it has become increasingly clear that a comprehensive, multi-disciplinary and dynamic policy on the sustainable development of Israel's coastal waters must be prepared. In 1997, the Territorial Waters Committee initiated an integrated coastal zone management (ICZM) approach in a policy document which was completed in May 1999. The policy stresses the importance of management of the coast and coastal waters as a primary national and public asset according to principles of sustainability.

The specific objectives are outlined below in hierarchical order according to their importance:

- assuring maximum coastal accessibility to the general public and providing for multiple uses on the beachfront and sea, both in the surf zone and shallow continental shelf;
- giving careful consideration to sand and marine resources, conserving ecological, archaeological and heritage resources, and assuring the diversity of landscapes and species based on a comprehensive vision which is multidisciplinary, multi-spatial and multi-generational;
- placing high priority on leisure and recreation uses for which a coastal location is essential;
- carefully utilizing the unique economic potential of marine resources including fishery, mariculture and energy;

- providing for the development of public infrastructures when a coastal location is clearly justified, preferably in areas where development already exists;
- allowing for limited development of economic infrastructures, when a coastal or sea location is clearly justified, while protecting the public interest, implementing the aforementioned objectives and creating appropriate tools for monitoring and control.

The policy statement proposes a two-tiered approach: one focuses on broad subjects such as economic and environmental effects while the other addresses issues within a specific geographic zone such as the beach area. The subject approach considers recommendations within three main subject areas: landscape, environment and economics. The landscape area refers to the physical nature of the coast and the management of the sand reserves. The environmental area considers the flora, fauna, archaeology and water pollution of the coastal region. The economic area relates to such uses as tourism, recreation, infrastructure, transportation, fishing and defense. Within each area, development proposals will be evaluated according to four major criteria as follows:

- *Environmental Sensitivity*: Value and vulnerability based on the uniqueness, sensitivity and inventory of natural resources in the specific section of the coastline.
- *Geographic Continuity*: Continuity from an environmental aspect (ecosystems, landscape units and public use) in terms of the east-west axis and north-south axis and in relation to the marine and coastal strips.
- *Public Accessibility*: Proximity to different types of population concentrations (e.g., large cities, smaller or sparsely populated areas, or open or rural landscape) and ease of access.
- *Importance*: Social importance and priority based on heritage and archaeological sites and level of attractiveness to the public for purposes of leisure, tourism and recreation.

The geographic policy is outlined in a series of five maps, each defining a longitudinal strip of land parallel to the coastline. Spatial policy was drawn up for specific geographical cells along the seashore, surf zone and shallow continental shelf. General policy guidelines were set for the continental shelf and slope which are more distant from the coast and thereby from the impacts of coastal land uses and designations.

Four possible levels of intervention were defined and allocated for each cell: preservation of an open and natural coast, limited recreation use, development for tourism and recreation, and infrastructure development.

Several thematic policies are specified in the document. The thematic policy on marinas and offshore structures is particularly important since it accepts environmental claims not previously accepted by the Territorial Waters Committee.

2.3.4. Environmental Impact Assessment

One of the most important tools for evaluating individual projects in the land-use planning process is environmental impact assessment (EIA). EIAs have been used in Israel from the mid-1970s although EIA regulations were only promulgated under the Planning and Building Law in 1982. The regulations have been fully integrated into the planning system, ensuring that at all stages and at all levels of the planning process, major development plans (as defined in the regulations) undergo environmental assessment.

Since 1983, the coastal masterplan requires environmental impact statements on all coastal development projects unless exempted by a decision of the planning authority. While this has not always been implemented, EIAs have been prepared for marinas, port expansion, breakwaters, and tourist and hotel projects along the coastline.

2.3.5. Geographical Information Systems

The first Geographical Information System (GIS) project undertaken by the Ministry of the Environment was the Mediterranean coast database, which originally produced the maps included in the National Masterplan for the Mediterranean Coast. The coastal area is divided into 18 designated sections/maps, each of which includes the following layers of information: land-use; coastal resources including archaeological, vegetation, and natural landscape sites; and communication lines (i.e., roads, railroads). The Mediterranean coast database has been expanded to include information on pollution monitoring sites and beach access.

In recent years, the GIS has been used for the following coastal projects:

- oil spill sensitivity mapping of the Mediterranean coastline in order to promote sound decision making on priority treatment in cases of large-scale oil spills; and
- maps on the built up area of the country for the purpose of ranking the landscape sensitivity of open spaces.

2.4. Existing Institutions with Coastal Responsibility

A list of the institutions currently involved in coastal planning and management is included in the appendix. Following is a short review of the most prominent institutions with direct responsibility for marine and coastal management.

2.4.1. Territorial Waters Committee

The Planning and Building Law confers exclusive rights on the Territorial Waters Committee to prepare, approve, postpone, or approve with revisions or conditions, any plan connected with the coast and the territorial waters of Israel. To provide a framework for responding to development proposals, the committee has recently completed a policy statement which defines its goals and intentions for coastal conservation and development.

2.4.2. Marine Pollution Prevention Fund

The Marine Pollution Prevention Fund concentrates the financial resources for preventing and combating marine and coastal pollution. It is comprised of fees imposed on all ships calling at Israeli ports and oil terminals and from fines on violators of the marine pollution prevention laws – thus implementing the “polluter pays” principle. The fund is utilized for operations of the Marine and Coastal Environment Division of the Ministry of the Environment, including inspection system, law enforcement, purchase of equipment and beach and shore cleanups.

2.4.3. Nature and National Parks Protection Authority

The Nature and National Parks Protection Authority (NNPPA), under the responsibility of the Minister of the Environment, is the government agency in charge of nature and landscape conservation. The NNPPA manages all nature reserves and national parks in the country. It also carries out marine monitoring in the marine and coastal protected areas along the Mediterranean.

2.4.4. Israel Oceanographic & Limnological Research

Israel Oceanographic & Limnological Research (IOLR), a non-profit corporation affiliated with the Ministry of National Infrastructures, is the national institution dedicated to advancing knowledge about the aquatic world and developing methodologies and technologies for sustainable use of coastal, marine and freshwater sources. In fulfilling its mandate, much of the IOLR's scientific effort is directed to monitoring and assessing the status of marine areas and predicting their response to environmental perturbations. Research activities involve field observations, theoretical and modeling work and laboratory experiments. The broad range of questions considered include such diverse topics as ocean circulation and mixing; air-sea interaction; coastal erosion; biogeochemical cycles; immunology, physiology and ecology of marine organisms and the dynamics of their populations; and impact of human activities on coastal and marine ecosystems and resources.

2.4.5. Geological Survey of Israel

The Geological Survey, also under the Ministry of National Infrastructures, is responsible for the systematic investigation of the geology of Israel and for providing geological information to the government and the public. It has carried out major studies on such topics as erosion of coastal cliffs and sand balance.

2.4.6. Non Governmental Organizations

Public awareness of coastal management issues is critical in the coastal conservation campaign. Through such means as litigation, protests, coastal cleanups and dissemination of information, the issue has been accorded higher priority on the national agenda. Non-governmental organizations (NGOs) have played an important part in educating the public to take greater responsibility for coastal management.

The **Society for the Protection of Nature in Israel (SPNI)** is the country's largest environmental NGO. During its forty-year history, the organization has initiated dozens of campaigns against the destruction of unique ecological systems and scenic landscapes through unwise development. As a public representative on the National Planning and Building Board, it has also been a strong advocate of environmental interests. Its activities have been backed up by public protest and legal action, including petitions to the High Court of Justice. In recent years, campaigns have largely focused on protecting open spaces and coastlines.

The **Israel Union for Environmental Defense (IUED)**, established in 1990, has significantly promoted the use of legal means to tackle environmental problems. IUED is Israel's main environmental advocacy group using the courts, independent scientific analysis and a range of other strategies to address the country's mounting environmental challenges. Coastal conservation is of foremost importance in the organization's current agenda and it has instigated several important court cases on the subject.

Other NGOs which have played an important part in increasing public awareness and participation, are **GreenAction**, an environmental activist group for social-ecological change, which was set up in 1994 and **Green Course**, a student environmental organization which was launched in 1997. The latter now includes hundreds of activists in twelve university and college campuses around the country. **GreenPeace**, which inaugurated its Israeli office in 1995, has focused its initial campaigns on preventing pollution of the Mediterranean Sea.

The activities of these and other organizations have already borne fruit. Firstly, the issue has penetrated the media, and issues relating to coastal conservation are appearing in the

daily press at a scope and frequency previously unknown. Secondly, the organizations have succeeded in mobilizing support for the issue, both among decision-makers and the general public. Position papers have been prepared, information has been disseminated, and protests have been organized. Furthermore, protection of open space along the coastline emerged as a central issue in Israel's November 1998 municipal elections. Staunch public support for this issue helped change the composition of municipal councils, especially in Haifa and Tel Aviv.

2.5. Future Changes in Coastal Management

2.5.1. Sand Management Policy

In recognition of the adverse impacts of offshore structures and in order to protect the coasts against erosion and preserve and maintain sandy beaches for tourism and recreation, the Ministry of the Environment has advocated the adoption of a national coastal sand management policy, including the following recommendations:

- Sand should not be removed from the littoral zone, and its movement along the coast should not be impeded. If this occurs as a result of construction activity, sand of similar properties should be deposited on the beach as compensation for the lost sand or a mechanism should be found to allow the sand to bypass the artificial obstacle and continue on its natural course. Sand trapped artificially by coastal structures should not be used for land reclamation. Such sand should be used for artificial feeding of impoverished beaches or be returned to the natural sediment transport system;
- Sand should be recognized as a national resource, and therefore, sand dredged from a port or another marine installation should remain the property of the state which would then determine how best to manage this resource;
- Monitoring the bathymetric and sedimentological changes next to any coastal engineering project should be mandated both before and after implementation. Monitoring results should dictate the remedial steps to be undertaken to minimize the adverse effect of the project on the environment.
- The country should search for sand deposits on the seabed as a potential source for beach nourishment and possibly for building material.

An estimated sand budget for the shoreline, based on past and present sources, natural and anthropogenic losses and estimates of future trends, was recently undertaken (see chapter on Management of Coastal Sand Resources and section on sand resources in the chapter on Evaluation and Integration of Camp Results).

2.5.2. Coastal Conservation Law

In 1998, in an effort to protect coastal resources in the face of mounting pressures for development, both the Ministry of the Environment and the IUED formulated draft coastal laws aimed at preserving and restoring the coastal environment and its fragile ecosystems, reducing and preventing coastal damages and establishing principles for the management and sustainable development of the coastline.

The rationale behind the draft prepared by the Ministry of the Environment is aptly expressed in the memorandum which was distributed among government ministries. Following are a few short excerpts from the preamble:

The seashore is a unique natural resource with importance to the entire public. The coastal environment and its natural resources serve the public for leisure and recreation purposes and constitute a national "green lung".

The purpose of this draft law is to establish in legislation the principles and legal framework which will ensure sustainable development of the coast, so that the public may enjoy and bequeath to future generations a coast whose value is no less than its present value.

The law is expected to determine, in the clearest and most explicit manner, that Israel recognizes its seashore as a public asset whose protection and conservation are of high national importance. Accordingly, its instructions, which are declaratory in nature, are meant to guide the activities of the general public as well as the consideration, activities and decision making processes of the authorities in carrying out their powers, implementing the laws, and undertaking administrative measures on matters related to the coastal environment.

The bill determines that the coast and the coastal sand are public property and sets guidelines and principles for prohibited and permitted uses along the coastline. It also proposes that coastal areas will not be allocated for uses for which alternatives exist that are economically feasible and environmentally preferential.

The bill specifies a long line of activities which are deemed to damage the coastal environment and determines that the coast is public property designated for public enjoyment. As such, the coast should be accessible to pedestrians and open sea views should be preserved.

Additional principles which are included in the proposed coastal conservation law relate to the integration of these principles and guidelines in the considerations of planning and licensing authorities. Moreover, it is proposed that the Marine Pollution Prevention Fund, which operates within the framework of the Prevention of Sea Water Pollution by Oil Ordinance, will include an additional objective, namely protection of the coastal environment. This will provide for the financing of activities to protect the coastal sand including coastal restoration.

A companion bill on coastal conservation, prepared by the IUED and submitted by a member of the Israel Parliament is currently under deliberation. It sets operative procedures and directives on developing, managing and preserving the coastal environment on the basis of the following two principles:

1. The coastal environment has unique landscape, environmental and natural value which must be preserved and protected from harm.
2. The coastal environment is a public asset intended for public benefit at present and in the future.

The proposed law contains a wide definition of the concept of "coastal strip" and of permissible development on it. It translates the principles of the beach as a public asset into concrete protective action, such as guaranteeing the use of the beach for public needs only. It calls for further public participation in the planning process and delineates the tools for enforcement. Special attention is given to the role of information and education. The bill prohibits damage and pollution of the beach and reinforces the responsibilities of the Territorial Waters Committee with regard to protection of the land and water of the coastal strip.

3. Management of Coastal Sand Resources

3.1. Introduction

The impact of anthropomorphic activity on the coastal zone is a matter of serious concern. The damage is especially grave adjacent to coastal structures which have caused changes in the coastline position: accretion on one side of the structure and erosion on the other. Furthermore, recent archaeological findings indicate that the coastal sand balance suffers from a significant deficit. Remains of a Neolithic village and a merchant boat dating back 2,000 years were recently exposed. These would not have remained intact had they not been covered and protected for thousands of years by a thick layer of sand.

It has been estimated that during the 20th century, some 20 million m³ of sand were removed from the coastal zone by mining and entrapment of sand behind coastal structures. This quantity is estimated to be equivalent to the natural influx of sand to the Israeli coast during some 50 years.

The anthropogenic and natural impact on the coast is likely to increase in the future. Activities which are already under way or in advanced planning and approval stages include: expansion of Ashdod Port and Haifa Port, a feasibility study for the construction of artificial offshore islands, and field surveys for laying a gas pipeline and a communication cable on the Israeli continental shelf. It is also expected that construction of Gaza Port, and installations for desalination and other structures will impact on the coast, as may the predicted global sea level rise and climate change.

3.2. Primary Issues in Coastal Sand Management

Coastal sand management must address the following urgent problems:

1. *Deficit in sand balance:* Although early warnings concerning the development of a deficit in sand balance along the Israeli coastline date back to the 1960s, the national importance of the problem was only recently recognized. Future demands may include:
 - sand for the building industry;
 - sand for the maintenance of beaches;
 - some 12 million m³ of fill material for the expansion of Haifa and Ashdod ports;
 - some 40-50 million m³ of material per 2 km² island, if plans for the construction of artificial islands materialize; and
 - an unknown but significant quantity of sand for nourishment of beaches suffering from loss of sand due to erosion (e.g., Haifa, Herzliya).
2. *Deterioration of the coastal cliff:* The erosion of the coastal cliff is a natural phenomenon and there is evidence that this process has been going on at least since sea level reached its present stand some 2,000 years ago. However, there are clear indications that the erosion of the coastal cliff has been intensified in the last century due to human intervention, mostly building and irrigation on top of the cliff. Since the top of the cliff has a high real estate value, the conflict between economic pressure to build on top of the cliff, on the one hand, and the desire to protect the cliff and reduce its erosion, on the other hand, is obvious.

3. *Changes in the configuration of the coastline:* Almost every coastal structure built on the beach causes changes in the configuration of the waterline. These changes may be manifested by accretion on one side of the structure and erosion on its other side, or the creation of spits or tombolos behind detached breakwaters.

In order to provide national planning institutions with scientifically-based guidelines for formulating a coastal and sand management policy, several studies have been performed:

1. Evaluation of changes in the waterline position which occurred during the last 50 years, by comparing old aerial photographs to recent ones.
2. Estimation of the volume of sediment eroded, or accumulated, on the seabed in the vicinity of coastal structures.
3. Estimation of the longshore sediment transport rate along the coastline as derived from wave energy flux, sand characteristics and beach profile.
4. Estimation of the sand reserves on the continental shelf.

3.3. Geomorphological Setting

The Israeli coastline is generally smooth, with the exception of Mt. Carmel, which protrudes into the sea thus forming Haifa Bay. Much of the coastline consists of a coastal cliff which ranges from low bluff mostly in the south to a pronounced cliff which is almost continuous in the center. The cliff is built of alternating layers of kurkar (a local term for eolianite sandstone) and red-brown sandy loam called hamra.

Large areas of the coastal plain are covered by sand dunes, mostly in the south. South of Tel Aviv, these dunes penetrate landward to a distance of 5 to 10 km from the shore. North of Tel Aviv, dunes are restricted to river outlets to the sea, where breaches in the coastal cliff allow sand penetration landward.

Beaches along most sections of the coast are relatively narrow, ranging in width between 20 to 50 m. The exceptions are river outlets where beaches reach up to 200-300 m in width.

Beach rock is present in most of the beaches. It consists of consolidated sand, kurkar fragments and shells. The beach rock is located on the beach at the water level and forms abrasional platforms which provide some protection for the beach from waves. In some places, small tombolos are formed behind the beach rock. Partially submerged kurkar ridges also cause formation of tombolos, lagoons and small bays.

Two sedimentological provinces are recognized along the beaches. South of Akko, the beaches consist of fine to medium-sized quartz grains with small quantities of carbonates, originating from the Nile Delta. The grain size decreases from 0.3 mm on Ziqim beach to 0.2 mm north of Tel Aviv to 0.18 mm in the vicinity of Haifa. North of Akko, the sand is biogenic, of local source, with some reworked kurkar or limestone fragments.

The orientation of the Israeli continental shelf follows that of the coastline, gradually changing from south-west in the south to north-south in the north. The continental shelf is generally smooth. Two major morphological features found on it are the Akhziv Canyon a few km south of the Israeli-Lebanese border and the protrusion of Mt. Carmel. Other irregularities on the continental shelf are submerged kurkar hills which crop out of the surrounding sediment. Their relief is a few meters although some reach above sea level to form small islets.

3.4. Sedimentological Conditions

The evaluation of present sedimentological conditions along the coast was based on the integration of three methods of analysis: comparisons of aerial photographs depicting changes of waterline and beach bluff or lower cliff line during the past 4-5 decades, seabed volumetric changes determined from depth differential charts of redundant surveys and longshore sediment transport assessment using wave data.

3.4.1. Changes in Waterline Position

In order to find out whether the deficit in the coastal sand budget has caused erosion of the entire Mediterranean waterline, beach sections remote from coastal structures (Ziqim, Palmakhim and Atlit-Haifa) were investigated.

An analysis of waterline behavior during the last few decades by means of aerial photographs was carried out for three purposes:

- to examine whether during this period of intensive human intervention and overall, significant change in the position of the waterline has occurred;
- to gather evidence on the direction of sediment flow along the coast; and
- to examine the rehabilitation rate of beaches that suffered damages from beach mining.

3.4.2. Sand Accumulation/Erosion Adjacent to Coastal Structures

Examination of depth differential maps next to marine structures in the south, the Rutenberg cooling basin (of the Ashkelon power plant) and Ashdod Port showed consistent sand deposition on the southern side of the structures. In Haifa, deposition in front of the main breakwater of the port was also consistent.

Results obtained at Rutenberg and Ashdod Port also show the important role that storms play in depositing sand next to coastal structures. It is estimated that close to half of the sediment volume which was deposited south of Ashdod Port by 1995 was trapped there by three storms which occurred in December 1991, February 1992 and December 1992. Therefore, most of the effect of a coastal structure on sand entrapment occurs during severe storms.

3.4.3. Longshore Transport Assessment via Wave Data

Based on both previous studies and new assessments of longshore transport using wave data, the results of the long-term yearly average longshore sediment transport at seven sites covering the Mediterranean coast from the Gaza area to Haifa are presented in the following table. The assessment is based on the average value assessed at Gaza for 4/92-3/99 and the long-term average value of about 100,000 m³/year, derived from the at least 5.9 million of sediment deposited in Haifa Bay between 1931 and 1997 (Table 1).

The actual yearly sediment transports may significantly fluctuate from the above average values, depending on the occurrence of strong storms and the availability of sand on the sea-bottom.

Table 1: Assessment of long-term average net longshore transport (m³/year) on the Mediterranean coast of Israel (1931-1997)

Place	Gaza	Ashkelon	Ashdod	Bat Yam	Herzliya	Hadera	Haifa
Distance	0	20	40	63	83	115	150
Long-term yearly average	400,000	360,000	300,000	275,000	230,000	170,000	100,000

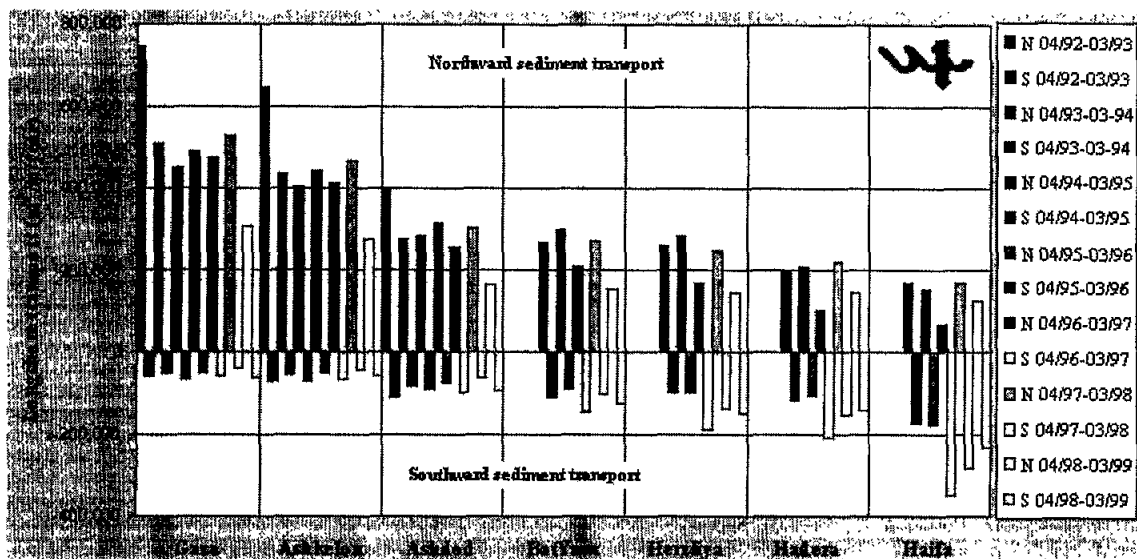


Figure 1: Longshore sediment transport assessment for the Mediterranean coast of Israel using Bijker formula. Sedimentological years 04/1992-03/1993 through 04/1998-03/1999

Consequently, the net longshore transport along the coast is seen as a stochastic process: mild accumulation to the south of coastal structures and mild erosion to the north of these structures during relatively calm periods followed by transfer of large volumes from the southern side deposits to the northern side coasts during very stormy years occurring once every ten or more years. These storms, however, are also associated with sediment reserve depletion offshore. During the intermediate “calm” years, the beaches recover from the stormy years by widening the dry beach-face from onshore sand transport, losing a significant part of these sands to the shore dunes by wind. In certain mild years, the occurrence of west-north-westerly storms may lead to reversal in sediment transport in the northern part of the coastal sector.

The net longshore transport may be larger or smaller depending on the direction and height of the waves. Moreover, there may be periods of reversal in the net transport confined to the shallow water in the region north of Shefaim.

Given the fact that the sea-bottom of the coast south of Haifa is presently covered with a relatively thin layer of sand and an exposed kurkar rocky bottom, further depletion of sand in the beaches in the northern part of the coast, from Atlit northward, may occur in the future. The conclusion is that remedial measures are necessary such as artificial beach nourishment from external sand sources including the sand which is deposited in Haifa Bay.

3.4.4. Coastal Sand Balance

The most important contributor of sand to the coast is the longshore sand transport from the south. It is estimated that the long-term mean input by this agent is 400,000 m³/year. Coastal cliff erosion is another contributor of sand to the coastal system responsible for an annual sand output estimated at 200,000 m³. On the basis of the volume of sand trapped in front of the main breakwater of Haifa Port and the longshore sand transport rate derived from computation of wave energy flux, the loss of sand to Haifa Bay is 100,000 m³. Two other losses that should be taken into account include sand blown landward by wind and sand carried offshore from the inshore zone.

The present state of knowledge regarding the coastal sand balance is that the annual gains are 600,000 m³ and losses 100,000 m³, leaving an unaccounted volume of 500,000 m³ that may either be lost landward, offshore or both.

3.4.5. Anthropogenic Interference in the Sand Balance

It is estimated that about 10 million m³ were mined from beaches in Israel during the 25 years following the end of World War I. During some of these years, the mining rate surpassed that of the natural input of sand to the coast.

In order to estimate the quantity of sand trapped by coastal structures two sets of data were used: volumes of sand trapped as computed from depth differential maps and measurements made from aerial photographs. As seen in Table 2, it is estimated that more than 12 million m³ of sand were captured by the structures. With the exception of Haifa Port, coastal construction along the Israeli coast began in 1960 with Ashdod Port. If the volume trapped by Haifa Port is disregarded, because it is located in the sediment sink and therefore does not affect the coastal sand balance, some 9 million m³ of sand are estimated to have been trapped by structures during the last forty years. On a long time average, this is more than 200,000 m³/year of sand which has been removed from the coastal system, or about a third of the annual input.

Table 2: Volume of sand trapped behind coastal structures (in 1,000 m³)

Site	Volume	Sources
Rutenberg power plant cooling basin	2,400	Golik and Rosen CAMP study, 1999
3 tombolos south of Ashkelon Marina	128	Golik and Rosen CAMP study, 1999
Ashkelon Marina	Unknown	
3 tombolos north of Ashkelon Marina	26	Golik and Rosen CAMP study, 1999
Ashdod Marina	266	Chesher and Dearnaley, 1999
Ashdod Port	4,500	Golik <i>et al</i> (1996b)
Tel Aviv, Gordon Marina to Clore Park	186	Golik and Rosen CAMP study, 1999
Tel Aviv, Hilton tombolo	50	Golik and Rosen CAMP study, 1999
Tel Aviv, Sheraton tombolo	95	Golik and Rosen CAMP study, 1999
Tel Baruch tombolo	30	Golik and Rosen CAMP study, 1999
Herzliya Marina complex	800	Baird & Assoc., 1996
Netanya southern tombolo	85	Golik and Rosen CAMP study, 1999
Hadera cooling basin	Unknown	
Hof HaCarmel tombolo	67	Golik and Rosen CAMP study, 1999
Haifa Port	4,000	Golik <i>et al</i> , 1996b
Total	12,633	

3.5. Sand Reserves on the Continental Shelf

The need for aggregates as building material in Israel has been on the increase since the beginning of the century. Beach sand was a major source material for building until it was prohibited by law in 1964. Other sites for aggregates are now sought, one of which may be the seabed at water depths greater than 30 m.

A recent study has shown that a volume of 1.3 billion m³ of sand is found at water depths greater than 30 m. This sand is covered by a layer of silt which gradually increases in thickness from zero at a water depth of 15 m to 25 m at a water depth of about 40 m. In order to locate sites in which large concentrations of sand with a relatively thin cover of silt are found, the ratio of sand to overlying silt thickness was computed and plotted as a ratio map. At water depths greater than 30 m, four areas were found in which the ratio was greater than 1: opposite Hadera-Netanya, Ga'ash, Jaffa and Ashdod-Ziqim. The volumes of sand and overlying silt were then computed for each. Based on these calculations, it was found that there is a general trend of reduction in

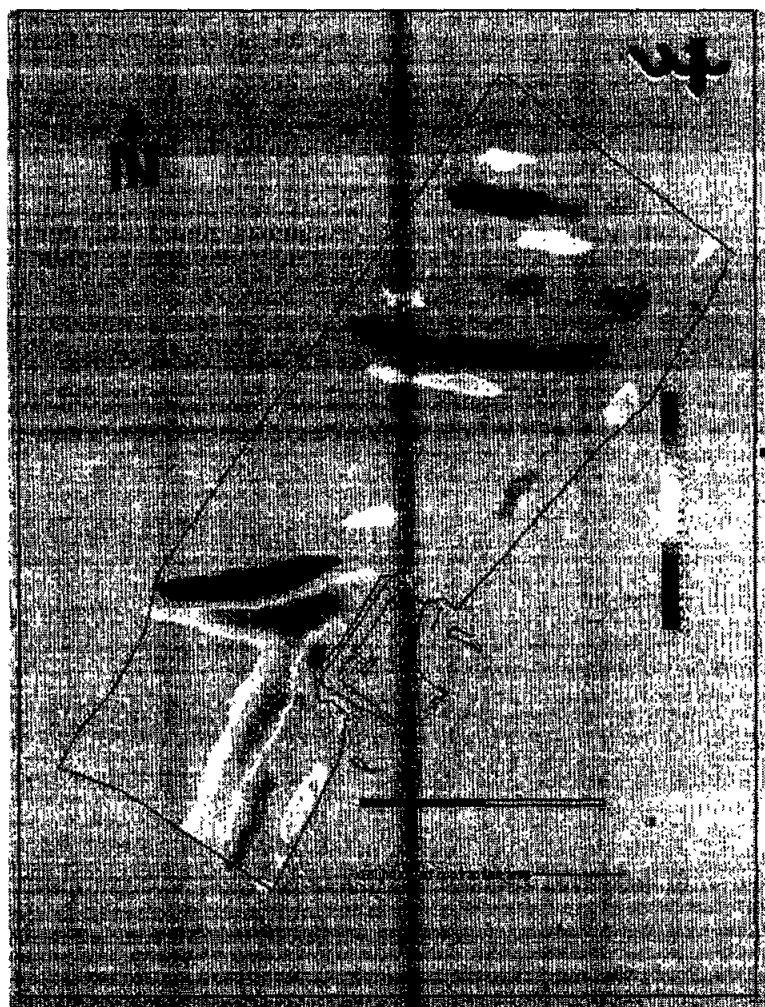
sand volume on the continental shelf from south to north. Therefore, an educated guess is that the volume of sand with a relatively thin cover of silt on the Israeli continental shelf, at water depths greater than 30 m, is approximately 500 million m³.

The results of geotechnical analyses show that the sand contains 35-50% silt and clay, making it unfit as direct fill material for the construction of artificial islands without further treatment. Potential use for this purpose or for beach nourishment or for the building industry requires further investigation.

3.6. Sand and Coastal Management

3.6.1. Sand Bypassing

It is now becoming accepted that future construction of coastal structures should not be permitted unless accompanied by sand bypassing of the natural longshore transport rates. The bypassing rate should be determined according to the volume of sand which was actually trapped. For this purpose, the seabed near coastal structures has to be routinely monitored and the quantity of sand to be bypassed determined on the basis of this monitoring. Moreover, it must be ensured that the coarser sand, which is trapped at the root of the structure, will be bypassed, or artificially provided downstream, and not the fine sand that may bypass naturally.



**Figure 2: Depth differential map 1986-1995. Rutenberg cooling basin.
(red indicates gain of sand, blue indicates loss of sand)**

3.6.2. Sand Management in Haifa

At the Haifa coastline, south of Tel Shiqmona, the direction of the longshore sand flow has not been clearly determined. If the flow is northward, construction of coastal structures may be permitted provided that they are built in succession from north to south. Beach accretion will then occur on the southern side of the structure, and time should be allowed for the beach to regain equilibrium before the next, southern structure, is built. In this manner, no erosion of the beach should occur and the only consequence would be cessation of sand flow into Haifa Bay.

If sand migrates along this coast from north southward, any construction structures which penetrate from land seaward should be prohibited unless sand bypassing is carried out. Without it such construction would cause beach starvation downstream of the structure. In view of the low rate of sand transport along this coast and the slow rehabilitation process, beach erosion would occur. The issue of natural sand flow direction in this area needs further investigation.

3.7. Conclusions and Recommendations

1. The long-term (20th century) mean of anthropogenic sand removal from the Israeli coast stands at 220,000 m³/year, which is more than a third of the annual input to that coastal system, resulting in a negative coastal sand balance. In view of the forecasted reduction of sand input due to the effect of the Aswan Dam and coastal structures on the coasts of Sinai and Gaza, the Israeli coast and its sand resources are under a serious threat.
2. Despite evidence indicating a negative sand balance on the coast, no signs of significant beach erosion were found between Ziqim and Shefaiim. There is no information regarding general coastal erosion in the northern part of the coast between Shefaiim and Atlit, yet this section is susceptible to coastal erosion since it is at the end of the Nile littoral cell. As human activity that may interfere in the coastal processes of this coast has been rather negligible, it is recommended that an analysis of the waterline position be carried out by means of aerial photographs. The results of such an analysis should show if general, not local, erosion has started to affect the coast.
3. Huge quantities (about 4 billion m³) of loose sediment in which sand is the dominant component are estimated to be present on the inner continental shelf (in water depths less than 30 m). It is recommended that mining in that area should be prohibited as it will deplete the beach sand. Exploitation of some 500 million m³ of sand, found under a relatively thin cover of silt and clay at water depths greater than 30 m should be examined.
4. Approximately 12 million m³ of sand was entrapped near coastal structures, most of it in the vicinity of major structures such as ports. This sand was removed from the coastal system and the possibility of dredging it to artificially nourish dwindled beaches should be investigated. Artificial beach nourishment should be complemented by proper means to prevent or minimize rapid removal of the nourished sand.
5. The long-term mean rate of the net longshore sand transport is assessed to be some 400,000 m³/year at Gaza going northward, decreasing to about 100,000 m³/year at Haifa, still northward. On the other hand, for the period 4/94-3/99, the approximate yearly averages were: at Gaza 400,000 m³/year northward, at Ashdod 188,000 m³/year

northward, at Hadera 26,000 m³/year northward and 100,000 m³/year southward at Haifa.

6. The longshore sand transport is a stochastic process. During a severe storm, such that may occur once in 10 years or more, the quantity of sand moved in the longshore direction during the storm period may be equivalent to several “normal” years.
7. In view of the large quantity of sand trapped near coastal structures, new marine construction should be forbidden unless of national importance. Such structures should be permitted only if proper steps are taken to ensure bypassing of the natural longshore sand transport for the entire lifetime of the structure and prevention of reflection-induced erosion to neighboring beaches. Taking into account the stochastic nature of sand deposition, the bypassing rate should be based on a permanent monitoring program of the beach and seabed area in the surroundings of the structure.
8. The forecasted sea level rise due to the greenhouse effect is expected to further deteriorate the condition of the beaches as well as increase cliff erosion. The locations of cliffs sited in coastal sectors critically sensitive to sea-level rise should be determined by an adequate sedimentological study, and protective means for the future must be considered, such as low reflection sea-walls and cliff/dune buried sea-walls.
9. Apparent conflicting evidence as to the direction of the longshore sand flow was found in the vicinity of Haifa. The existence of Nilotic sand in Haifa Bay, deposition of sand in front of the main breakwater of Haifa Port and computed longshore sand transport indicate a long-term northward net transport. Beach accretions on the northern sides of coastal structures between Hadera and Haifa seem to indicate southward net sand transport. In view of the complicated bathymetry at the Carmel Cape coastal sector and the changing local coast orientation, further clarification of the three-dimensional sediment transport mechanism in this region is needed. Field experiments using sand tracers and wave measurements in the vicinity of Haifa are recommended in order to clarify the pattern of sand flow.
10. In order to enable reliable information and correct decision making, a national, long-term, extensive coastal monitoring program, financed by the government, is recommended. This program should include mapping the waterline, by means of aerial photography and orthophoto rectification of the entire coast every two years, and next to major coastal structures every year. In addition, aerial photography should be conducted in years with storms exceeding 6 m deep water characteristic wave height. Bathymetric charting of the entire coast should be carried out once in several years. Environmental factors (sea level, wind, waves and currents) should be monitored continuously at sufficient sites for proper coverage of the whole coast.
11. A National Oceanographic Data Center, similar to those present in other countries, and advocated by UNESCO, should be established. This center should serve as Israel’s repository and dissemination facility for oceanographic data and data products.

4. Risk of Cliff Instability: the Case of the Sharon Escarpment

4.1. Introduction

The coastal plain and continental shelf of Israel consist of a system of subparallel longitudinal carbonate-cemented quartz sandstone (locally termed kurkar) ridges separated by longitudinal shallow depressions. The broadly concave shoreline cuts this ridge-and-depression system at a slight angle. Consequently, the northern shoreline includes a continuous backshore ridge whereas the coastal ridge along the central shoreline, from the Hadera River to the Yarqon River is abraded, forming a prominent backshore cliff. In this 40 km long stretch, known as the Sharon Escarpment, the cliff (and ridge) is at its highest (10-45 m).

Scientists have calculated that the coastal cliff along central Israel retreats landward at an average annual rate of 15-22 cm. Since cliff abrasion shows no signs of abatement or of attaining topographic stability, it is expected to continue actively in the future.

Given the consequences of sudden collapse of a section of cliff and the value of land at the top of the cliff, a study was carried out on the stability, dynamics, risks and environmental management of the heavily-populated Sharon Escarpment in the central coastal plain. The study is based on field work and periodic surveillance of the cliff dynamics over some 10 years.

4.2. Natural Processes and Human Interference

The Sharon Escarpment forms a sharp dividing line between the coastal plain to the east and the beach and upper shelf to the west. It is up to 45 m high and has 75-90° slopes, across layers of cross-bedded eolianite interlayered with up to four beds of loam, and is capped by a ledge of hard calcarenite. The natural processes that shape the Sharon Escarpment include: rockslides and slumping, erosion as an effect of runoff and interstitial waters, and wind and vegetation.

The escarpment moves evenly eastward by discontinuous collapse on the seaward side. Rock slabs, commonly about 2 m thick and several meters long, become separated from the face of the cliff along tensional fissures, slide downward and come to rest as 30-55° aprons of loose sand which are removed in seasonal stages by wave swash. The main driving force behind cliff retreat is wave-shore interaction. The multiannual rate of cliff retreat is controlled by the rock's overall strength and the frequency of apron clearance by wave swash (a climatic constant), and cannot be slowed or accelerated without modifying these constants. No rockfalls occur as long as the talus protects the cliff's foot. The frequency of rockfalls, averaged on a multiannual basis and along the entire length of the escarpment, is uniform and independent of cliff height or rock properties.

In addition to natural processes, direct and indirect human activities may interfere with cliff retreat and cliff morphology. These include drainage, road-building and back-cliff excavations, beach maintenance including offshore structures, removal of beach sand and beachrock and removal of talus aprons, slope grading, buttressing and aproning.

4.3. The Value of the Sharon Escarpment

Following are the qualities that make the Sharon Escarpment worthy of preservation:

1. The cliff top commands open seascapes, receiving day-long sea breezes throughout the hot rainless summer. Because of its immediate proximity to bathing beaches, recreation and commercial centers, land prices are among the highest in the country.
2. The cliff deflects nearground sea breezes upward and provides a barrier against flying sand, salt spray, windblown flotsam and beach refuse which plague the non-cliff shores.
3. The cliff forms a functional barrier between two zones of activity: bathing beach which is bounded by the sea and urban sea front which is bounded by the city center.
4. The cliff preserves relics of the natural, pre-settlement maritime environment: unique landscape forms, sculptures of nature, endemic phyto-communities with rich winter-spring blooms and cliff-adapted wildlife.
5. The cliff contains and reveals historical relics and remnants of ancient shore civilizations – the only data from which to study extinct environments and cultures.

On the other hand, the cliff presents problems and risks, some of which may be remedied at a cost. These risks include:

1. Hazards of falling from the cliff's rim (unrelated to rock slumping).
2. A belt of potential slumping risk, about 2 m wide, in back of the rim (liability to existing or planned structures).
3. A belt of danger from falling rock and sliding talus, up to 12 m wide prohibiting human use and incurring partial (though temporary) obstruction of beach traffic.
4. Difficulties in beach access due to the cliff's steep nature. This curtails to some degree the full utilization of about 10-20% of total Mediterranean beach length that is available to the public.

4.4. Evaluation of Slump Risk Along the Cliff Front

The most serious risk incurred by conservation of the cliff in its natural state is the slumping hazard. However, it can fairly well be determined where and how large the affected area will be, or when rock sliding and talus slumping will not occur. A study of the risk situations along the undisturbed Sharon Escarpment identified three levels of slump risk (rock slides and talus collapse) along the escarpment and described the slide cycle and the duration of risk at each level. Risk A, the severest, is the degree of hazard presented by exposed rock cliff, bare of talus. In this situation, the most dangerous next event is the slumping of rock. Risk B is the situation where a talus apron has lost its toe to wave swash and the next event is collapse of its loose sand and riding chunks of calcarenite onto the beach in front. Risk C is presented by a cliff aproned by talus that has not been wave-swept and is, in effect, a no-risk situation. By comparing photographs and field observations taken over more than 10 years, it was established that Risk A (bare cliff) may persist up to 10 years or longer; Risk B (untouched talus) for several years, and Risk C (stepped talus apron) for one or two seasons.

4.5. Conclusions and Recommendations

- In order to preserve the environmentally desirable properties of the cliff, the most effective – and cheap – policy is one of strict non-intervention.
- Since the rate of cliff retreat is slow with regard to settlement and building development, safety requires no more than a 10 m belt of no-development along its rim. Superficial structures such as roads, playgrounds, etc. may well last their time at this distance. A long-range safety margin of 50 m is recommended for more permanent structures and high investments although large structures built at this distance from the rim may within their lifetime find themselves partly isolated on headlands.
- Overhanging ledges of calcarenite, especially if displaying shear fissures, are dangerous. Since overhangs evolve randomly at different time and rim localities, a general safety warning should be posted on the rim and 2 m back of it.
- At localities where building close to the rim is inevitable or already exists, buttressing of the cliff's base may be recommended provided it does not damage the beach.
- Sand quarrying between the cliff and the alluvium line of the western trough should be prohibited. Under no condition should surface sands be removed from any area that eventually drains beachward. Stripped areas and gullies should be filled in with porous material that does not sustain surface flow or undermining.
- All conduits that carry runoff toward the beach should be made and kept leakproof down to beach level.
- A 15 m safety strip should be marked on the beach, wherever a cliff is bare of talus (Risk A), and on bathing beaches the strip should be staked off or fenced. This marking should be renewed every season, preferably in early spring, when Risk A is not expected to increase by storms sweeping the beach.
- Talus aprons present no hazard (not even Risk B) and should be left as they are, except to clear passages for movement along the beach. Vehicle movement should be strictly prohibited between the water divide at the top of the cliff and the beach below.
- The cluttering of the beach with boulders, rip rap and other “energy-dissipating” obstacles should be prohibited. The removal of beachrock should only be allowed at bathing beaches.

5. Implications of Climate Change on the Coastal Region

5.1. Introduction

Global climate change may have implications for coastal management and policy in Israel. For this purpose, an analysis of present climatic characteristics of the Mediterranean coast of Israel, of extreme events and of predicted future variations in temperature and precipitation was carried out.

5.2. Climatic Characteristics of the Mediterranean Coastal Area

Present climatic characteristics are related to regional wind flow and pressure patterns, influencing air masses, local wind flows and their assigned synoptic systems and seasonal wind roses, spatio-temporal distribution of sea, air and soil temperatures and volume and intensity of precipitation, on a seasonal and annual basis, as well as variability along the coast.

Subtropical highs play an important role in Mediterranean climates. Israel is located on the northern edge of a subtropical high, around latitude 30° and is featured during the summer by a stable subsidence inversion which inhibits vertical motions by capping the rising air. This subsiding air generally yields clear skies and warm temperature and hence arid climatic conditions. The northern coastal area belongs to the dry summer subtropical (Mediterranean) climate, but its southern continuation belongs to the semi-arid climate, characterized by potential evaporation and transpiration exceeding precipitation. This marked transition between two climatic types along the coast may serve as an important indicator of the sensitivity of the Eastern Mediterranean Basin to regional climate change.

The yearly mean of rainy days is 70, 64 and 50 for the northern, central and southern coastal region, respectively (about a quarter of the frequency recorded in the northern coast of the Mediterranean Basin). These winter precipitations largely result from the relatively elevated sea-surface temperatures during this season with the mean sea surface temperature in January being about 2.5°C higher than the mean air temperature.

5.2.1. Air Temperature along the Coast

The range of the average daily maximum temperature along the coast is 17°C-18°C for January to about 30°C-32°C for August, whereas the range of the average daily minimum temperature is 8°C-9°C for January to 21°C-22°C for August. For all stations along the coast, the diurnal means are almost the same for each month. The daily range of temperature increases with the advance further inland. This continental effect increases rapidly in the first hundred meters from the coastline. Near the coast, the mean diurnal fluctuations are higher for the winter months and lower during the summer. These findings are explained by the fact that during summer, the temperature rise caused by the relatively strong surface heating toward noon is soon cut off, when the sea breeze reaches its maximal intensity. The cut off of temperature rise is explained by the rapid dissipation of turbulence caused by the reduction of ground heat convection, coinciding with wind speed intensification of the sea breeze during noon hours. At

night, the moist air along the coast keeps the minimum temperature high by absorbing infra-red radiation and re-radiating a portion of it to the ground. The average monthly maximum temperatures (i.e., the multi-year average of the warmest day for each month) occur usually in May or at the beginning of June. This period is susceptible to hot and dry spells which strike the coastal region. A second peak is registered during hot spells associated with easterly winds featuring the fall season.

5.2.2. Soil Temperature along the Coast

Several studies have emphasized the important role of the sensible heat flux induced by land use changes in explaining regional climate changes. The strong relationship between land use changes, surface albedo, soil and sensible heat fluxes emphasizes the importance of presenting the seasonal and diurnal variation of the surface temperature along the coast.

In warm days with clear skies, the soil temperature along the coast reaches the highest values in the country due to the sandy soil featuring this region. The maximum soil temperature recorded along the coast is 44°C for the northern part and up to 55°C for the southern part. Higher extreme values due to a regional climate change might intensify the outgoing sensible heat flux, resulting in turn in a possible local climate change.

5.2.3. Relative Humidity along the Coast

The spatial distribution of the yearly average of the relative humidity shows that the coastal region is the most humid part of the country. The high humidity values diminish rapidly inland. Relative humidity normally has a fairly large diurnal variation, mainly due to the diurnal variation of temperature. This is especially the case along the coast, where the absolute humidity rises during the day as a result of evaporation reinforced by the effects of the sea-breeze and falls at night due to condensation and to the persisting land-breeze advecting continental warmer and drier air. The yearly mean fluctuation (i.e., the difference between the mean wettest and driest months) is only 7% along the coast as opposed to 20% at a distance of 30 km inland. Since the humidity of the air depends to a large extent on its origin and pathway, major changes may occur along the coastal region whenever easterly (continental) winds prevail. The most humid season occurs during the end of spring and beginning of summer when the sea-breeze cycle is at its maximal intensity.

5.2.4. Rainfall Depth along the Coast

About 80% of the total rain depth during the wet season (the winter) is generated by cold depressions. The mean annual rainfall depth diminishes from north to south, from about 600 mm in Nahariya and Akko to 550 mm from Haifa through Hadera, to 500 mm in the central coastal region through Ashdod and 350-400 mm along the coast between Ashkelon and Gaza. This trend is explained by extratropical cold cyclones frequently sweeping the northern part of Israel during the winter and generating most of the rain volumes.

Since rain intensity reflects the effectiveness of rainfall to cause soil erosion which could alter the delicate coastal geomorphology, it is important to present this feature beside values of accumulated depth of rain along the coast. Furthermore, rainfall intensity is indicative of large (synoptic) scale and physical atmospheric processes. Therefore, any change in rain intensity may serve as an indicator of regional climate change. Studies have shown that rain intensity along the coast is characterized by the highest values and that transitional seasons are characterized by a higher proportion of high-intensity rain.

It has also been shown that as annual precipitation depth diminishes over a certain region, the variability of the annual amount for that same region becomes larger. Therefore, a change in rainfall regime should not be attributed only to the amount of rainfall but also to its variability. The average annual depth is known to decrease sharply southward along the coast. Assuming that the frequency distribution of the annual amounts is normal, the relative standard deviation could be used as an indicator of climate change. A decrease in the coefficient of variation could serve as a symptom of long-term changes in annual rainfall patterns, especially in regions situated at the border of aridity such as the southern tip of the southern coastal plain.

5.3. Extreme Events

The study of extreme weather events is especially important in predicting future climate change, since a change in the mean time interval between extreme events (i.e., the return period) may be a manifestation of climate change. As a way of adapting to climate change and its implications along the coast, decision makers and civil engineers are interested in the time interval between extreme events such as shower spells of high intensity that could induce floods. For this purpose, the probability of maximum rain intensities and their return period were calculated for the northern and central coast. They show, for example, that a high intensity shower exceeding 200 mm h^{-1} for a 5 minute duration occurs every hundred years for Haifa and Tel Aviv and a shower of half this intensity occurs about once every five years. Extreme wind events were also investigated for a return period of 50 years. The calculation shows a relatively elevated basic wind (30 m s^{-1}) along the coastal strip, for the first few kilometers from shore, due mainly to the daily sea-breeze cycle being most intensive along the shore during the summer. This value diminishes rapidly when penetrating into the coastal plain.

5.4. Predicted Variations in Temperature and Precipitation

Predicted variations in temperature and precipitation as a result of climate change are based on an interpolation of the results obtained by the Climatic Research Unit of the University of East Anglia for the two contiguous regions (Northeastern Mediterranean and Northern Egypt). As can be seen from the Table 3 below, the predicted annual temperature change is only 80 to 90% of the increase in the global mean temperature following a doubling of atmospheric CO_2 concentrations. This finding is consistent with results obtained for most of the Mediterranean coasts.

Table 3: Sensitivity values of temperature and precipitation for the coast of Israel

	Temperature ($^{\circ}\text{C}$ change per $^{\circ}\text{C}$ global change)	Precipitation (% change per $^{\circ}\text{C}$ global change)
Annual	0.8 – 0.9	(-4) – (-2)
Winter	0.8 – 0.9	(-4) – (-2)
Spring	0.8 – 0.9	N. Coast (-2) – 0 S. Coast: (-7) – (-2)
Summer	0.7 – 0.9	(-4) – 0*
Fall	0.9 – 1.0	0 – 3

*Values derived from Palutikof *et al.* (1992) due to insufficient data from the northeastern Mediterranean study.

Based on the IPCC curve describing the projected global temperature change as a function of time for the “business-as-usual” scenario, the predicted annual mean temperature change along the coast is expected to be:

- in 2020: 0.3 – 0.4°C;
- in 2050: 0.7 – 0.8°C;
- in 2100: 1.6 – 1.8°C.

Annual precipitation along the coast is projected to decrease according to (-4) – (-2)% per °C of global change, resulting in the following values:

- in 2020: (-2) – (-1)%;
- in 2050: (-4) – (-2)%;
- in 2100: (-8) – (-4)%.

Furthermore, it is important to try to assess whether the climate has become more variable and/or extreme, since climate change may alter the climate variability, influencing both the amplitude and the frequency of extreme weather events. No conclusive evidence of changes in frequency of extra-tropical cyclones has been detected in the Atlantic (i.e., global scale) nor in the Mediterranean (i.e., regional scale). Since the majority of the coastal area belongs to the dry summer subtropical (Mediterranean) climate, it is likely that a trend of more extreme rainfall events will not be apparent. Indeed, calculations of maximum rain intensity for 30 minutes which were conducted at sites along the coast, in the northern, central and southern coastal plain, have shown no evidence of a specific trend in maximum rain intensity in the last 40-50 years along the coast of Israel. At the same time, investigations found no global pattern of a change in the frequency of dust storms and it is concluded that aside from regional-scale human activities, the major factor affecting the number of dust storms is rainfall.

5.5. Significance of Climate Change for Coastal Management

Although this study found no significant indication of local climate change, recent studies by other experts in Israel have indicated that lower precipitation and higher temperatures may be expected over the next century. This subject requires further clarification and research. In addition, assuming that worldwide climate change may result in a rise in global sea level, the implications of such a rise on the Mediterranean coastline and on different sectors of the economy which are dependent on the coast should be studied.

6. Conservation and Sustainable Use of Biodiversity

Israel's biodiversity is affected by its spatial climatic diversity, expressed in a south-north rainfall gradient so that most of its territory is occupied by drylands, by the human factor, and by the country's geographical placement at a crossroads of continents (Africa, Asia, and Europe) and biogeographic regions – the Saharo-Arabian (African), the Irano-Turanian (Asia), and the Mediterranean. This has three implications:

- overall species richness is very high;
- most of the species are represented by peripheral populations;
- though most of the species are not unique (endemic) to Israel, the communities (i.e. the assemblages of species) are unique.

Due to its geographical placement, Israel serves as one of the biogeographically most important land bridges of the globe. Along this land bridge, defined by the Rift Valley, biota have advanced and retreated during the last fifty million years. The Palearctic biota of Eurasia use the two N-S mountain ranges east (Jordan) and west (Israel) of the Rift Valley in their southward advance. The Ethiopian biota of Africa and of the Saharo-Arabian deserts, use the Rift Valley and the coastal plain in their northward advance. Future climatic change will undoubtedly influence the distribution patterns along these corridors. In addition, the corridors are used for the bi-annual Europe-Africa Palearctic bird migration, one of the most spectacular global flyways. A large part of this influx of birds is attracted to alight by water bodies and by irrigated agriculture. It also affects local ecosystems directly, by preying upon local resources, and indirectly, by transporting parasites and propagules of other species, mostly aquatic.

Finally, the long influence of humankind is expressed in the large number of domestications that have occurred in Israel. Many of the progenitors, relatives and field races of these species are still evolving in the region's natural ecosystems. The combination of climatic diversity, geographical placement and long evolution with human beings points at an impressive degree of richness and uniqueness of Israel's biodiversity – both with respect to its current state and to its evolutionary potential.

6.1. Human Impact on Biodiversity

Interventions, substitutions and transformations of natural ecosystems have significantly affected the biodiversity. While in the past, the major interventions included hunting, overgrazing and overexploitation of vegetation for firewood, this was alleviated by legislation and enforcement. Today, the strongest effect on biodiversity is the substitution of natural ecosystems by agricultural ecosystems, planted forest ecosystems or urban areas and infrastructures.

The spatial expansion of these substitutions and transformations not only dramatically reduced the size of natural ecosystems but also increased their fragmentation. Natural ecosystems are now embedded as small patches within the matrix of urban, agricultural and afforestation development. Both the reduction in size and the fragmentation of the natural ecosystems have dramatically increased risks of extinction of species, much more than the direct threat of hunting and collecting.

Substitution of natural by agricultural ecosystems is exacerbated by the impacts of agrotechnologies practiced within the agricultural ecosystems, that have cascading effects on adjacent natural ecosystems. Pesticide application, in general, and aerial spraying of pesticides, in particular, can have a serious effect.

Natural ecosystems were also transformed into urban areas and into industrial and transportation infrastructures. These too contributed to a reduction in species population sizes and to the fragmentation of populations. The scarcity of water in a dryland country such as Israel made urban and industrial development dependent to a large extent on water resource development, which further exacerbated the pressure on aquatic ecosystems.

6.2. Towards Conservation of Biodiversity

Accelerated population growth and increase in standard of living are bound to increase the conflict with biodiversity. If biodiversity loses, development that is generated by socio-economic demands will become non-sustainable. Ways should therefore be sought to minimize this risk, by designing strategies and tactics for prudent development.

The consequences of further loss, fragmentation and reduced water allocations to natural ecosystems include loss of species, reduction of within-species diversity and loss of particular combinations of populations and species. This, in turn, will lead to impairment of ecosystem services and loss of biodiversity assets of potential economic significance. On the international level, it will impair Israel's ability to comply with the requirements of international environmental treaties, such as the Convention on Biodiversity, the Convention to Combat Desertification, and the Framework Convention on Climate Change.

To avert these risks, two courses of actions are required: development and implementation of national planning policies that integrate development with biodiversity conservation and rehabilitation and reconstruction of damaged natural ecosystems.

The first prerequisite for a plan that optimizes development with conservation of biodiversity is the valuation of the benefits of the development against the costs of the lost biodiversity and ecosystem services. An area can be valued by three criteria: its ability to provide ecosystem services; the number of species of materialized and potential direct economic benefit that it harbors; and its ability to absorb anthropogenic disturbances without reducing the provision of services and without losing biodiversity ("resistance"), and its potential for rehabilitation, following disturbance ("resilience").

Since Israel is relatively poor in aquatic ecosystems, it is proposed to attribute a higher score in the valuation to areas that contain aquatic ecosystems, or to attribute a higher value to each aspect of an aquatic ecosystem, as compared to a terrestrial ecosystem having the same scores. For example, the value of an aquatic ecosystem of a given number of species will be higher than that of a terrestrial ecosystem of the same number of species and the same size.

6.3. Guidelines and Recommendations

The implementation of these guidelines can be promoted by the following recommendations:

1. Identify and then quantify the services provided by each of the Israeli ecosystem types.
2. Identify species of Israel that are endangered or at risk of becoming endangered, and assess the contribution of each to ecosystem services.
3. Compare the local water losses due to evapotranspiration of restored natural ecosystems to water gains due to the service provided by each of these ecosystems, of increasing infiltration and reducing surface runoff and its associated topsoil erosion.
4. Assess the biodiversity (species, ecotypes, populations) of current and potential economic significance, and determine the amounts of natural resources (land, water) required for their dynamic conservation.
5. Evaluate the amount of water lost due to appropriation of natural watersheds by agriculture and urban development in the region, for generating guidelines for land use allocation in areas still not developed, and for changes in current land use.
6. Estimate the rates of extinction of species populations as a result of fragmentation and reduction in size of natural ecosystems, and use the results for providing guidelines for land and water allocation for future development projects.
7. Evaluate the amounts of water allocated to nature reserves and other “uses” of biodiversity, that recharge aquifers after being “used” by biodiversity.
8. Study the role of the natural ecosystems in Israel in treating wastewater varying in quality, the degree to which freshwater allocated to nature can be replaced by treated wastewater and the technologies appropriate for this future substitution.
9. Conduct the research required for defining criteria for evaluating the significance of biodiversity for the provision of ecosystem goods and services under various climate change scenarios.
10. Develop tools to assess, evaluate and value the incremental cost to national biodiversity, hence to potential uses and to ecosystem services, hence to detrimental effect on sustainability, incurred by every new development project.
11. Assess a current baseline and develop indicators for the effects of biodiversity on sustainability of development, and use these indicators in a national, long-term monitoring scheme.

7. Identification of Main Sources of Pollution of the Kishon River and Determination of Best Available Technology

7.1. Introduction

Contamination of rivers and of the sea is prohibited under a number of laws, foremost among which are the Water Law of 1959, the Prevention of Sea Pollution from Land Based Sources Law of 1988 and the Prevention of Sea Pollution from Land Based Sources Regulations of 1990. The Water Law prohibits “any action which contaminates water or may result in water contamination, directly or indirectly, immediately or subsequently, regardless of whether the water was already polluted prior to that action or not”. The Land Based Sources Law prohibits the discharge of waste and effluents into the sea, either directly or indirectly, including discharge into streams. The attendant regulations establish the concept of “best available technology economically achievable” for the treatment of liquid wastes prior to conveying them to a marine outfall and set detailed criteria for permissible, prohibited and conditionally permissible discharges according to the Barcelona Convention.

One of the major pollution “hotspots” along the Israeli Mediterranean coast is the Haifa Bay area. Inadequately treated wastewater is discharged by the major chemical industries in this area into the Kishon River and from there indirectly to the sea. As a result, the northern part of the river has become severely contaminated and constitutes an ecological problem for the entire region.

In order to significantly reduce pollution levels in this pollution “hotspot”, a survey of wastewater quality levels was undertaken in the area. One of its purposes was to serve as the basis for environmental conditions attached to permits granted to the industries discharging wastewater directly or indirectly (via the Kishon River) to the Mediterranean Sea.

7.2. Main Sources of Industrial Pollution to the Kishon River

The Kishon River emanates from the Gilboa mountains and flows through the Jezreel Valley to the Haifa Bay area and into the sea. As much as 15,000 m³ of industrial waste are discharged to the Kishon River every day, along with 50-95,000 m³ of partially treated municipal wastewater. These effluents enter the river along its northern section which is severely contaminated and completely void of both plant and animal life. This section is both an aesthetic and environmental problem for the residents of Haifa and its suburbs.

A survey of land-based sources of pollution identified the following industries as the major industrial polluters of the river and hence the Mediterranean Sea:

- Fertilizers and Chemicals Ltd (Deshanim);
- Haifa Chemicals Ltd.;
- Carmel Olefins Ltd.;
- Gadiv Petrochemical Industries Ltd.;
- Haifa Oil Refineries Ltd.; and
- Gadot Biochemical Industries Ltd.

These industries and the municipal wastewater treatment plant have not complied with directives on effluent standards which were issued in 1978.

As a first stage toward reducing pollution, the refinery and petrochemical industries were selected for a brief study to identify existing disposal and treatment practices and recommend the best available treatment and control technology for the effluents.

7.3. Description of the Refineries and Petrochemical Industries

Carmel Olefins Ltd consists of plants for the production of ethylene, polyethylene, polypropylene and polystyrene. The plants discharge two streams into the Kishon River: the first is water generated from steam condensation and the second is wastewater from the production of polyethylene, polypropylene and polystyrene.

Gadiv Petrochemicals Industries is a petrochemical plant for the production of organic compounds including toluene, xylene, benzene, hexane, heptane, C9-aromatics, phthalic anhydride and fumaric acid. The wastewater treatment plant is designed principally to handle the problems of BOD, fats and oils. The major problem with the effluent is its high organic content.

The Haifa Oil Refinery processes crude oil and produces LPG, gasoline, diesel oil, solar oil (gas oil), asphalt, fuel oil and feed stock for the ethylene plant (Carmel Olefins) and the aromatics plant (Gadiv). In spite of the sophisticated wastewater treatment plant in the refineries, the load of organic contaminants in the effluents is high.

7.4. U.S. and European Regulations and Requirements for the Oil Refinery and Petrochemical Industries

EPA regulations are based on Best Practicable Control Technology Currently Available (BPT) and Best Available Technology Economically Available (BAT). Effluent limitations based on the performance of best conventional pollutant control technology (BCT) include conventional pollutants such as oil and grease, total suspended solids, biochemical oxygen demand, fecal coliform and pH. They replace BAT for control of conventional pollutants. In addition to limitations for existing direct discharges, EPA also establishes new source performance standards (NSPS), based on the best available demonstrated control technology, processes operating methods or other alternatives. These standards apply to new direct dischargers. Generally these limitations are as stringent or more stringent than BAT limitations for existing sources within the industry category or subcategory. Dischargers may meet their requirements using whatever combination of control methods they choose, such as manufacturing process or equipment changes, product substitution and water reuse.

The principal components of effluent guideline regulations are numerical wastewater discharge limitations controlling specified pollutants for a given industry. These are typically concentration-based limits (specified in units such as milligrams of pollutant per liter of water) or production-based mass limits (specified in units such as milligrams of pollutant per unit of production). Numeric limits also cover parameters such as pH and temperature.

Based on a review of environmental standards worldwide, BPT, BAT and BCT effluent regulations were proposed for Haifa Oil Refinery Ltd., Carmel Olefins and Gadiv Petrochemicals and comparisons were made between the actual quality of the effluents according to the Israel Water Law and according to EPA requirements.

7.5. Conclusions

All three of the industries under consideration have installed wastewater treatment plants based on internationally applied technologies. Both the Oil Refineries and Gadiv employ biological treatments which are recognized as the best available technologies. Nevertheless, in all three of these industries, effluent quality does not meet standards required by Israeli law. EPA requirements are not met in some cases and in others, data are not available. Additional analyses are needed before definite conclusions can be reached. The values for COD, sulfide, total chromium, hexavalent chromium and phenols have not been addressed by the Oil Refineries. Furthermore, testing methodologies differ. Gadiv's effluents do not meet Israeli standards with respect to BOD and oil and grease, but do comply with TSS, ammonia and pH standards. Carmel Olefins' effluent meets Israeli requirements for TSS but not for oil and grease, and BOD values do not always meet acceptable levels. Neither of the latter two industries meets the BPT standards throughout the year.

Based on the report, environmental authorities have met with the industries to undertake the following:

1. To agree on the additional tests needed to establish present effluent compositions within the context of the BAT.
2. To follow up on the implementation of these tests and evaluate the test results.
3. To determine which aspects of their operations do not meet the BAT.
4. To examine which of these can be relatively easily modified so as to meet the BAT requirements as well as those which will require more extensive process modifications and/or heavy additional investment, taking into account the overall process conditions.
5. To establish a timetable for implementing the needed changes.

Furthermore, more stringent supplementary conditions may be required by a permit which must be granted for each one of the industries under consideration in order to achieve the requisite environmental standards.

8. Remote Sensing Support for Analysis of Coasts

8.1. Introduction

The Remote Sensing Support for Analysis of Coasts (RESSAC) project, within the framework of the European Commission Programme on Environment and Climate, was conceived to demonstrate the advantages of integrating remote sensing techniques with other sources of information in order to improve knowledge and understanding of environmental conditions in Mediterranean coastal areas and help develop a sound database for management systems.

The project was intended to confirm the effective contribution of multi-satellite based data (from a number of optical and microwave sensors) to the assessment and monitoring of coastal transformations and dynamics, relevant to both marine and terrestrial environments, in particular regarding:

- total suspended matter analysis;
- offshore and inshore sea state and wind conditions;
- morphology and composition of the coastal sea bottom;
- sand inventory;
- shorelines changes; and
- coastal land cover and urban sprawl assessment.

8.2. Project Area Description

The project focused on the 100 km coastal stretch between Hadera (south of Haifa) and Ashdod (on the central part of the coast) which includes the urban area of Tel Aviv. This area is the center of urban and economic activities and is therefore under highly intensive development pressure. The major issue of land use is the rapid change from agricultural to urban use. Tourism is also a major land use activity in most of the coastal communities.

8.3. Outline of Major Topics

The project focused on the monitoring and study of the following topics:

1. Analysis of total suspended matter distribution along the coast, by using either low spatial resolution sensors (NOAA-AVHRR) or high medium spatial ones (LANDSAT; MOS; airborne data: CASI) which demonstrated the complementarity of these tools for a mesoscale and local scale monitoring.
2. Construction of a complete offshore and coastal database over a seven-year period (1991-1998) in two specific areas (Hadera and Ashdod) as well as a statistical analysis of the sea state, allowed by the use of data acquired by microwave satellites relevant to wind and sea state and processed through suitable models. A calculation of longshore sand transport rate was compared with the ones derived using only *in situ* data.
3. Characteristics of the marine platform, assessed by using optical and microwave sensors, in order to verify the suitability of such an approach in the Mediterranean coastal area. Bathymetric maps in three specific sites (Hadera, Tel Aviv and

Ashdod) were provided, and sand granulometry distribution and carbonate content in front of Ashdod were determined.

4. Coastline changes, investigated in a seven-year period (1987-1994) by relying on SPOT panchromatic images (10 m geometrical resolution). Main observed transformations at this scale are relevant to the presence of anthropic structures (ports, barriers and protection structures).
5. Land use changes over a ten-year period (1987-1996), based on Landsat TM images processing, which showed and quantified how much the main land use changes are dependent on urban and industrial expansion around the major cities and are caused by new settlements along the coast and in inland areas.

For each of these applications, validation by the Israeli partners was always performed, providing an accurate analysis of the usefulness and effectiveness of the used tools and outcomes according to Israeli requirements.

8.4. Geographical Information System

An information system, relying on ARC/INFO GIS software, was set up for the management of enhanced Earth Observation outputs, as well as the production of synthetic information to support decisions pertaining to coastal planning. Moreover, a specific module was developed in order to provide the Planning Department of the Ministry of the Environment with a new tool for the simulation of urban expansion in the year 2020 – based on urban expansion between 1987 and 1996, obtained from Landsat TM images processing, according to different planning scenarios.

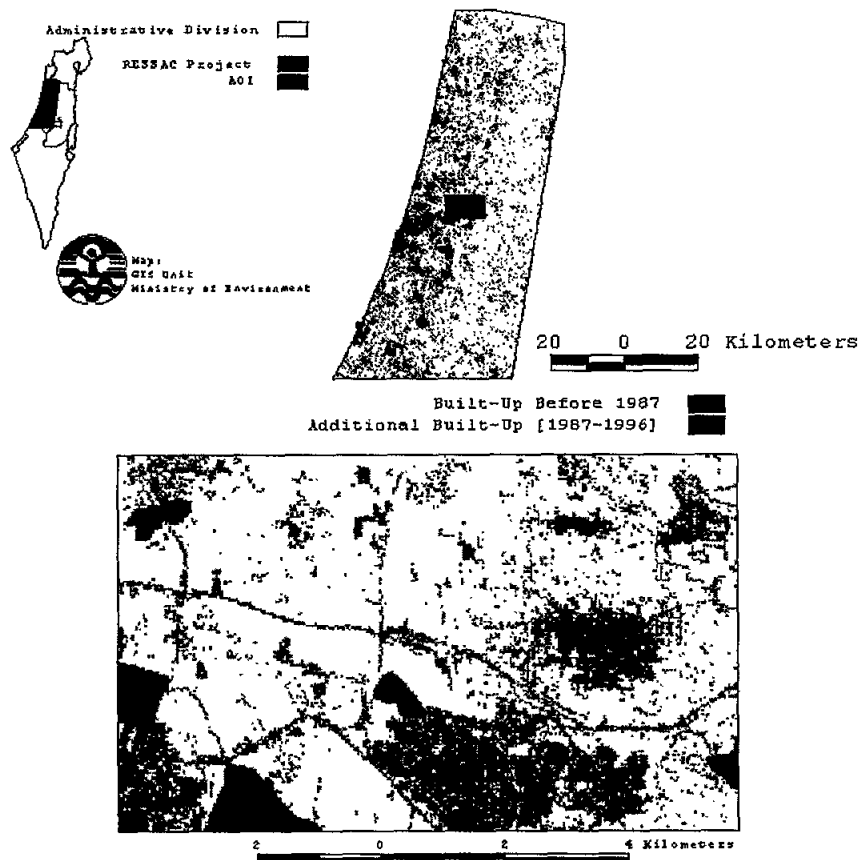


Figure 3: Monitoring the loss of open spaces (modified from RESSAC Project / Telespazio)

8.4.1. Urban Expansion Modelling

Land cover assessment over a ten-year period relying on Landsat TM analysis showed that the main transformation in the studied area is due to urban sprawl associated with a loss of natural and agricultural areas. This time period was characterized by heavy immigration which brought 850,000 additional inhabitants between 1990 and 1996, 530,000 of whom reached Israel in the 1990-93 period.

In order to provide the Planning Department with a new tool for analyzing the urban expansion and making urban forecasts following different planning scenarios for the year 2020, a specific model in ARC/INFO – relying on spatial analysis – was developed.

Three kinds of scenarios were defined by the Planning Department:

1. Urban expansion continues without specific environmental rules and constraints.
2. Urban expansion continues in the entire area except for a coastal strip of 300 m.
3. Urban expansion continues taking into consideration all the natural spaces to be preserved from any anthropic activities such as national parks and nature reserves, forests, sensitive landscape units, riverbanks, etc.

An analysis of the evolution of the different land use classes between 1987 and 1996 in this area pointed out that:

- the cities and settlements classes increased considerably by 380 km² (+245%). This increase mainly occurred between 1991 and 1996;
- the scrub class decreased by 140 km² (-33%);
- the open spaces class decreased by 230 km² (-35%);
- the bare soils class decreased by 24 km² (-48%); and
- the sands class decreased by 21 km² (-28%).

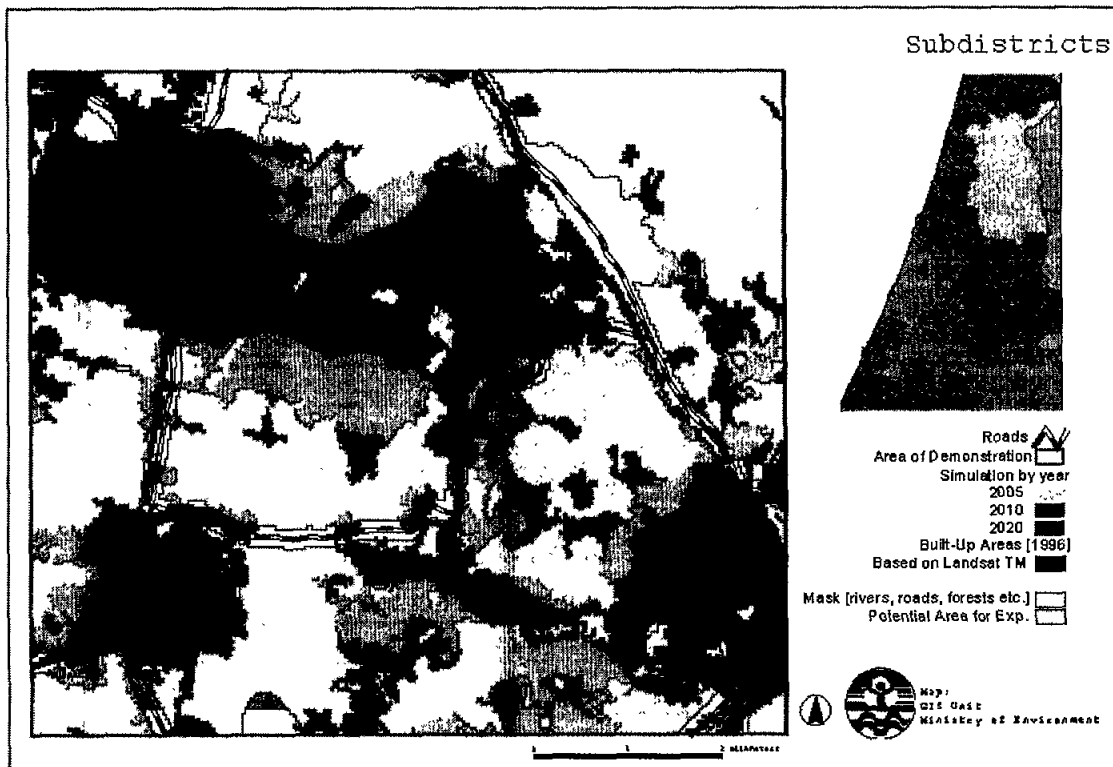


Figure 4: Urban expansion model (modified from RESSAC Project /CTM)

Based on the findings, some “trends” for future expansion could be proposed to support model devising. Relying on this analytical approach and on the different scenarios, which introduced rules to limit the urban expansion, it could be assumed that the urban growth phenomena in this area could be “modelled” considering two main hypotheses: spatial factors from which new growth could start such as expansion around existing urban nuclei or around existing attractive economic poles, and spatial constraints preventing urbanization such as buffer areas along coasts, rivers and forests, etc. Relying on the appropriate combination of factors and constraints, the model was set up in order to provide potential maps on future urban expansion.

8.4.2. RESSAC Partners

The RESSAC project was developed by a consortium made up of five European companies with different and complementary experience and expertise and of the Israel Ministry of the Environment, Planning Department, with two Israeli associated partners, as follows:

- Centro di Telerilevamento Mediterraneo (CTM), Italy, Project Coordinator;
- Ministry of the Environment, Planning Department, User;
- Advisory and Research Group on Ge-observation Systems and Services (ARGOSS), the Netherlands, Partner;
- MeteoMer, France, Partner;
- Telespazio, Italy, Partner;
- National Aerospace Laboratory (NLR), The Netherlands, Partner;
- Israel Oceanographic & Limnological Research (IOLR), Israel, Associated partner to the Ministry of the Environment; and
- Geological Survey of Israel (GSI), Israel, Associated partner to the Ministry of the Environment.

8.5. Conclusions

The RESSAC project, relying on a multidisciplinary partnership and applying to a wide range of satellite sensors, contributed to the setting up of an Earth Observation System devoted to improve knowledge and understanding of Mediterranean coastal transformations in both marine and land environments. It relied on both existing techniques and innovative methods. Data calibration and validation were performed, whenever possible, using *in situ* data, in order to improve the reliability of the produced data and to assess their accuracy. In each of the applications, lessons were learned with regard to future refinements and use of the method. In some cases, remote sensing applications proved especially useful, while in others, analysis revealed that different techniques would be more suitable.

An important aspect of the project was the setting up of a GIS with tailored interfaces which allowed for easy and sound use by the Ministry of the Environment of the main GIS functionalities. The storage and detailed dictionary of the gathered and processed data in a single database will make the information available to all the partners.

9. Social and Economic Valuation of the Mediterranean Coast

9.1. Introduction

Thus far, insufficient attention has been paid to internalizing environmental externalities in the cost-benefit evaluation of policies, projects and programs in Israel. An attempt was therefore made to evaluate the economic and social value of the shoreline by attaching a value to the benefits gained by different users from coastal proximity. This estimate will serve as a basis for drawing up a management mechanism for the activities carried out on the seashore as well as a mechanism which will bring the involved parties to internalize the external costs of their development activities.

Estimating the value of economic activities on the coast involves four main factors: the value of accommodation facilities; the beach as a site for public recreation and leisure; the value to the public of an open seashore; and the impact of the seashore on property values. In this study, the estimated values were based on quantifiable data, bearing in mind that the values of certain properties and their intrinsic benefits cannot always be quantified.

9.2. Methodology

Most of the activities examined have a cash flow stream extending over a period of years. In order to calculate their expected net present value, the expected cash flows were capitalized at an annual rate of 6%. Three periods were considered in these calculations, namely, a one-year period, a 20-year period up to 2020 and a 40-year period up to 2040. The assumption that the value of the environmental benefit will increase in the future was taken into consideration in the appropriate assumptions in the calculations. The assumption was not applied to the setting of a different discount rate for environmental benefit as against other benefits.

The calculations for the economic value of the various uses of the seashore were based on the following:

- the revenue derived by hotels and other accommodation facilities;
- the outlay incurred by visitors to beaches and sites in the municipal hinterland;
- municipal expenditure on beach maintenance;
- consumer willingness to contribute to beach conservation; and
- the added value of property in the vicinity of the seashore.

9.3. Economic Value of Accommodation Facilities along the Mediterranean Coastline

There are about 11,300 hotel rooms along the coast of Israel, most of which are in large hotels approved by the Ministry of Tourism and the rest in kibbutz and cooperative settlement guesthouses, in rural locations and in field schools and youth hostels. The number of night occupancies along the seashore was estimated for the year 1997 at 4.12 million of which 2.64 million (64%) were tourists (see Table 4 below).

Table 4: Accommodation facilities along the Mediterranean coast of Israel

Item	Hotels recognized by Tourism Ministry	Small hotels and kibbutz & other settlement guesthouses	B&Bs in kibbutzim and cooperative settlements	B&Bs in private rural homes	Field schools & youth hostels	Total
No. of rooms	9,980	950	34	103	227	11,294
No. of night occupancies (thousands)	3,608	448	13	39	8	4,116
Of which occupancy by tourists	67%	44%	20%	20%	33%	64%
Revenue from accommodation including VAT (NIS thousand at NIS4=\$1)	1,429,461	55,926	1,503	4,553	479	1,491,922
Of which revenue from tourists	55%	37%	20%	20%	33%	55%
No. of directly employed persons	6,253	367	11	32	?	6,680

Source: Central Bureau of Statistics, 1998 and CARTA, 1997. Data relate only to accommodation facilities adjacent to the seashore (within 2 km), including hotels in coastal cities.

In order to estimate the added value stemming from a coastal location, prices for accommodation adjacent to the sea were compared with prices for nearby accommodation further away from the seashore. It was estimated that the added value of accommodation facilities stemming from their proximity to the seashore is about 30% of the revenue. Calculations were then made for the coming decades of the added seashore value from operation of hotels near the sea based on optimistic, intermediate and pessimistic scenarios of tourism.

9.4. Economic Value of the Seashore for Recreation and Leisure

Surveys of vacationers and bathers at the seashore of Israel were conducted in 1982 and 1994 by means of aerial photography. In 1994, some 62,000 people were counted at one time on the seashore at noon on Saturday in the month of August and the number of private vehicles parked by the sea amounted to one vehicle per 2.8 people. Assessing the value that the public attributes to the beach is problematic since the seashore is not a marketed commodity. In order to obtain an index of the sum that the public is prepared to spend in order to relax by the sea, a number of items were examined. These included price for entry to beaches where an entrance fee is levied, cost of travel to the beach, parking costs, municipal expenditure for maintaining the beaches within their jurisdiction and willingness of the public to pay for access to the beach. These data were examined together with an estimate of the number of visits to the beach for bathing and recreation in the municipal hinterland of the seashore and the length of the seashore within the municipality's jurisdiction. Based on these figures, the total outlay of the public for the possibility of spending time at beaches and in the municipal hinterland was assessed as well as the net present value of the benefit to the public of regulated beaches in 1999, 2020 and 2040.

9.4.1. Willingness to Pay for Conservation of the Seashore

In addition to the active use of the beaches by residents as a place for recreation, the public also attaches a value to the very existence of the seashore as an open, unbuilt area. Based on a survey carried out in 1999, it was possible to estimate, in part, the value that the public attaches to the existence of the seashore. In the framework of the survey, 306 residents of Tel Aviv, Ramat Gan and Givatayim were asked how much they would be willing to contribute to a fund devoted solely to seashore conservation. The average sum that these residents were willing to pay for conservation of the beaches was about NIS 31/year (about \$7.8). Based on the survey, the monetary value that the public attaches to the existence of an open seashore was calculated. It was assumed that growing population density and accelerated development would only increase this value in the course of time and therefore the study assumes that this value will increase at a rate of 0.5% per year.

9.5. Economic Value of the Seashore for Property Development

An assessment was also made of the economic value of the seashore for property development based on the assumption that the seashore itself contributes an added value of about 30% to the property in its vicinity. However, it is essential to note that this does not bring an added value to the public and reduces the value of apartments situated behind the seashore apartments by blocking their view of the sea. Moreover, the value of property is not uniform for the length of the entire coastline: the closer the property to Tel Aviv, the higher its value.

Another aspect of the property value of the seashore relates to the loss of property value due to damage to the cliffs. The Geological Institute estimates that the coastal cliff retreats landward at an average rate of 20 cm/year. Apart from landscape damage, this collapse represents a loss of land to property owners along these cliffs. On the basis of the attributed land values and the length of the built-up area along the cliffs, an estimate was made of the damage which will be caused by loss of property on the cliff as a result of cliff erosion in strips of seashore within municipal jurisdiction (Table 5).

Table 5: Estimate of value of property lost to owners along municipal seashores resulting from cliff collapse and erosion up to the year 2020

Strip of seashore	Length of municipal strip (km)	Estimated property value lost (NIS millions)
Hadera-Givat Olga	2	21.7
Bet Yanai	1 (50% municipal)	14.3
Netanya – up to Poleg outfall	3.6	51.4
Herzliya	4.4	70.4
Tel Aviv-North	2	45.7
Ashkelon	7.5	68.6
Total	20.5	272.1

9.6. Summary of Added Value Derived by the Economy from the Seashore

Table 6 presents the specific added value derived by the economy from the seashore for hotels and other accommodation facilities, leisure and vacation, and property development. Willingness of the public to pay for seashore conservation was also assessed. For those uses for which there are substitutes which are not located directly on the seashore, such as hotels and residential apartments, the added value to these services derived from their proximity to the seashore was estimated by analyzing and evaluating the additional contribution which various consumers are willing to pay for proximity to the seashore.

Table 6: Specific added value derived by the Israel economy from the seashore

Use	Annual revenue (\$ million)	Net Present Value over a 20-year period (\$ million)
Hotels	105	1,500
Vacationing and leisure	125	1,720
Property for housing	265	4,400
Willingness to pay	12	65

9.7. Sample Assessment of the Estimated Value of the Coastal Impact of the Herzliya Marina

Construction of the Herzliya marina is one of the prime examples demonstrating the impact of development activities on the seashore by one user on the benefits of other users of the seashore. The marina impedes the natural movement of the sand along the seashore and its establishment has resulted, on the one hand, in increasing the depth of sand of the adjacent southern beach, and, on the other hand, in reducing the depth of the sand on the beach lying to its north.

The coastal strip is occupied by bathing beaches operated by the Herzliya municipality, by private beaches belonging to the hotels on the seashore, by the marina, and by residential apartment buildings and other consumer facilities. Due to the narrow strip of the northern beach, the kurkar cliffs are subject to excessive weathering, erosion and collapse with resultant losses to property.

On the basis of the values attached to the various uses, it was possible to estimate the damage caused to the various users of the seashore north of the marina. The economic impact of the change to the beach is summed up in the following table and constitutes a sample assessment of the estimated value of the impact on the seashore resulting from construction of the Herzliya marina.

Two alternatives have been proposed for restoration of the beaches affected by the marina: a proposal by the Herzliya municipality to construct additional breakwaters and a proposal by the Ministry of the Environment to restore the seashore by marine excavation of sand for beach nourishment. The Herzliya municipality contends that unconnected breakwaters opposite the damaged beach would delay the northward movement of the sand and increase the sand depth in the adjacent northern beach. However, this would transfer the problem of sand loss to the beaches further to the north. The cost of restoring the seashore along a length of 2 km according to this proposal is estimated at \$2.6-9.0 million. Implementation of this plan would restore a

20-m width of beach, a 4 hectare area whose value to the public is estimated at \$34 million (Table 7).

According to the approach advocated by the Ministry of Environment, the beach would be widened and restored by feeding the beach with sand. For this purpose a marine dredge would be employed to excavate sand from the sea floor and deliver it to the beach by means of a pipeline. In order to reduce movement of sand during the operation, measures would have to be taken to reduce the movement of the sand during the filling operation. The total cost of the filling is estimated at \$700,000 and the work would have to be repeated every few years.

Table 7: Estimated added value and loss of value resulting from construction of the Herzliya Marina

Subject	Added value (\$ millions)	Loss of value (\$ millions)
Added seashore value to property in the marina	150	-
Endangered property to the north of the marina	-	80
Denial of opportunity to vacationers and bathers	-	27
Expansion of the southern beach for vacationers and bathers	27	-
Possible damage to hotels north of the marina	-	25

9.8. Conclusions

Despite the realization that the beach has a high social value, entrepreneurs are often granted rights to use the seashore without compensating the public for potential environmental damage. The award of property rights denies benefits which would otherwise be available to the public. Developers are currently not required to repair the damage they cause by their activities nor to compensate the general public for this damage.

Damage to the public may be categorized as follows:

- occupation (expropriation) of a section of the beach;
- denying public access to the beach for leisure and recreation;
- damage to neighboring beaches;
- obstruction and aesthetic detriment to the landscape.

The study therefore proposes the imposition of measures which would require commercial interests to internalize the external effect of their development. It is proposed to impose a levy on property development in the vicinity of the seashore. This would internalize the value of damage, and the revenues – both from land betterment taxes and from ongoing annual property taxes – would be diverted to protect the environment and upgrade public welfare. The levy rate should be at least equal to the harm caused to the public. The municipality and the Israel Lands Administration would also have to allocate sums from the revenue obtained from the development promoter to prevent environmental damage and upgrade environmental quality.

10. Sustainable Development Strategy

10.1. Introduction

The process of formulating a sustainable development strategy in Israel was influenced by international, regional and national factors, foremost among which was the 1992 Earth Summit and the formulation of Agenda MED 21. Within Israel, several studies set the scene for anticipating future developments, particularly the recently completed masterplan for the 21st century – Israel 2020. The environmental team of Israel 2020 reviewed the environmental issues likely to influence long-term development policy and proposed several approaches for building a sustainable development strategy. The vantage point for all approaches was directly related to present demographic and development trends. In the thirty year period between 1960 and 1990, Israel's population more than doubled and its built-up area quadrupled. According to Israel's long-range masterplan, the country's population will reach about 8.5 million in 2020 (nearly doubling the 1990 population) and its built-up area will more than double. Increased stress will be placed on a diminishing pool of land resources. The conclusion of the Israel 2020 document is that if present development trends continue (business as usual scenario), a major deterioration in environmental quality may be expected during the course of the next twenty years. However, it is possible to reverse negative trends by initiating changes in the economy and in consumption and production patterns.

The original papers which were produced by the 2020 team were compiled in a preliminary policy paper which was widely disseminated by the Ministry of the Environment in 1996 as a first step toward introducing the concept of sustainable development into government discussions. It was followed up by presentations by Israeli experts on present problems and future goals for air quality, water, biodiversity, open space and solid waste and hazardous substances.

10.2. Phases in the Development of a Sustainable Development Strategy

In developing its strategy, Israel took note of experiences gained in other countries, specifically the European Union directive, "Towards Sustainability", and the experience of The Netherlands in formulating National Environmental Policy Plans. The Dutch approach, largely based on stakeholder participation, target setting, consensus building and generation of public support, illustrated the means by which all segments of society and of the economy participate in formulating sustainable development policies.

The program itself, which was initiated in 1996, included the following elements:

- opening seminar on approaches to preparing a strategy for sustainable development;
- organization of seven target groups (industry, energy, transport, tourism, agriculture, urban sector, biodiversity) composed of a wide range of stakeholders including national government, local government, the private sector, academics and NGOs (see appendix for details);
- appointment of Israeli experts to act as facilitators for each of the target groups; and
- formulation of conclusions and recommendations for a national strategy for sustainable development in Israel.

10.3. Proposed Strategy for Sustainable Development in Israel

10.3.1. Objectives of Sustainable Development Policy

Three primary objectives of sustainable development were identified: intergenerational equity, intragenerational equity and expansion of the resource base available to the economy by means of economic growth.

Intergenerational equity means that future generations will be at least as well off, from the point of view of well-being, as present generations. The level of welfare of the present generation is the minimal level of well-being in a multigenerational perspective. This does not mean that there will not be environmental deterioration, but it does mean that everything should be done to prevent damage which threatens the recovery of vital or rare resources.

Intragenerational equity means that the well-being of strong groups will not be at the expense of weaker communities. Therefore, steps should be taken to improve environmental quality in areas in which weaker groups are concentrated.

Economic growth is presumed to be a precondition for implementation of the former two goals. Efforts must be made to increase the total available resources in the economy. A sustainable development strategy must encourage growth.

In order to implement these primary objectives, which represent the widest common denominator, more concrete goals were identified, based on information collected within the framework of the Israel 2020 plan and the background documents prepared specifically for this process. The following concrete goals were proposed for sustainable development policy:

1. To secure maximal freedom and opportunity for future generations to determine their environment and style of life, especially in light of increasing pressures on land and other natural resources in Israel.
2. To assure a reasonable quality of life and the environment to the entire population, including weak communities and minorities. Everything should be done to minimize the growing gap in the environmental quality which is available to different population groups and to actively work on behalf of environmental improvement in neglected areas.
3. To encourage developments which internalize environmental impacts. Development should increase the stock of resources at the disposal of the economy. At the same time, the cost of development to entrepreneurs or other developers should incorporate its social and environmental costs in order to ensure that development will be optimal in a social and intergenerational context.
4. To maintain minimal standards for the prevention of irreversible damage to vital or rare natural resources so as to protect Israel's resource reservoir and biodiversity.
5. To define environmental targets beyond the establishment of minimal environmental standards which may be achieved in the short and medium terms.
6. To increase environmental awareness and to establish institutional structures to facilitate cross-boundary environmental awareness and action.

10.3.2. Targets of the Sustainable Development Strategy

The foregoing environmental goals guided the target groups throughout their deliberations. Each team then defined the specific targets and means necessary to advance these goals in its own sector. A number of comprehensive and complementary targets were thus identified. Their advancement forms the basis for the proposed sustainable development strategy for Israel. These targets include:

- *Full internalization of externalities by means of realistic pricing:* A significant portion of the problems identified in the background documents is caused by the fact that businesses and organizations do not take responsibility for their actions. These bodies should be required to pay for the full impacts of their actions. This is especially so for resources and services which are under the control of or have a direct impact on the country, such as water and energy.
- *Conservation of land, water and energy resources:* Actions to promote conservation of scant resources are essential even in the presence of a policy of realistic pricing since it is often difficult to quantify the intergenerational benefits of conservation. In order to provide future generations with the widest range of possibilities, resource conservation should be encouraged.
- *Development of technologies and approaches which will minimize environmental damages:* The greatest potential for minimizing environmental damages, including damage to different resources, lies in the advancement of scientific knowledge, both in terms of technology and policy. Such development requires continuous investment, and its fruits may only be evident in the long term in an intergenerational perspective.
- *Improvement of urban quality of life:* Most of the population resides in urban areas, and recent national and strategic plans call for increasing the density in these areas in order to preserve land resources and to reduce dependence on the private vehicle. The implementation of this goal without adversely impacting on the well-being of future generations is dependent on the cultivation of urban areas and the promotion of a high quality of life within them.
- *Increasing the awareness of the public and policy makers of environmental quality and natural resource issues:* Political and public support are needed to help implement environmental targets, some of which will require hard decisions entailing price hikes for services and activities. Public and political support must be based on wide understanding of the importance of these steps.
- *Increasing the scope of public participation in environmental issues and, in particular, in planning processes:* Since the environment relates to all residents of the country, increased awareness should lead to increased involvement in decision making. Such participation is especially important in the realm of planning since this process will impact on the image of the country for future generations.
- *Protection of weak communities and expansion of the circle of opportunities open to them:* Since economic growth is usually not equitable and certain groups in the population do not enjoy the fruits of growth, special efforts must be directed toward protecting weak and marginal groups in order to increase their chances of taking part in growth processes which will improve their quality of life.

10.3.3. Means of Achieving the Objectives and Targets

It is anticipated that the synergistic implementation of the measures outlined below will help fulfill the objectives and targets of sustainable development. However, these means cannot be simultaneously implemented and the impacts of different measures will only be felt in different time frames. Moreover, since it is impossible to forecast all of the means required to implement the objectives in the long term, the strategy should be continuously updated to keep up with new knowledge and to respond to unanticipated problems. Alongside the measures outlined below, the proposed sustainable development strategy enumerates specific steps for implementation by specific bodies.

While most of the measures identified below may be implemented within a period of five years, their impact will not be uniform and may range over different time frames. In the short range, it may be possible to promote better integration of environmental considerations in decision making processes and to increase the quality of life of weaker communities. In the medium term it should be possible to impact on urban quality of life, which will be difficult to attain in the short range. In the long term, the impacts of resource conservation activities should be felt. Nevertheless, some activities should be initiated immediately even though their impacts will only be felt in the more distant future. This is especially so with regard to research and development or changes in land use patterns.

Following are the recommendations for helping to achieve the objectives and targets of sustainable development:

Internalizing externalities in decision making: The difficulties of quantifying environmental and social impacts into monetary terms require research and consensus on the appropriate techniques for translating these impacts into economic terms. Once agreement is reached, such techniques should be integrated into cost/benefit analyses conducted by the Treasury and other bodies. It is important to differentiate between different qualities of service or different sensitivity levels of resources, in pricing decisions, especially with regard to water pricing. It is also essential to review the impacts of different forms of government intervention, such as subsidies, since these may encourage inappropriate resource allocation. It is suggested that parking subsidies by employers, for example, should be stopped. Additional measures may include vehicle taxes as a function of environmental impact, higher fines on pollution generation, and realistic energy tariffs on the basis of marginal costs.

Encouraging natural resource conservation: Conservation of natural resources seeks to minimize damage to resources, including biotic resources, especially by giving priority to utilization of renewable resources. The protection of open space systems in a country with scant land resources is of top priority, but is discussed in more detail in a variety of recent policy papers. Natural resource conservation may be implemented by such steps as tax exemptions on investments in energy and water conservation, waste to energy plants, higher building densities in cities, reutilization of solid waste disposal sites, quarries and industrial areas, green building, promotion of renewable sources of energy, etc.

Reducing environmental damages: Since the greatest potential for reducing environmental degradation lies in technological advances, it is essential to increase the scientific base and to adapt it to Israeli conditions, with government support. Once a database is established, ways should be found to distribute it to a wide variety of bodies, including small businesses. Means should also be found to increase the effectiveness of enforcement and to promote economic tools to achieve environmental goals.

Improving urban quality of life: In order to promote a good quality of life in the urban environment, it is essential to reduce pollution at source and to separate environmentally disturbing uses from residential areas. At the same time, steps must be taken to improve the landscape quality of cities through provision of green spaces at all levels – from neighborhood to region.

Increasing awareness and public participation: Since public awareness is a prerequisite for public involvement, means should be found to generate environmental information which is relevant to the public and to distribute it through the written, aural and electronic media. The public should be afforded the tools to express preferences for environmental products and services, through such means as the “green label”, Israel’s system of ecolabeling. Systems that promote links and communication between potential sources of pollution and surrounding communities should be established in order to involve communities in preventing pollution, improving the environment and developing means of resolving conflicts.

Preventing harm to weaker communities: The strategy calls for identifying communities exposed to unreasonable levels of environmental damage or very low quality of life. Minimal levels for quality of life must be established which will entitle those below them to assistance. Action plans should strive to broaden the opportunities available to disadvantaged segments of the population, to marginal areas and to minority groups.

10.3.4. Preventing Unsustainable Development

Development is deemed unsustainable when it contradicts one of the three primary objectives of sustainability. At this stage, seven processes were identified which clash with the proposed sustainable development strategy. The test of the strategy will be in its ability to reverse negative processes which are already taking place and to prevent the growth of negative processes which are still in their initial stages. The following processes have been identified as impeding sustainable development:

1. *Economic deterioration:* A decline in income per capita will bring about a decline in social welfare and will hamper efforts to reduce environmental deterioration since inadequate funds will be available for research and development. At the same time, possibilities to improve the lot of weaker populations will be significantly restricted.
2. *Decrease in buying power and available services to weaker communities:* This state of affairs will reduce the level of available health and education services to the lower echelons of society and may serve to reinforce a situation whereby weaker communities will be precluded from improving their quality of life.
3. *Overexploitation of resources and irreversible damage to them:* Overexploitation of some resources may hamper the ability of future generations to use them. Damage may also be caused by the use of non-renewable resources rather than alternatives or by contamination of water and soil, which is expensive to clean up.
4. *Continuous impairment of the ability to generate data:* This may be caused by lack of new research staff in essential fields such as agricultural research or by reduction of research funds. This may reduce the pool of qualified researchers in academia who may help to overcome future environmental problems.
5. *Impairment of regulation, inspection and enforcement capability:* Any damage to the institutional system and its image will be expressed in reduced motivation to

work within the framework of government and will harm the ability of society to tackle future problems and promote sustainable development goals.

6. *Unbalanced development*: Accelerated and wide-scale development in a specific field (i.e., residential) without adequate consideration of its impacts may result in irreversible harm to both future generations and to certain segments of society.
7. *Scattered suburbanization based on private cars*: In light of the scarcity of land resources, scattered suburbanization may discourage public transportation, promote the consumption of large tracts of land by a small and financially secure population group, and negatively impact on the composition and structure of cities while impairing air quality.

10.4. Sustainable Development in Different Sectors

Israel's sustainable development strategy was formulated by sectorial target groups, each of which was made up of representatives of central government, NGOs, academic experts, professionals, and public and private enterprise (see appendix for further details on the participants). Discussions were conducted in a round table framework and focused on major issues in each sector, reviews of existing information, forecasts and scenarios, and potential policy directions toward achieving the goals of sustainable development.

While the sustainable development documents do not yet reflect full consensus on several critical issues, they do propose changes – at times dramatic – in Israel's development path. One of the foremost recommendations is a change from end-of-pipe technologies to resource conservation and use of technologies which incorporate measures to prevent pollution and waste in production processes themselves.

Following is a summary of the sustainable development documents which were produced by the target groups in each sector.

10.5. Sustainable Industrial Development

10.5.1. Sustainable Development Approach to Industrial Development

In order to prevent exploitation and depletion of existing sources, the industrial approach must be reversed from that practiced today. The aim of industry should be:

- to produce products with long life;
- to produce products which may be upgraded;
- to produce products which may be recycled during their lifetime;
- to produce products without producing wastes (industrial waste, effluents or air pollution);
- to produce more products which supply services to the public and less products which serve an individual consumer;
- to reduce to a minimum the consumption of energy and emission of greenhouse gases during production; and
- to substitute, to the greatest degree possible, non-renewable resources with renewable resources.

In order to implement these changes, industry will have to undertake the following:

- to develop, produce and advertise products complying with the requirements of sustainable development;
- to develop production processes complying with the criteria of zero waste;
- to recycle raw materials;
- to take responsibility for cradle to grave management of the product, where grave is defined as the return of the product to nature and its disappearance as a product;
- to reduce the energy consumption of each product;
- to reduce the emission of greenhouse gases to the atmosphere; and
- to examine each potential product before production according to the following criteria: is the product necessary, does it degrade and during what time frame? what are the byproducts and their impact? are the raw materials for production recyclable or reusable?

On the one hand, no sector is required to sacrifice as much in terms of economic interests as industry. On the other hand, industry has the manpower and financial resources to advance the passage to sustainable development more than any other sector. Therefore, plants with similar activity should be reviewed in terms of requirements, changes and financial costs. Five year action plans should then be formulated which will direct all plants in the group to sustainable development.

10.5.2. Guidelines and Principles for Sustainable Industrial Development

In coming years, industrial development will be characterized both by an increase in potential sources of pollution and by increased environmental awareness and more stringent environmental requirements. Following are some of the salient guidelines and principles for industrial environmental policy for the year 2020:

Establishing a sustainable development policy for industry:

- A sustainable development plan for industry should define targets which can be measured and quantified.
- The plan should be accompanied by a follow-up system for reviewing progress toward sustainability.
- A permanent committee on sustainability should be set up to review achievements, costs, and impacts on the population and on the economy. The committee should formulate and amend guidelines once in five years.

Adoption of structural changes in production processes:

- Obstacles to changing industrial processes and raw materials should be removed.
- While end-of-pipe facilities help to provide immediate solutions to some problems, changes in production processes and raw materials should be investigated and implemented concurrently.
- Processes which undergo frequent changes should introduce structural changes to reduce environmental degradation.
- The Ministry of the Environment, in cooperation with the Chief Scientist of the Ministry of Industry and Trade, should set up a fund to promote research into

industrial processes which minimize environmental impacts and risks without requiring end-of-pipe solutions.

- The Ministry of the Environment should promote, by means of subsidies, awards, and penalties, the development of industrial processes which conserve raw materials and energy, do not emit pollutants to the environment, do not produce waste, and do not endanger nearby residents.
- The Ministry of the Environment should develop the necessary measures (e.g., financial support, institutions) to help small plants institute structural changes, while preserving their advantage with respect to other plants.

Prevention of environmental pollution:

- The Ministry of the Environment should prepare a list of priority pollutants on the basis of risk to man and the environment including permitted concentrations.
- Air pollution standards and effluent standards should be reviewed every five years.
- The monitoring and enforcement system should be improved and strengthened.

Research and development:

- The government should help establish a research body to promote research on production processes which reduce raw materials and energy and minimize waste generation and environmental risks.
- Environmental conservation principles such as recycling, longer shelf life, and renewable sources of energy should be incorporated in standards for consumer goods and materials.
- Existing research institutions should be encouraged to investigate environmental issues which are relevant to industry.
- Cooperation should be promoted among countries and international bodies in the transfer of environmental knowledge and technology.
- Information should be collected at the individual plant level on consumption of energy and raw materials and on waste and its utilization.
- Environmental protection costs should be evaluated by research institutes which will assess the mutual relations between environmental management, technology and economics.
- Research institutes should review anticipated technological developments, their environmental impacts, and requirements from environmental management systems.

Increasing public awareness:

- Activities should be taken to promote environmental awareness and purchase of environment-friendly products.
- Information centers which are open to the public should be established with data on environmental issues which are of importance to public health and welfare.
- The government should subsidize environment-friendly products and behavior.
- Covenants should be signed with producers to stop production and sale of products which are harmful to the environment.

The industrial sector will need to take steps to prevent global warming and ozone depletion, reduce emissions of sulfur oxides, nitrogen oxides and hydrocarbons through a shift to low-sulfur fuel and natural gas and stricter emission standards, reduce damage to aquifers by industrial effluents through installation of pretreatment facilities at the plant level, prohibit saline discharges to the municipal sewage system, clean up polluted soil and prevent fuel leaks to soil and groundwater.

10.6. Sustainable Energy Development

10.6.1. Energy Consumption: Present Status and Forecasts

Today, expenditure on fuel imports represents a sizable percentage of Israel's balance of payments – \$2.25 billion in 1997. Increased energy consumption, especially for transportation, as a result of rising standards of living, coupled by new expenditures on desalination and wastewater treatment due to water scarcity, are expected to lead to an immediate increase of 7-8% in electricity consumption, followed by an annual increase of no less than 1% per year. There is reason to believe that expenditure on fuel imports will exceed \$10 billion per year by the year 2020, or \$1200 per capita for fuel import alone.

Objective considerations, such as world fuel reserves, considerations specific to Israel, such as political considerations, and environmental constraints, require a long-range program for development of the energy sector in which the state will invest in alternative energy technologies and will encourage efficient use of energy.

10.6.2. Environmental Impacts

The team emphasized the environmental impacts of fuel use both in Israel and worldwide, in terms of both global warming and such impacts as increased morbidity, acid rain, damage to monuments and other cultural elements, and degradation of ecosystems and species.

In Israel, carbon dioxide emissions have grown from 23.3 million tons per year in 1980 to 35.1 million tons per year in 1990 to 59.8 million tons per year in 1997 alongside substantial increases in methane emissions. In order for Israel to reduce its emission levels to 1990 levels (not currently required since Israel was classified as a developing country under the Kyoto Convention), it will have to reduce its fuel combustion by more than 40% and its emission of greenhouse gases by more than 50%. Therefore, in order to fulfill possible global obligations, to better its balance of payments and to improve its environmental quality, Israel should reduce its dependence on imported fuel and increase its dependence on renewable sources of energy. Furthermore, it must develop technologies for energy conservation and clean and renewable energy which will have the added benefit of potential export.

10.6.3. Assessment of Social Costs and External Costs

There is major importance in assessing the social and external costs of environmental damage in order to create a sound economic basis for decision making on energy sources. Since the damages caused by generation of energy may be partially irreversible and certainly cumulative, Israel must formulate and implement a clear policy on air pollution prevention. The economic implementation of sustainable development principles will require the internalization of external costs into financial terms in three spheres:

1. External costs should be taken into account in all feasibility calculations, and a discount rate which takes account of the welfare of future generations should be adopted.
2. Energy prices should reflect the externalities caused during production and transport of energy.
3. Energy policy should enable the development of renewable energy sources and energy conservation technologies.

The economic objective of sustainable development should be to ensure that the marginal social benefit equals the marginal social cost, where social cost includes the direct cost and externalities. This will entail the institution of a system of “green” accounting and correct pricing of energy sources on the national level. At the same time it will reexamine energy subsidies and examine the feasibility of alternative solutions to fossil fuel use.

Alternatives to the implementation of sustainable energy development may be reviewed through such tools as integrated resource planning, which takes account of the cost of different technologies, environmental requirements, reliability of supply, and other factors, or through a comparison of alternatives for optimal development of the energy sector taking account of environmental aspects, in general, and greenhouse gas emissions, in particular. On a practical level, several actions may be taken to internalize externalities. These may include emission fees, trade in emission quotas and obligatory quotas for clean energy generation using proved and applicable technologies.

10.6.4. Technologies for Sustainable Energy Development

Several technologies are available for achieving sustainable energy development, each with its advantages and disadvantages. These include energy conservation, natural gas, nuclear energy, renewable energy sources and alternative local sources of fuel.

Energy conservation, especially in building, industry, transport and water, is an essential part of any sustainable development plan. The Ministry of National Infrastructures estimates that it is possible to reduce energy use by 21% based on investments which will be paid back within 5 years. The sustainable energy target group believes that this figure can be doubled.

Side by side with energy savings, renewable energy technologies are essential for achieving sustainable energy development. Renewable energy technologies include wind power, waste to energy technologies, and solar energy including solar collectors, solar towers and parabolic mirrors.

In order to reduce greenhouse gas emissions, the following activities are proposed: energy conservation and implementation of two available technologies: combustion of most of the country's solid waste in order to prevent methane emissions (13%) and to provide for electricity generation (6%) and possible utilization of wind energy in order to bring about a further reduction of 3%. At the same time it is necessary to develop and adopt energy generation technologies from renewable sources, including parabolic mirror, solar tower, energy towers, etc.

While research and development in the field of energy over the past two decades have yielded positive results, further government-sponsored research on renewable energy sources, in general, and solar energy, in particular, is required alongside private investments. In order to make energy more efficient, it is imperative to provide the necessary financing for research, development and demonstration.

It is essential that Israel adopt a policy directed at broadening the technological options which will enable pollution prevention in energy production and use, including, *inter alia*, reducing greenhouse gas emissions, at the lowest possible economic, environmental and social cost. Many of the technologies designated to reduce greenhouse gases will also contribute to solving additional problems related to energy use, including reducing dependence on imported fuels, diversifying energy sources and supply systems, increasing the export of energy technologies, reducing water and air pollution, and reducing the safety and security risks of energy systems.

10.6.5. Toward Sustainable Energy Development

Sustainable development calls for an efficient, reliable and decentralized energy economy, based on local and clean energy sources, in which the price paid by the consumer will reflect the real cost of energy products to the economy.

In order to consolidate a national strategy which will promote alternative energy sources and advance the efficient use of energy resources, the following steps are advocated:

1. Planning and development of the energy economy on the basis of Integrated Resource Planning (IRP) so that discount rates reflect the different risk levels in the different components of cash flows.
2. Implementation of a comprehensive national policy directed at energy conservation which will include regulation, enforcement and use of financial tools in all cases where benefit to the national economy can be proved.
3. Basing energy prices on their real cost to the economy by revoking subsidies which may discriminate against one source of energy, establishing yields to capital according to economic criteria, internalizing externalities (environmental and social) and reviewing technological alternatives using models which do not discriminate against new technologies. This will bring about better integration between energy policy and environmental policy (e.g., rational policy of fuel taxes, preferential tariffs for electricity from clean sources).
4. Promotion of natural gas use, recycling of industrial waste, and reduction of methane emissions from landfills through a shift to new waste treatment methods.
5. Allocation of appropriate resources for research, development and demonstration of sustainable energy technologies and ways of abating and adapting to the greenhouse effect. Budgetary allocations should be at a fixed rate of the national expenditure on fuel import.
6. Supply of continuous, reliable and updated information to the consumer on energy efficiency and the adverse environmental impacts of energy use, in order to bring about a positive change in public attitudes to energy conservation and environmental issues.
7. Safeguarding open spaces for utilization of local sources of energy so that these spaces will be available when new technologies mature.
8. Establishment of criteria for sustainable energy development policy and their assimilation in development plans and statutory physical planning.

10.7. Sustainable Transport Development

10.7.1. Environmental Impacts of Transport Systems

The transportation sector presents major difficulties in terms of sustainable development due to the multi-faceted positive and negative impacts of transport. Transportation systems play a crucial role in modern economies, but alongside their benefits, they generate such adverse impacts as congestion, environmental pollution and safety risks.

From a sustainability perspective, the variety of environmental impacts associated with transport systems differ in their relevance and significance. Probably the greatest concern is air pollution, both in terms of the association between emissions and global warming trends and the impact of vehicular air pollution on mortality and morbidity and damage to flora and fauna. Based on the assumption that for the next decade or two the vehicle fleet will continue to be based on the internal combustion and diesel engines, simple correlations between growth in Vehicle Kilometer Traveled and emission quantities can be used to forecast the future situation. The overall objective should be to reduce the number of Vehicle Kilometers Traveled without necessarily reducing Personal Kilometers Traveled.

The “consumption” of open land by transportation systems may be the most crucial issue from a sustainability perspective, since changes in land use are irreversible. The problem is compounded in a small and densely populated country such as Israel. The relationship between transport and open land is at least twofold. On the one hand, transportation facilities (roads, tracks, parking lots, stations) are major consumers of land. On the other hand, development of land and its consumption for residential and commercial purposes is dependent on the provision of transportation infrastructure and services. Preferences for single-family dwellings and private cars result in a circular process which is clearly at odds with a sustainable approach.

Other impacts of transport facilities include increased impermeable surfaces, risk of pollution from road surfaces to underground aquifers, noise, vibration, and aesthetic degradation of the landscape.

In general, the objectives of sustainable transport development include:

- land coverage by transportation facilities should be minimized and balanced against the economic and social benefits of particular projects;
- dependence on the private car should be reduced while accessibility of all population groups should be maintained and even enhanced;
- energy consumption and pollutant emissions should be reduced without compromising accessibility to opportunities.

In most respects, the issues of sustainable transport systems in Israel are identical to those faced by most other developed countries, but Israel does have some unique attributes which require special attention. These include an uneven distribution of the population, high density and limited land resources, limited traffic between Israel and neighboring states, low level of car ownership which allows for a relatively high share of public transport, and lack of public transport service on the Sabbath (Friday evening to Saturday night).

10.7.2. Toward Sustainable Transport Development

The present relationship between transport and the environment is not sustainable. The literature has classified the range of interventions to make environment and transport

more sustainable into five types: technological intervention to improve the efficiency of vehicles or their use, economic approaches to encourage efficient use of the transportation system by changing relative prices and creating incentives for individuals and firms to make choices which reflect the full costs of their decisions, regulatory measures set by authorities, planning tools which allow society to intervene in the spatial dimension of allocation of land use and infrastructure and education of the public and of decision makers on the nature of transport-environment interactions and their implications.

Despite a divergence of views on several issues, following are the basic proposals of the transport group:

1. Caution should be practiced in adopting international experience in Israel in view of special conditions in this country, especially land scarcity.
2. A target level for private car ownership should be adopted.
3. Since land use patterns are strongly influenced by transportation infrastructure and services, physical planning should take into account transportation considerations and impacts. Land use planning is the main tool for attaining sustainable goals.
4. Planning in the transportation sector requires a long-term view which goes beyond the year 2020 to 2040 or more.
5. The institutions dealing with transport and the environment should be restructured in order to stimulate a change in the structure of the process.
6. Infrastructure which does not require user fees and taxes is a major impediment to the implementation of a sustainable development strategy. Economic measures such as congestion taxes and pollution fees should be instituted.
7. Land use patterns are strongly influenced by transportation infrastructure and services. Rail and roads should be used to effect efficient land use patterns.
8. Normative standards should be set for public transportation services.
9. Development of the road network should not be justified based on demand trends since this is inconsistent with sustainability.
10. Policies for curbing private car use should be implemented. Travel Demand Management (TDM) measures should be implemented immediately to attain improvement within 5 to 8 years.
11. The public should be made more aware of the consequences of "business as usual" behavior which will bring about environmental degradation and congestion.
12. The complexity of the system calls for the adoption of tools to study system dynamics.
13. Economic measures alone may not always be useful since people develop ways of circumventing the costs, and enforcement is not efficient.
14. Experience in the United States has demonstrated that significant reductions in emissions can be accomplished through technological improvements of cars.
15. Despite high investments in urban and commuter rail systems in the United States, little was accomplished in terms of changing modal choice of travelers and commuters. The personal benefits of the private car are very difficult to compete with.
16. A series of specific objectives defined in physical terms were suggested. For example, infrastructure should be planned so that minimum quantities of earthwork

would be caused per unit area of road surface. The objective should be to halve the current norms.

17. Use of public transport should be enhanced at the expense of private cars, but means to attain this objective have not yet been consolidated.
18. Policy packages which combine multiple efforts into a coordinated package should be developed in order to reduce conflicts between the different measures.

Examples of specific recommendations for policy measures according to time frames and geographical locations – urban areas, city centers, metropolitan areas, interurban/rural areas and countryside – include:

- parking restrictions and pricing mechanisms (fines, taxes) in the immediate term in order to reduce the number of vehicles entering the city;
- development of biking paths, restriction of through traffic speed, signal coordination and vehicle restricted zones within five years;
- development of clean, non-polluting buses within a decade;
- land use changes within a decade to two to improve accessibility; and
- development of zero emission vehicles within 20 to 25 years.

10.8. Sustainable Tourism Development

Israel has always been a popular destination for pilgrimage, sightseeing and touring based on its historical heritage, association with biblical and religious events, nature and scenic resources and comfortable climate, combined with modern infrastructure systems, easy access and high quality services. On the other hand, environmental threats from tourism include severe limitations in terms of land and space resources, damage from the construction of roads, pressures on the terrain, flora and fauna, damage to archaeological sites, visual pollution, congestion, and activities which may diminish the value and image of tourist sites.

Sustainable development of tourism in Israel should seek to assure the development and advancement of the tourist sector while conserving tourist resources such as landscape, nature and the built heritage, both as cultural and social values and as economic assets.

10.8.1. Work Tools for Sustainable Tourism

The work tools for achieving sustainable tourist development include planning quotas (a quantitative index which expresses the desired ration between the size of the population and open spaces in different radiuses); capacity quotas (a quantitative assessment of the tourist supply in a given area); carrying capacity (a qualitative assessment of the daily maximum number of visitors per area unit, which would not have a detrimental impact on the unique features of the site), and bottlenecks (external or local limits which specifically reduce the potential capacity of the site or tourist and region and which are subject to change).

10.8.2. Guidelines for Action

The following guidelines for action toward sustainable paths are proposed:

Metropolitan tourism: Urban tourism relies on a small number of sites and is largely concentrated in metropolitan areas. Due to the sensitivity of land, nature and landscape

resources in Israel, incoming tourism should be directed toward metropolitan tourism, and natural resources should be left for domestic tourism.

Historical heritage sites: Israel has an abundance of monuments and sites which have been declared conservation sites. These should be combined with the tourism experience, as hotels or tourism sites, both in order to add another dimension to tourism and to contribute to their protection. It is proposed that heritage sites throughout the country should be declared high priority tourist areas, eligible for assistance, support, grants, and professional guidance in becoming tourist enterprises.

Beaches: The National Masterplan for the Mediterranean Coast maintains that the main use of the seashore should be for tourist and recreational purposes, and that any use which is not directly connected to the shore, should be physically removed from it (see section on existing policies and tools in the chapter on Integrated Coastal Zone Management). Today rapid development of tourist projects, resort villages and holiday apartments, some of which are mere “real estate” transactions under the guise of tourism, threaten to turn the coastal area into a long stretch of built-up area which will lead to the disappearance of one of the country’s main tourist resources (see section on loss of areas for tourism, recreation and public access in the chapter on Integrated Coastal Zone Management).

Increasing the carrying capacity of recreational areas: Existing recreational areas, nature reserves, national parks and forests, especially in the heart of the country, should be protected, and loss of open space from the existing inventory of green and open space should be prevented. Visitor capacity should be increased in specific centers and sites capable of accepting intensive recreation activities in order to alleviate visitor pressure on sensitive areas and to increase regional carrying capacity.

Regulating the nature and capacity of rural tourism: Rural tourism has been the tourism success story of the last decade, but its growing popularity threatens its very underpinnings – quiet and serenity amidst natural surroundings. Limits must be imposed on the scope of this type of tourism to ensure that its special features are maintained. This may, for example, call for determining a ratio between tourist accommodation and size of the local population in order to maintain an atmosphere of “hospitality” where guests assimilate with hosts rather than outnumbering them.

The following activities would promote sustainable tourism:

Information and awareness: Sustainable development is a long-range commitment based on an integrated and multi-generational vision. The first step in any such long-term effort is to instill the concept of sustainable development, bring about a change of attitudes, and deepen awareness among planners who create, conceive and realize tourist projects, the public at large which motivates and influences processes and attitudes, and decision makers who in the final analysis determine planning policy on the location and distribution of projects.

Transportation systems: Growing private vehicle demand in Israel carries with it growing demands for additional roads, interchanges and parking facilities. It is important to investigate alternatives to meet transportation needs which will not necessarily increase demands for these infrastructures. Proposals relate to an integration between private and public transportation. Visitors in private cars should be able to reach convenient transfer points, from where they can travel by mass transportation to main points of attraction.

Open spaces: New tourist areas and projects should be established near existing built-up areas and should not be established in open space areas. This is particularly pertinent

in view of the demand for tourism in attractive areas: open beaches, forests, nature reserves, and wide open spaces.

Interministerial cooperation: Common interests between the Ministries of Tourism and Environment has become increasingly evident since tourism requires a qualitative environment, on the one hand, and serves an important function in preserving environmental quality, on the other hand. The integration of tourism and environment is of prime importance in protecting sensitive complexes and achieving sustainable development.

10.8.3. Strategic Principles for Sustainable Tourism Development

- Sustainable development of tourism will first and foremost aspire to steer the existing demand for Israel's historical-heritage values to centers which are not environmentally sensitive (i.e., historical, religious and archaeological sites located in cities, national parks or archaeological spots). Tourism will continue to concentrate on site visits, excursions and pilgrimages.
- Tourism to Israel will be urban in character and will be concentrated in organized sites and routes designated for this purpose. Exceptions for recreational or environmental tourism will only be made in order to diversify the vacation package and will be targeted at relatively limited market sectors.
- Sustainable development of tourism will not encourage the development of "purely" recreational tourism which requires large scenic expanses and surrounding resources, such as tourist development in vacation and resort towns along beaches (except for certain centers along the Dead Sea and Red Sea).
- There is literally no room in Israel for the development of "mass tourism" that requires few services but uses and overloads the main infrastructure system. Tourist planning and promotion will aim at relatively high value market segments.
- The conservation of scenic and landscape resources, beaches, parks and nature areas will be granted top priority for the benefit and well being of the local population. Natural and beach resources may be used for creating tourism packages which combine site visits and excursions with recreational tourism.

10.9. Sustainable Urban Development

Since the major problems in Israel have been identified as growing land and water scarcity and environmental problems in the urban sector, the study has two main objectives: resource conservation and environmental protection. The first includes such elements as conservation of land, water, raw materials, and energy from non-renewable sources. The second includes such elements as prevention of air pollution, unacceptable noise, pollution of water sources, safety, protection of micro-climate, treatment of waste, prevention of soil contamination and improvement of urban landscape.

10.9.1. Efficient Land Use

Efficient use of land, which is significant throughout the world, is even more critical in Israel due to the increasing land shortage relative to the current and projected rate of development. Higher housing density, reuse of existing built-up areas, joint infrastructures, efficient land use for public areas and buildings, mixed land uses, utilization of underground space, utilization of marine space, utilization of desert areas by means of appropriate technologies, utilization of megastructures, and

rehabilitation/reuse of areas for alternative uses – all are critical issues in a country characterized by scarce land resources.

Particular attention is paid to efficient land use in terms of higher housing density. Both advantages and disadvantages are associated with high housing density, but it is possible to plan and act in such a way as to increase advantages and decrease disadvantages. This may be achieved through the following actions:

1. Provide a variety of services, employment and living quarters in a location and quantity befitting the population.
2. Significantly improve public transportation.
3. Provide sufficient amenities and resources: sewerage, power, communication, sidewalks, parking spaces, playgrounds, open spaces, benches, etc.
4. Match the apparent density to the neighborhood, avoid creating an overload of stimuli of all kinds: visual, acoustic, odors, people, etc.
5. Prevent breaches of privacy in apartments from outside and maintain light and air rights within.
6. Clearly delineate the territorial boundaries: the outside, private space, common and public areas, among others, in order to provide a clear division of maintenance and responsibilities.
7. Increase the readiness of the public to participate in recycling efforts and other environmental activities.

10.9.2. Water Conservation

The goal of water conservation in the urban sector may be achieved by more efficient water use, recycling, and groundwater conservation. Urban planning which is water sensitive is intended to minimize or stop risks by increasing the quantity of rainwater penetrating the ground, some for irrigating green areas, but most for replenishing the aquifer, reducing surface runoff and diminishing pollution by urban surface runoff which penetrates into the ground. A special Technion – Israel Institute of Technology team reviewed the topic and drafted recommendations on the following:

- *effects of urban construction on the groundwater of a phreatic aquifer in order to identify the damage caused by urban settlement along the coastal plain to water sources;*
- *creation of databases needed for water-sensitive urban planning. Such planning should include useful and efficient means for minimizing damage by issuing planning guidelines and recommending engineering facilities which may be integrated into the urban landscape in order to reduce surface runoff and urban runoff pollution.*

10.9.3. Conservation of Raw Materials

Conservation of raw materials is achieved through efficient use of non-renewable materials, use of alternative materials, utilization of waste materials for building and development (e.g., coal ash) and development of building methods according to conservation principles.

10.9.4. Energy Conservation

Energy conservation may be achieved through “green building”, promotion of energy-efficient public or other transportation and planning of a municipal system which

reduces travel. Environmentally sound and resource efficient guidelines for both house and neighborhood have already been prepared. Environmentally responsible building promotes energy efficiency by calculating the life cycle cost of the building envelope and its mechanical systems, maximizing sustainable utilization of natural resources, utilizing recycled and recyclable materials, and incorporating healthy interior environments through enhanced natural lighting and ventilation and avoidance of toxic products in interior furnishings. In addition, it requires economic and ecological evaluation of construction alternatives including factors which do not currently count as “costs”, such as resource depletion or energy expenditure on mining, transportation and production of materials.

In green construction, attention must be paid to all phases of a project and to all its components – use of energy, interior environment, daylight, noise control, choice of materials, water management, operation and maintenance of the building, and effects on the surroundings and on the environment generally.

10.9.5. Environmental Protection

Protection of the environment in the urban sector includes several elements – from prevention of air pollution to prevention of soil contamination. As an example, sustainable development of the urban environment should not only enable work, recreation and business activity, but also let residents sleep, think, rest and study in relative quiet. This will reduce the need for dormitory suburbs and stop thousands from commuting back and forth daily with their cars. Means to achieve noise reduction include acoustic construction, reduction in urban traffic and quieter public transportation, and separation of noisy industrial zones and commercial and recreation centers from residential areas. Similarly, measures exist for the prevention of water, air and soil pollution and for waste treatment.

Cities throughout the world generate specific climatic conditions, mainly characterized by the phenomenon of the so-called “urban heat island”. This leads to higher urban temperatures than in surrounding open areas. Moreover, high density urban construction leads to high rise building which creates environmental damage by affecting the wind regime and the sunlight rights of city residents. Suitable climate coordinated planning and energy-thrifty construction measures must therefore be undertaken to minimize the adverse effects of these processes on climatic quality and comfort. To carry out sustainable urban planning and construction as cities grow and become more crowded, the following principles should be implemented: change of the traditional skyline; urban planning adapted to local climate; widening shaded areas and afforestation of urban space; utilization of urban underground space; and reduction of conventional energy use in all urban activities, mainly for cooling and heating, and by means of climate coordinated construction.

Climatic restoration may be achieved by a wide variety of ways – from massive planting of trees along sidewalks, public open spaces, and open spaces of public buildings, to creation of large shaded areas, to painting houses and roofs in light colors and improving insulation and ventilation systems.

Urban landscape may be enhanced through careful building and infrastructure maintenance, attractive signposting, underground electricity and communication lines, concealment of facilities on building roofs, integration of air conditioners and solar collectors, landscape treatment of public and private areas and along roads and parking areas.

10.9.6. Toward Sustainable Urban Development

Sustainable urban development may be achieved through planning, promotion and management. Planning tools include:

- integration of environmental considerations in planning briefs for specific projects initiated by government ministries;
- integration of environmental considerations in the planning guidelines issued by the Ministry of Housing;
- re-examination of public area programs and combined use of infrastructure corridors; and
- preparation of a shadow plan for underground space as part of the urban space plan.

In order to promote the introduction of sustainable urban development, a climate of economic viability should be created for developers by means of positive and/or negative incentives (subsidies, building right benefits, taxation and fines, as needed). Economic viability should be built into the project itself, independent of public subsidy, except in the case of public projects. Another important element is formation of highly aware public opinion which sets requirements for environmental quality in urban development, and exerts pressure on developers to respect such requirements.

The local authority also has a decisive role in environmental management and the promotion of sustainable development objectives because of its role in urban development and maintenance as well as its direct contact with voters. Adoption of the environmental management standard known as ISO 14000 is especially important in this regard.

10.10. Sustainable Agricultural Development

Sustainable agricultural development must take account of such critical issues as allocation of production factors in sustainable agriculture, sustainable use of water, risks to sustainable agriculture, and prudent use of pesticides in agriculture.

10.10.1. Allocation of Production Factors in Sustainable Agriculture

Agricultural planning from an environmental perspective must emphasize the sustainable use of non-renewable production factors which are in short supply in Israel: namely, water and soil. Water, as a production factor, will restrict agriculture and/or the composition of agricultural sectors if its price will rise. Extensive use of wastewater will have implications for future agricultural planning based on water quality rather than quantity. Land availability in the central region will be dependent on loss of agricultural land to development.

Agricultural land is not in short supply today. Some 700 km² of land allocated for agricultural use are not cultivated. However, it is envisioned that future pressures will require extensive areas to be converted from agricultural to urban use. The goal, therefore, is to minimize the land areas which will be transferred from agriculture to the urban sector and to maximize the area left for agriculture. The problem is especially acute in the center of the country and in the vicinity of major cities where the protection of orchards and field crops is an important means of safeguarding essential “green lungs” and preventing urban sprawl.

Freshwater is already in short supply today – both in terms of quality and quantity. Since Israel's freshwater potential will be targeted to the urban sector in the future, development of marginal water sources and wastewater will be essential in order to supply agricultural needs in the long term. The water reclamation forecast is 50-75% of the water supply to cities and industry (as opposed to less than 40% today). While wastewater can and should be used in agriculture throughout the country, wastewater quality must be adapted to each specific use. Precautions must be taken to assure a suitable quality of effluent in the highly sensitive central region of the country above the coastal aquifer in order to minimize potentially adverse effects on soil and groundwater. On a nationwide scale, about 200 million cubic meters of wastewater should be reclaimed by the year 2010.

The agricultural forecast for the year 2020 calls for maximum conservation of agriculture in the central region of the country, but it anticipates that land and water limitations will generate a shift from irrigated crops to dry farming and a process of transferring crops from the center to the periphery of the country.

The main conclusions drawn from the agricultural production forecast for the year 2020 are:

- increased efficiency in agricultural production will reduce the number of persons employed in agriculture;
- a downturn in the trade conditions in agriculture will lead to increased efficiency of remaining farmers and development of specialized products;
- a cut in the backing and support that agriculture has received will lead to a transition of the livestock branches from the center to the periphery of the country due to a reduction in the number of small units (moshav settlements) and their concentration into larger units;
- the raised awareness and sensitivity to environmental protection will encourage the development of “environmentally friendly” agriculture;
- the growing demand for “quality of life” will encourage the development of recreation activities based on open spaces and rural tourism;
- agricultural irrigation will have to be based on marginal water;
- there will be stiffer competition for lands between agriculture and urban development.

10.10.2. Sustainable Use of Water

In terms of the national water economy, the sustainable use of water may be defined as the long-term use of freshwater while conserving as far as possible the quantity and quality of water resources. In the agricultural sector, sustainable use of water will enable protection of soil and soil quality and conservation of land reserves. Ways should be found to optimally conserve water resources and to grade water qualities according to generally accepted quality indices. Preserving the quality of water resources will also allow for the integrated use of surface water and ground water for consumption and storage. Restoration of polluted water sources and renewal of water sources (desalination) are related to maximal conservation since they increase the water inventory and possibly improve its quality.

Conclusions and recommendations for sustainable use of water include:

- sustainable use of water would enable the physical conservation of land reserves and soil quality;

- water consumption and its composition will change according to the increase in population, increased consumption per capita, change in the spatial and urban distribution, change in the division between land use sectors (urban, industrial, agricultural, tourist, landscape, etc.);
- reliable water supply will call for desalination of an added 15-30 MCM a year and multi-annual storage;
- multi-annual storage is feasible only in the coastal aquifer, and therefore water quality in this aquifer must be conserved. Storage entails raising levels which, on the one hand, leads to a loss of water to the sea and a reduction in the overall water potential and, on the other hand, to an improvement in water quality;
- the percentage of wastewater within the entire water potential will rise. Most of the wastewater will be diverted for agricultural use. Out of close to 1 billion cubic meters of water allocated for agricultural use a year, wastewater will comprise about 600 MCM. The quality of the water may be problematic;
- the use of wastewater will require a long-term regional organization for suitable utilization of the water, optimal above-ground storage and conservative use to prevent an increase in salination and pollution levels.

Conservative use calls for:

- improved quality of water supplied to the city in wastewater irrigation regions (mainly in the region overlying the coastal aquifer);
- improved agrotechniques which will lead to a reduction in runoff quantities, reduction in leakage of pollutants, and maximum detention of the movement of brines in the unsaturated zone;
- allocation of resources for investigating the possibility that pesticide seepage to groundwater and wastewater will accelerate the movement of pollutants;
- shifting pollution generating agriculture, such as dairy farms, to less pollution sensitive regions;
- control and monitoring of the flow of pollutants to groundwater. A mechanism should be created for identifying polluters of soil and water and penalizing them. Monitoring and control may also include underground sampling and reports on inputs of water, fertilizer, manure and yields.

10.10.3. Hazards for Sustainable Development

Irrigation, cultivation, fertilization, pest control and disposal of agricultural waste may adversely impact the environment.

The environmental risks of irrigation include the addition of salts to soils and potential salinization of aquifers, and are largely dependent on the features of the soil and the hydrology of the region. Sustainable agriculture requires measures for making irrigation more efficient and utilizing rainwater to complete the rinsing of salts.

Increased irrigation by effluents in future years carries additional dangers because effluents include a higher concentration of salts, toxic substances, organic substances, fuels, soaps and detergents, and heavy metals originating in industry as well as a higher SAR ratio. Many of the adverse impacts may be averted by prohibiting the discharge of industrial effluents and brines, preventing use of detergents containing boron, reducing

the organic load of effluents, adapting effluent irrigation to different types of crops, and drafting and enforcing regulations on effluent quality and use.

Irrigation by saline water is known to damage soil structure and consequently to reduce yields. Thus, irrigation by saline water should be restricted to areas where no risk of aquifer salinization exists and to salt-tolerant crops.

Storage reservoirs for drainage water and effluents present yet another hazard since stored waters may permeate to the environment causing salinization. Effluent storage has also been associated with odor and potential permeation of pollutants and pathogens to groundwater.

With regard to fertilization, environment-friendly methods, soil and plant monitoring and farmer education are advocated to assure appropriate doses and prevent soil and aquifer pollution. Intensive research and development are necessary to develop methods for optimizing the quantity and timing of fertilization for each crop in each region.

Sustainable agriculture requires attention to tillage and effluent practices which may affect the fate of pesticides in the soil. It also requires a national monitoring system for pesticides in all types of water including surface water, ground water and natural and artificial drainage water from agricultural lands.

Pesticide application poses yet another risk to groundwater. At present, there are insufficient data on the impacts of pesticide use on water quality in the region overlying the coastal aquifer. In the short term, resources should be allocated to research and legislation in areas where damage can be minimized. In all cases, farmers should reduce pesticide quantities and develop biological control methods which are environment-friendly.

Disposal of ever-growing quantities of sewage biosolids poses a serious environmental problem which may be solved through land application in agriculture. However, sludge application to soil should be according to locally relevant risk factors and must include consideration of sludge, soil and aquifer properties and of crop behavior. For example, on top of an aquifer, the main risk is from possible leaching of nitrates and soluble organic matter into the groundwater. In the absence of an aquifer, possible risks are from ammonia toxicity and from buildup in the soil of excess nutrients, especially phosphorus, and from heavy metal accumulation.

Wastewater and sludge utilization in agriculture should be based on potential risks to humans, soil, crops and water sources. An approach is recommended that takes into account sludge properties and irrigation water quality in combination with geographical-pedological conditions. This approach advocates combined use of wastewater and sludge in the region where they are generated along with their transport to regions where they are needed on a year round basis and adjustment of treatment levels to designated use.

Composting is viewed as a viable and important means of stabilizing and transforming solid organic wastes into safe and beneficial inputs in agriculture, horticulture and forestry. Composting reduces the weight and volume of the byproduct while abating odors, destroying pathogens, eliminating undesirable chemical and physical properties and converting nutrients to forms that are more available to plants. Biosolids, animal manures and selected municipal solid waste composts can be used as biofertilizers and soil conditioners. Pathogen destruction and organic matter stabilization can also be achieved by the high pH and heat produced by blending industrial alkaline byproducts, such as cement kiln dust or coal combustion ash, with biosolids. The prediction is that Israeli agriculture can assimilate the entire potential quantity of composted materials.

10.10.4. Pesticides in Sustainable Agriculture

The use of approved pesticides while reducing potential environmental damages raises the following subjects:

- technology: improved equipment, new technologies and treatment of residues;
- guidelines for pesticide application and treatment and updating of the existing list of pesticides in relation to presence in wells and water sources;
- new substances: registration and cancellation, uniform testing methods, alternative methods;
- supervision and control;
- licensing, education, and concentration of pest control; and
- risk assessment of the impact of pesticides on water bodies.

Application technologies, soil disinfection, controlled release, problem soils, residues, seed disinfection, and reuse of runoff from greenhouses are all important issues in the effort to reduce damages from pesticide application in agriculture. Management techniques for pesticide application should be developed and a database is needed on climate, soil, crop history, and focal points of damage in order to allow for path application of pesticides and predict the spread of pests in different areas. Automated follow up of crop and aerial spraying should also be implemented.

11. Evaluation and Integration of CAMP Results

11.1. Introduction

When considering CAMP Israel as a whole, it is clear that the major activities contributed to furthering coastal area management and sustainable development at the national governmental level of decision making. Activities are currently needed to promote further public involvement in coastal area management and to advance better coastal area management at the local authority level, particularly along urban coastlines.

Over the three years of CAMP activity, several changes in coastal policy have occurred and, without doubt, some are attributable to the new directions indicated by the CAMP activities. Some activities helped herald new policies and approaches. Others had more specific or localized impacts. The contribution of still others will only be more accurately evaluated in the future following further clarification and implementation.

Following are the salient results of the different activities:

- The new attitude among policy makers to coastal sand management and to the management of cliff retreat was significantly influenced by the translation of scientific oceanographic and geological studies to practical management guidelines.
- Sustainable development became a locally accepted practical approach instead of just an internationally known term.
- RESSAC established a new basis for information management but the actual ongoing results will only be seen as the Ministry of Environment produces land use change maps and demonstrates likely impacts of future urbanization using the new techniques and models.
- The climate change activity was not sufficient to indicate whether this should be considered a major issue. The coastal sand study by Israel Oceanographic and Limnological Research recommended further study of possible impacts of global climate change on Israel's coastal area, such as possible infiltration of seawater into the coastal aquifer.
- The Kishon "hotspot" study was useful for the local program of reducing industrial effluents.
- The economic study raised questions which require further study and consideration in the future.

These and other results are further elaborated below.

11.2. Integrated Coastal Zone Management

The results of Israel's integrated coastal zone management review have been applied to each and every one of the activities carried out within the framework of CAMP. Existing practices and policies are currently being reviewed by different forums and new policies and institutions are being examined. One of the most recent initiatives is a proposal for a coastal environment protection law.

At present, a private member's bill on coastal conservation is being discussed by a parliamentary committee along with a draft law, prepared by the Ministry of the Environment. Both laws were born of the realization that current coastal zone management practices are inadequate in protecting the coastline from the dangers of uncontrolled development. Based on coastal protection laws in other countries, notably Spain and the European Community, and based on the growing recognition that new instruments for coastal management are required to assure sustainable sand management and public access, for example, a coastal conservation law was drafted by both the Ministry of the Environment and the Israel Union for Environmental Defense, a non-governmental body. The broad base of public support for the issue should accelerate the enactment of the bill in the near future.

Moreover the heightened awareness of coastal management issues has been reflected in the media, in public protest, and in numerous court decisions against coastal development plans which violate environmental laws and masterplans. In a recent landmark decision, for example, the Tel Aviv District Court ruled that owners of apartments in the Herzliya Marina project will be required to rent them to the general public for at least part of the year. The judge accepted the contention that the apartment units were misleadingly labeled "holiday apartments" for the sole reason of justifying their coastline location. He therefore ruled that since the building permits for the project were issued for "holiday apartments", they must be accessible to the general public through rental.

11.3. Management of Coastal Sand Resources

Until recently, coastal sand resources were regarded as a free public good. The only restriction imposed on their use was the prohibition of quarrying coastal sand for building purposes. It is now becoming increasingly clear that a management policy is required for defining property rights of the coastal sand resources, responsibility for their maintenance for public purposes and responsibility for damages. Consideration needs to be given to the institutional structure needed for the management of coastal sand resources and the economic measures necessary to ensure their conservation and maintenance.

The CAMP activity on sand resources has highlighted several urgent issues that need to be addressed in future discussions on sand resource management in Israel. An issue of central importance is interference with the natural longshore drift. Coastal structures are known to create accumulations of coastal sand resources on the upshore side and loss of sand supply on the downshore side. A new approach to coastal sand management is necessary which ensures sand supply to waterlines while maintaining beaches and preventing coastal erosion.

Another issue that needs to be clarified is the definition of building rights along the coastal area. The statutory coastal masterplan prohibits building within 100 m of the waterline. However, there is no clear definition of the waterline nor any directive on whether the prohibition relates to a specific date nor whether it is variable according to seasonal changes or as a result of sand accumulation or loss of beach width. The result is that developers may claim additional building rights where sand has accumulated. This may result in claims for compensation for loss of building rights in cases where the waterline has retreated.

Future issues on sand property rights may arise over proposals to use sand from offshore sources for fill material for offshore islands. There is no current management

policy which clarifies whether coastal sand resources can be used for such purposes or whether other public purposes, such as beach nourishment, should take preference.

Although the Israel Lands Authority is the official manager of public lands including the shoreline, it has not shown any interest in the management of coastal sand resources. In fact, it has frequently partnered with local authorities and private developers in projects which have caused significant damage to coastal sand resources. Local authorities along the coastlines also do not represent the public interest in protecting coastal sand resources since they too have caused damage and have not taken steps to repair the damage or claim compensation for the damage. Moreover, individual local authorities are only concerned with the shoreline within their jurisdiction and do not consider the impacts of remedial measures on the shore of neighboring authorities.

At a recent meeting held to discuss the results of the CAMP activity, attended by representatives of government ministries and environmental NGOs, it was concluded that a national policy for sand management was required. The Director General of the Ministry of the Environment will approach the Directors General of the Infrastructures and Interior Ministries and of the Israel Lands Authority to discuss what legal and institutional measures are needed, and whether the responsibilities of the Marine Pollution Prevention Fund could be broadened to include sand management.

The compilation of scientific information on management of sand resources, on coastal sand movement, and on the natural and anthropomorphic processes affecting its accumulation and loss along the shore provides a solid basis on which deliberations concerning the management of coastal sand resources can take place.

In addition, the Territorial Waters Committee has recognized the impacts of offshore structures on sand dynamics. Accordingly, its recently completed Coastal Waters Policy Document sets a clear policy on marinas and offshore structures. Today, plans for offshore structures and breakwaters are no longer approved. One recent case has seen a refusal to approve additional breakwaters in Herzliya as proposed by the municipality. Discussions are now ongoing between the Ports Authority and the municipality of Herzliya on the possibility of using dredged sand from the entrance channel to Ashdod Port for beach nourishment. If this will not be possible, the dredged sand will be deposited at a depth of 25 m offshore where it can be regained in the future for sand nourishment.

On a practical level, the documentation and presentation of scientific information on the dynamics of sand movement in a systematic and analytical manner has influenced decision makers. The Ports Authority has recognized the principle of bypassing and will apply it in the case of Ashdod Port. This will be the first example of coastal sand management where the Ports Authority has been required to take action to bypass the trapped sand around the marine structure due to be extended. All previous decisions on marine structures related to preventing coastal erosion but did not require bypassing of the trapped sand.

The principles of sound sand management have also been incorporated into two coastal protection bills which are now being discussed by the Israel Parliament (see section on the coastal conservation law in the chapter titled Integrated Coastal Area Management).

11.4. Risk of Cliff Instability

The report generated within the CAMP activity on cliff instability provided essential information on the stability, dynamics, risks and environmental management of the

Sharon Escarpment in the central coastal plain. A most important conclusion of the report is that cliff retreat is a natural and dynamic process, and that the frequency of rockfalls, averaged over several years and along the entire length of the escarpment, is uniform and independent of cliff height or differential rock properties.

Yet another finding which emerged both from this report and from the sand resource report is that coastal cliff erosion is a major contributor to the sand budget. In fact, based on estimates of cliff retreat at a rate of some 20 cm/year, it has been estimated that the annual sand input from cliff erosion may reach as much as 200,000 m³.

While the findings of the report added significant data to the body of scientific information on cliff instability and retreat, several of the recommendations put forward in the report require further investigation and evaluation in terms of their environmental and planning aspects.

On a practical level, the issues of cliff instability have been raised in recent discussions of the National Planning and Building Board. In one case, a request for building permits on the Bet Yanai cliff top was refused on the grounds that no clear cliff management policy had been presented in the impact assessment.

11.5. Implications of Climate Change

As is the case for each of the subjects examined within the framework of CAMP, the climate change study served to increase the body of scientific knowledge on climate patterns and to raise the issue for public discussion. While the present study does not predict significant changes as a result of regional or global climate change, it should be noted that other studies have maintained that such changes are anticipated. Therefore, it is important to continue the investigation of likely impacts of climate change in this region.

This issue was also raised within the context of the sand resources report in relation to sea level rise. It is expected that the forecasted sea-level rise will further deteriorate beach conditions and increase cliff erosion. Therefore, the locations of cliffs sited in coastal sectors which are critically sensitive to sea-level rise should be determined by sedimentological studies, and preventative means for the future should be identified.

While one study day on the subject has already been held in the framework of academia, it is essential to raise the subject for discussion at the level of government and to assess the implications of climate change in a multidisciplinary context in terms of how such change may impact on different sectors. Issues that should be raised for discussion include management of the seashore, penetration of seawater into the coastal aquifer and management of floodwater.

11.6. Identification of Main Sources of Pollution of the Kishon River

One of the primary aims of the survey on land-based sources of pollution into the Mediterranean Sea via the Kishon River was to serve as a basis for permits which will be given to the industries which discharge wastewater directly or indirectly into the sea. The severity of the problem has led to a joint initiative by the Ministry of the Environment, the Kishon River Authority and the Haifa District. In an all-out effort to clean this severely polluted river and to stop the indirect discharge of pollutants into the Mediterranean Sea, the major industrial polluters have been targeted for vigorous enforcement. As of 1998, the plants and the wastewater treatment plant are required to

abide by both the Water Law and the Prevention of Sea Pollution by Land-Based Sources Law. They must apply for permits to discharge their wastes indirectly to the sea and to fully comply with the conditions of the permit. These include stringent conditions and strict timetables for waste treatment to the level of best available technology. Effluents will be treated to the level of brines which may then be safely discharged to sea, bringing about a full stop to the discharge of industrial and municipal effluents to the river and the sea. As per the action plan for the Kishon River, complete cessation of effluent discharge into the Kishon is slated for 2004. All of the plants are currently upgrading their treatment systems, and significant improvements are expected by mid-2001. The project is in line with the shift in approach embodied in the Barcelona Convention which prohibits indirect marine pollution through intercoastal waterways.

In yet another development, a pilot project was launched to install sensors on pipelines which discharge effluents to the sea. The sensors will relay on-line information on everything spewed into the sea from land-based sources to a computerized control system in the offices of the Marine and Coastal Division of the Ministry of the Environment in Haifa. In case of violation, an automatic alert will be transferred both to marine inspectors and to the plants themselves. The anticipated result will be a computerized system with comprehensive data on the entire coastline able to provide real-time supervision of each individual plant which discharges waste to the sea within the framework of a permit.

Alongside these national efforts, Israel is actively participating in the Strategic Action Programme for reducing and eliminating land-based sources of pollution. Within this framework, it has submitted a national survey on municipal and industrial discharges to the sea and has identified priority pollution "hot spots" and sensitive areas in its Mediterranean coastline, including Haifa Bay. Israel is now preparing a detailed plan with timetables for reducing or preventing the pollution discharged from these sources.

11.7. Remote Sensing Support for Analysis of Coasts

The close work of all the partners in RESSAC with the Planning Department of the Environment Ministry provided the latter with important insights into the applicability of remote sensing to sound planning.

The main results on Earth Observation data analysis reflect both successes and shortcomings in the use of remote sensing applications. Thus, besides confirming the usefulness of remote sensing data to a number of purposes, RESSAC paved the way to future developments regarding monitoring of total suspended matter, evaluation of coastal and offshore wind and sea state, monitoring of coastal erosion, etc. The main results may be summarized as follows:

- Analysis of total suspended matter distribution along the coasts by means of either low-spatial resolution sensors and high/medium spatial ones demonstrated the complementarity of these tools for monitoring at mesoscale and at local scale. Monitoring activities using new sensors are recommended to study spatial and temporal distribution of total suspended matter along the coasts which are characterized by low river discharges and to better characterize the influence of the Nile River on this coastal area.
- The implementation of offshore and coastal wind and sea state databases over a seven-year period based on data acquired by microwave satellites and processed through suitable models allowed the setting-up of a complete database as well as a

statistical analysis of the sea state in two specific areas. A comparison of these coastal databases with *in situ* data showed good comparability for significant height and period of the waves, but further efforts have to be made to make wave direction derived by satellite more reliable. The reliability of SAR imagery for measuring sea state parameters and wind vectors was also demonstrated. Longshore sand transport rate was also calculated relying on the sea state coastal database.

- The assessment of sea bed topography, using optical and microwave sensors demonstrated the applicability to a certain extent of the approach followed in the Mediterranean coastal area, while sand granulometry distribution and carbonate content assessment highlighted the need of further analyzing the operational use of such a methodology for sand investigations.
- The observed coastline changes in a seven-year period based on the analysis of SPOT panchromatic images are rather limited (taking into account the satellite geometrical resolution of 10 m) and mainly due to the presence of anthropic structures. This analysis may serve as a first step towards permanent monitoring of the coastline transformation using other platforms which are equipped with more suitable sensors.
- The analysis of land-use changes over a ten-year period based on Landsat TM processing showed and quantified how much the main land use changes are dependent on urban and industrial growth around the major cities. It is important to perform regular monitoring relying on Landsat TM but also on other sensors with geometrical resolution more suitable for analyzing urban growth.

Based on the results of the latter, the Ministry of the Environment has been convinced of the cost-effectiveness of the land-use change detection method. It expects to begin to implement this method on a national level in the near future. This will serve as an annual data source which will support decision making on both national and regional levels.

11.8. Social and Economic Evaluation of the Mediterranean Coast

The social and economic evaluation of the Mediterranean coast is a pioneering study which requires follow up and expansion. Some of its conclusions should be treated with caution, especially those relating to willingness to pay for coastal conservation versus the economic value of the seashore for property development. Means should be found to refine the quantification of environmental values and to promote understanding of how to translate environmental and values into economic terms.

In recent years, there has been growing recognition, both by government and by the public, of the importance of economic tools to promote environmental quality. Other studies which are being carried out at present, namely on the economic evaluation of air pollution and noise impacts, reinforce the importance of internalizing environmental externalities into the cost/benefit evaluations of policies, projects and programs.

11.9. Sustainable Development Strategy

Indubitably, CAMP provided the impetus for promoting discussions on sustainable development. It provided the spark which was necessary and essential to initiate the subject by showing its relevance to Israel. By harnessing local experts and locally

involved stakeholders, the concept was made relevant to Israel and allowed it to become part of the global move toward sustainable development.

Although the proposed strategy requires further refinements and completions, its positive impacts are already felt. Each stakeholder in the discussions was not only enriched by the process, but has taken steps to disseminate the information further. Several participants in the round-table discussions of each sector have continued to raise the subject in other ministries, non-governmental organizations, academic circles and public bodies.

Today, sustainable development in Israel is more than a “buzzword”. Although full consensus on all issues in all sectors was not reached, practical issues were put on the table and some of the results are already being implemented by the Ministry of the Environment and by other bodies.

The National Planning and Building Board, Israel’s top planning authority, has incorporated sustainable development principles in many of its goals and targets. Of foremost importance is the integration of sustainable development principles into the newest masterplan, the Integrated National Masterplan for Building, Development and Conservation (NOS 35) which is currently nearing approval. This comprehensive plan integrates several subjects which were previously addressed within the framework of sectorial masterplans. Most importantly, sustainable development principles are integrated throughout the plan, especially with reference to protection of open space. In fact, of the thirteen proposed goals of the plan, a clear majority relate to the principles of sustainable development, as follows:

- Minimization of damage to open space areas and preservation of future land reserves through efficient land use.
- Improvement of urban quality of life through regulations on urban renewal plans, improvement and reuse of built up areas and preservation of cultural assets.
- Municipal cooperation and assurance of accessibility to employment centers through public transport.
- Promotion of agriculture and preservation of rural character through regulations on the expansion of rural communities and prevention of non-agricultural uses in agricultural land.
- Minimization of environmental problems and damages through regulations on environmental protection and infrastructures and through integration of sustainable development principles in planning and implementation processes.
- Protection of nature, landscape and land reserves for future generations through regulations for areas of high landscape sensitivity, water resources, landscape complexes and strips, and coastal and river strips, and through integration of landscape-environmental considerations in the planning process.
- Assurance of maximum public access to the seashore.

The Territorial Waters Committee, the national level statutory committee responsible for approval of offshore and coastal structures has also incorporated sustainable development principles in its recently approved Coastal Policy Document (see Coastal Waters Policy Document in the chapter titled Integrated Coastal Area Zone Management).

Another important development is the adoption of several of the recommendations of the urban sector target group by the Ministry of Housing. In cooperation with the

Heschel Center for Environmental Learning and Leadership, the Housing Ministry has organized study days for architects, planners, builders and contractors on such subjects as green building, planning policy and water conservation, sustainable transport and social justice in the urban environment. As a result, the physical planning profession has adopted sustainable development as its own agenda and has promoted it in its own policy documents.

12. Follow-up Activities

Follow up activities have already been generated based on the CAMP activities themselves. Some subjects will be discussed in terms of future organizational responsibility, others in terms of greater public awareness and participation, still others in terms of the need for further investigation and study.

Over the past couple of years, several documents have been produced and distributed by both governmental, non-governmental and educational and research organizations on such issues as principles of sustainable development of urban shores, conservation of coastal open space and planning of marinas. In parallel, several organizations, foremost among which are the Society for the Protection of Nature in Israel, the Israel Union for Environmental Defense, the Heschel Center, the Jerusalem Institute for Israel Studies and the Van Leer Institute, are investing major efforts in instilling the environmental ethic into specific professional groups and individuals, by such means as study days, lectures and written material.

Plans are now being advanced to publish and distribute several of the documents produced within the framework of CAMP as a means of further increasing the awareness of the general public and of professionals in different fields. The Management of Israeli Coastal Sand Resources document and the Integrated Coastal Zone Management Document are slated for publication in the near future. The document on the Social and Environmental Evaluation of the Mediterranean Coast will be further elaborated through discussions among stakeholders and will then be published in Hebrew. The RESSAC document has already been published and distributed by the Centro di Telerilevanmento Mediterraneo (CTM), the Regional Activity Centre for Environment Remote Sensing (ERS/RAC) of the MAP/UNEP.

Within the framework of CAMP, in general, and the process of formulating a sustainable development strategy, in particular, stakeholders have become increasingly aware of the importance of learning both from general international experience and from the experiences of individual countries, especially The Netherlands. This country, which is similar to Israel in terms of size and high development pressures, has implemented the consensus building approach to sustainable development. To help further this approach, not only within the framework of sustainable development but in a wider context, seminars on Dutch and American models of consensus building and conflict resolution have been organized and others are being planned. In 1999, a special workshop on conflict management and resolution was held in Israel with the participation of world experts. Specific case studies in several environmental areas of conflict were presented for discussion, including coastal planning.

Since sustainable development cannot be implemented at one level by one body, it is essential to coordinate between different forums and levels and to continuously update objectives and targets. Therefore, the sustainable development strategy should be backed up by a system of control and revision which will be targeted at a wide audience. The follow-up system should have five targets:

1. To update itself on research, deliberations and initiatives worldwide and in Israel.
2. To update different bodies and institutions on these developments through information transfer.

3. To follow up and identify challenges on the basis of indicators in order to propose revisions.
4. To coordinate between activities within Israel and regional and international approaches and views and between national and local initiatives. New institutions or changes to existing institutions may be required in order to respond to this cross-boundary vision.
5. To propose amendments and revisions based on future views of the public and of decision makers.

A two-part institutional system is suggested. The first could be a professional public council on sustainable development, composed of relevant government bodies and representatives of public organizations and academia; the second could be an institute for environmental-social-economic research which would serve as a coordinator for environmental policy. The ultimate aim is to instill responsibility for implementation of the strategy in the greatest number of bodies.

It is anticipated that the sustainable development strategy which was developed within the framework of CAMP will be presented to the directors general of all government ministries in order to familiarize them with the concept and encourage them to integrate this approach into their own sector. While the sustainable development strategy is not expected to become a statutory document, it is expected to point the way to new paths and a new approach which takes account of causes, not just effects. The immediate goal is to help bring about a change in thinking and orientation on the part of all relevant bodies and complement regulatory approaches with conflict resolution and consensus building approaches, in terms of both content and process.

The real challenge for the immediate future will be to introduce the concepts of sustainable development to local government, the only sector that was not actively represented in formulating the sustainable development strategy, partly because of lack of interest and partly because of inadequate partnership and collaboration between central and local government. Today, as decentralization trends become more dominant worldwide and conflicts between local and central government are lessening, ways must be found to harness local government to adopt more environmental approaches. Alongside central government, local authorities must translate the principles of sustainable development into the local scene, in line with Local Agenda 21. The integration of these principles into the processes and activities of the local authority will be a key element in the introduction of sustainable development to Israel as a whole.

Appendix

A. List of Project Documents in CAMP Israel

- Arlozorov, Saul: *Present Problems and Future Goals in Water Management*, 1999
- Avnimelech, Yoram: *Present Problems and Future Goals in Solid Waste Management*, The Technion, Israel Technological Institute, Haifa, 1999
- Brandt, Harry: *Sustainable Urban Sector Development*, 1999
- Dayan, Uri and Koch, Jean: *Implications of Climate Change on the Coastal Region of Israel*, Jerusalem, 1999
- Fein, Pinchas: *Sustainable Agricultural Development*, 1999
- Feitelson, Eran: *Proposal for a Sustainable Development Strategy for Israel*, Hebrew University, 1999
- Gabbay, Shoshana: *Coastal Zone Management in Israel*, Ministry of the Environment, Jerusalem, 1999
- Goldshmidt, Yehuda: *Sustainable Development in Industry*, 1999
- Golik Abraham and Rosen, Dov S.: *Management of the Israeli Coastal Sand Resources*, Israel Oceanographic and Limnological Research, Haifa, 1999
- Hasson, Shlomo: *Background Document on Social Aspects of Sustainable Development*, 1999
- Kaplan, Moti: *Sustainable Tourism Development*, 1999
- Luria, Menahem: *Present Problems and Future Goals in Air Quality Management*, Hebrew University of Jerusalem, 1999
- Marinov, Uri: *Sustainable Development in Energy*, 1999
- Ministry of the Environment: *Towards Sustainable Development in Israel – Background Document for a National Workshop on Sustainable Development*, 1996
- Ministry of the Environment: *Towards Sustainable Development – Preliminary Documents*, 1999
- Nehme, Mouna (Noufi): *Identification of Main Sources of Pollution to the Kishon River and the Determination of the Best Available Technology (BAT) for Them*, Haifa District Association of Municipalities for the Environment, 1998
- Perath, Itamar and Almagor, Gideon: *The Sharon Escarpment (Mediterranean Coast of Israel): Stability, Dynamics, Risks and Environmental Management*, The Ministry of National Infrastructures, Geological Survey of Israel, Jerusalem, 1997
- RESSAC: *Remote Sensing Support for Analysis of Coasts*, CTM-UNEP/MAP, Palermo, Italy, 1999
- Safriel, Uriel N.: *Present Problems and Future Goals in Biodiversity Conservation*, Ben-Gurion University of the Negev and Hebrew University of Jerusalem, Jerusalem, 1999
- Salomon, Ilan: *Sustainable Transport Development*, 1999
- Tropp, Zvi and Zaban, Shaul: *The Mediterranean Coast in Israel – Social and Economic Evaluation*, 1999

B. Members of the Sustainable Development Sectorial Target Groups

Administrative Coordinator: Yosef Gamliel, Ministry of the Environment

Scientific Coordinator: Eran Feitelson, Hebrew University of Jerusalem

Sustainable Development of Industry

Facilitator: Dr. Yehuda Goldshmidt, Environmental Consultant

Target Group Members: Representatives of the Israel Manufacturers Association, Ministry of Industry and Trade, Small Businesses Authority, Small and Medium Industrial Plant Council, Association of Trade Bureaus, Institute for Applied Research, Ben-Gurion University of the Negev, Kibbutz Industry Association, Jerusalem Business Development Center, Haifa University, Association of Engineers, Ministry of the Environment, Standards Institution of Israel, corporations and industrial plants, and economists and private consultants.

Sustainable Development of Energy

Facilitator: Dr. Uri Marinov, Environmental Consultant

Target Group Members: Representatives of the Israel Electric Corporation, Ministry of Energy, Tahal Water Planning Co., Ormat Co., Oil Refineries, Ministry of National Infrastructures, Tel Aviv University, Ben-Gurion University of the Negev, Technion-Israel Institute of Technology, Hebrew University of Jerusalem, Weizmann Institute of Science and private consultants.

Sustainable Development of Transport

Facilitator: Prof. Ilan Salomon, Department of Geography, Hebrew University of Jerusalem

Target Group Members: Society for the Protection of Nature in Israel, Dan and Egged Bus Corporations, Ministry of Transport, Israel Institute for Transport, Technion-Israel Institute of Technology, Israel Railroad Authority, Trans-Israel Highway Corporation, Ministry of the Environment, "Transport Today and Tomorrow", engineers and private consultants.

Sustainable Development of Tourism

Facilitator: Moti Kaplan, Environmental Planner

Target Group Members: Representatives of the Ministry of Tourism, Society for the Protection of Nature in Israel, Government Tourist Corporation, Institute for Development Studies, Negev Tourist Development Corporation, Israel Hotel Association, Jewish National Fund, Jerusalem Institute for Israel Studies, architecture firms and private consultants.

Sustainable Development in the Urban Sector

Facilitator: Harry Brandt, Architect and Urban Planner, Technion-Israel Institute of Technology

Target Group Members: Representatives of the Ministry of Housing, Tel Aviv University, Technion-Israel Institute of Technology, local authorities of Modi'in and Haifa, Ministry of the Environment, Ministry of the Interior, Society for the Protection of Nature in Israel, architects, economists, planners and private consultants.

Sustainable Development of Agriculture

Facilitator: Dr. Pinchas Fein, Coordinator, Soil and Water Institute, Volcani Center

Target Group Members: Ministry of Agriculture, Water Commission, Agricultural Research Organization: Volcani Center, Tahal Water Planning Co., Nature and National Parks Protection Authority, Ministry of the Environment, Kibbutz Eyal, Mekorot Water Co., Plant Protection and Inspection Department, and Ministry of Health.

C. Legislation Relating to Coastal Zone Management

Following is a brief description of the laws which directly impact marine and coastal area management in Israel:

- *Prevention of Sea Pollution by Oil Ordinance (New Version), 1980*: This law provides the legal basis for controlling marine oil pollution. It prohibits discharge of oil or oily substances into territorial and inland waters from any shore installation or vessel, and makes any such act a criminal offense. The Minister of the Environment is empowered to appoint inspectors to discover or prevent violations. The law establishes maximal fines for oil spills and liability for cleanup expenses. Other salient features of the law and its regulations include an obligation to keep oil record books on vessels, measures to be taken in case of oil discharge, and requirements for vessels to use port reception facilities for oily wastes. Regulations promulgated within the framework of the ordinance establish a Marine Pollution Prevention Fund to generate income for preventing and combating marine and coastal pollution, cleanup operations and purchase of equipment. The major sources of the fund are fines collected from court convictions and fees levied on owners or operators of vessels calling at Israeli ports and on shore facilities handling oil.
- *Prevention of Sea Pollution (Dumping of Waste) Law, 1983*: This law prohibits the dumping of any waste from vessels and aircraft into the sea, except under permits which may be issued by an interministerial committee, headed by a representative of the Minister of the Environment. A court convicting an offender under this law may require, in addition to the fine levied, payment of cleanup expenses or of locating the waste dumped into the sea. The law provides for the appointment of inspectors to carry out inspections, investigations and searches to prevent or discover offenses. Regulations under the law, drafted according to the Dumping Protocol of the Barcelona Convention, include lists of substances which may or may not be dumped and conditions for issuing permits.
- *Prevention of Sea Pollution from Land-Based Sources Law, 1988*: This law forbids the discharge of waste, including wastewater, into sea in all cases where practical and economic alternatives for treatment or reuse exist on land, under the condition that such processes are less harmful from an environmental point of view. An inter-ministerial permits committee, chaired by a representative of the Minister of the Environment, determines what may or may not be discharged into the sea and under what conditions. The conditions and criteria for granting permits, and the types of waste which may not be discharged at sea were established according to the provisions of the Land-Based Protocol of the Barcelona Convention. The law provides for the appointment of inspectors to carry out investigations and searches for the purpose of preventing or discovering offenses. Israel has initiated steps to broaden the prohibitions on land-based sources of pollution to discharges from rivers, coastal establishments, outfalls or any other land-based sources and activities.
- *The Ports Ordinance, 1971*: This ordinance provides for the operation and management of ports. It contains a specific section on handling hazardous substances in ports. Regulations promulgated under the law cover such matters such as collection of waste, bilge and ballast water from vessels. Regulations on Loading and Discharging of Oil, promulgated in 1975 under the Ports Ordinance, control all procedures for safe loading and discharge of oil and contain specific instructions on the following: entry into territorial waters and ports; vessel operations during their stay in terminal; measures for fire prevention and fire fighting; conditions of oil terminals; transfer of oil from road tankers; and other regulations aimed at ensuring

environmentally-safe practices. While most of the regulations are supervised and enforced by the Ministry of Transport, provisions concerning environmental issues are administered by Environment Ministry inspectors.

- *Fisheries Ordinance, 1937*: This ordinance is enforced by the Fisheries Board of the Ministry of Agriculture. The ordinance requires a license to fish with the exception of fishing from shore with hook and rod. It sets conditions and restrictions on a wide range of subjects including prohibitions on use of explosives or poisons to catch or kill fish, prohibitions on fishing methods which may damage or threaten the survival of fish species, prohibitions or limitations on fishing in certain areas or during certain seasons, size limits for species of fish, and mesh size and caliber of fishing nets. Other regulations prohibit fishing of marine turtles and restrict fishing of sponges.
- *The Bathing Places Law, 1964*: The law permits local authorities to formulate bylaws for maintaining beach cleanliness. It empowers the Minister of the Interior, in consultation with the Minister of Health, to close bathing beaches for the protection of bathers.
- *Prohibition of Vehicle Driving along the Coast Law, 1997*: This law was specifically enacted to stop the growing use of vehicles, especially all-terrain vehicles, along the coastline.

In addition to the above, the following legislation is also relevant to the coast:

- *Planning and Building Law, 1965*: This law sets the legal framework for development and land use and serves as the basis for environmental policy. All development is subject to the approval of statutory planning boards, on the national, regional and local levels. The law has major significance for all development activities on the coast.
- *Planning and Building Regulations (Environmental Impact Statements), 1982*: These regulations under the Planning and Building Law mandate the preparation of an environmental impact statement when the planning authority considers that significant impacts may occur as a result of a plan or project. The regulations can be utilized as an important tool in protecting and using Israel's coasts. Any proposed project which is liable to adversely affect the coast may be subject to the preparation of an environmental impact statement according to specific guidelines issued by the Ministry of the Environment.
- *National Parks, Nature Reserves, Memorial Sites and National Sites Law, 1998*: This law, first enacted in 1963 and revised in 1992 and 1998, provides the legal structure for the protection of natural habitats, natural assets, wildlife and sites of scientific, historic, architectural and educational interest in Israel. It establishes systems for declaring nature reserves, marine protected areas and national parks and for listing protected natural assets which include many families and species of flora and fauna. This legal protection extends to many taxa, originating within or outside of Israel. The law establishes a new and united Nature and National Parks Protection Authority (NNPPA) which replaces the previous Nature Reserves Authority and National Parks Authority as separate entities. A National Parks, Nature Reserves and National Sites Council, composed of all relevant stakeholders and appointed by the Minister of the Environment, advises the relevant ministers on implementation of the law.
- *Antiquities Law, 1978*: This law, which is enforced by the Antiquities Authority, protects all artifacts of human civilization prior to the year 1700. No collecting, selling or disturbing of such artifacts is permissible anywhere in Israel, including territorial waters.
- *Zifzif Law, 1964*: This law prohibits beach sand quarrying and sand removal.

D. Masterplans Relating to Coastal Zone Management

Following is a short review of masterplans which relate to coastal zone management:

The National Masterplan for the Mediterranean Coast (NOS 13) was approved in 1983. It is based on two underlying principles: preference to recreational activity on the coast and land use as a function of the carrying capacity of the coastline. Based on these principles, the plan determines land allocations along the coastal strip for the purpose of managing, preserving, developing and using them for such purposes as: swimming, recreation and sport; tourist facilities; protection of antiquities, nature reserves, national parks, forests and coastal reserves; ports and other essential uses which require a coastal location. The plan aims to prevent development which is unrelated to the coast and to resolve conflicts of interest among land uses which require a coastal location. It includes a clause prohibiting development within 100 meters of the coastline and requires environmental assessments as prerequisites for all coastal plans (specification of local conditions including coastal impacts, surveys and analysis of plan proposals, environmental impact statements, detailed coastal surveys, surveys and proposals on access routes, surveys of infrastructure systems and their impact on the proposed site). The masterplan also allocates sites for several ports and fourteen marinas.

The National Masterplan for Ports and Marinas (NOS 13B) was commissioned by the National Planning and Building Board to regulate use of marine and land areas for seaports, which include ports for tourism and sport activities. The discussions of the steering committee on marinas revolved around such issues as distribution of marinas, scope and type of development in the hinterland of marinas, anchorage spaces, and allocation of coastal and marine areas based on the number of vessels. The proposals have not yet been presented to the National Board.

The National Masterplan for the Resource Management of the Mediterranean Coastline for Tourism and Recreation (NOS 13C) was commissioned by the National Planning and Building Board to help provide a comprehensive long-term guide to planning policy. The coastal management plan, prepared by the Environment Ministry and approved in principle by the National Board, bases development policies on principles of suitability and sensitivity of coastal resources. Suitability for tourist and recreation development was assessed on the basis of geological, vegetation, landscape and archaeological surveys, and levels of development were then defined for each site along the Mediterranean coastline in relation to resource sensitivity.

The National Masterplan for Tourism (NOS 12) was first prepared in the early 1970s and approved by the government in 1983. It determined, *inter alia*, coasts designated for extensive development, recreation villages, numbers of hotel rooms, and spaces in bathing beaches based on a population forecast of five million residents. An amendment to the masterplan was prepared in the 1994 and is now in the final stages of approval. Prepared by the Tourism and Interior Ministries, in close cooperation with green organizations, the amendment incorporates many of the principles of the coastal masterplan. It recognizes the importance of maintaining sufficient land reserves for tourist accommodation and services, in the face of development pressures, in order to help realize the country's long-term tourism potential. The amendment will strengthen the measures for preserving land reserves for tourism purposes, especially along the coastal strip, and will protect important open space landscapes for tourist activities.

The National Masterplan for National Parks, Nature Reserves and Landscape Reserves (NOS 8), approved in 1981, is a legally binding national plan setting aside specific areas as national parks or nature reserves. The purpose of the plan is to

designate areas for nature conservation, protect areas of high scenic value from unsound development and preserve areas with high recreation and tourism potential. The scheme constitutes an initial safeguard and is backed by another legal procedure – declaration of areas as nature reserves or national parks through the Nature Reserves Law. Over one-quarter of the country's land area is designated for these purposes in the masterplan.

The National Masterplan for Forests and Afforestation (NOS 22), in force since 1996, grants certain areas legal status as forested areas, and thus protects them from development. The main purpose of the scheme is to protect existing “man-made” and natural forests and to designate areas for future afforestation to meet ecological and recreation goals. It designates 1620 km² for the development and conservation of forested lands and includes eight categories of forest including coastal park forests and riparian plantings. Some 42 km² of coastal parks are allocated along the shoreline. Tree planting along rivers for recreational purposes is also an important component of this masterplan.

The National Masterplan for Building and Development (NOS 35), now nearing completion, is an integrated development plan which gives strong emphasis to environmental management principles and to the protection of areas of high natural and landscape value. Among other provisions, it calls for the protection of open space both in the periphery and in the densely populated central area of the country where “buffers” along riverbeds will separate urban concentrations and where coastal protection areas will be designated.

E. Existing Institutions and Responsibilities

A wide range of stakeholders are involved in issues related to the coastal and marine environment in Israel. They include local authorities, government ministries, independent authorities and private and public bodies. Following is a general description of the institutions involved in coastal planning and management today.

Institution	Responsibilities
Ministry of the Interior Territorial Waters Committee National Planning and Building Board District Planning & Building Commissions Emergency Services, Special Duties & Bathing Beaches Administration	National planning and building, declaration of new protected areas Approving offshore structures National masterplans Regional masterplans Supervision of bathing beaches, bathing safety and instruction
Ministry of Transport Shipping and Ports Administration	Testing, licensing and supervision of vessels and anchorages
Ministry of the Environment Marine and Coastal Environment Division Environmental Protection Control	Marine pollution prevention, supervision of environmental legislation
Ministry of Agriculture Fisheries Division	Inspection and supervision of fishing and of fishing vessels
Ministry of Health	Inspection of bathing beaches
Ministry of Tourism	Development of tourism and recreation
Ministry of Education	Naval schools, clubs, Diving Authority
Ministry of National Infrastructures Israel Oceanographic & Limnological Research Geological Survey of Israel	Gas and oil infrastructures Monitoring and research on coastal and marine resources Investigation of Israel's geology, coastal studies
Ministry of Defense	Marine and coastal security, closed military areas on the coast
Ministry of Internal Security Coast Guard	Law enforcement at sea, search and rescue operations
Ministry of Police Naval Operations Border Police	Security, registration of entrances and exits
Ministry of Foreign Affairs	International marine conventions
Ministry of Justice	Marine legislation and conventions
Local Authorities	Coastal planning, business licenses, maintenance of public areas
Israel Land Administration	Management of national land in Israel
Nature and National Parks Protection Authority	Nature protection and administration of coastal national parks and nature reserves
Antiquities Authority	Coastal and marine archaeology
Ports Authority	Commercial ports, loading and unloading facilities
Eilat-Ashkelon Pipeline Co.	Fuel loading, unloading and storage
Natural Gas Authority	Marine pipeline for natural gas
National Coal Supply Corp.	Coal supply to power plants
Israel Electric Corporation	Power plants
Petroleum & Energy Infrastructure Ltd.	Tank farm and fuel pipeline along the coast
Water Commission	Infiltration of seawater to groundwater
Artificial Islands Committee	Advancement of planning for islands
National Sewage Authority	Marine outlets



UNITED NATIONS ENVIRONMENT PROGRAMME
MEDITERRANEAN ACTION PLAN



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PROGRAMME



Coastal Area Management Programme (CAMP)
“Israel”

Report on the Final Conference for the CAMP “Israel”
(Jerusalem, May 24 – 25, 2000)

CAMP/1997-1999/IL/FC.1
Priority Actions Programme
Regional Activity Centre
Split, October 2000

**REPORT
ON THE COASTAL AREA MANAGEMENT PROGRAMME (CAMP) ISRAEL
FINAL PRESENTATION CONFERENCE**

(Jerusalem, May 24-25, 2000)

Background Information on CAMP Israel

1. About 70% of Israel's 6 million residents live along its 188-kilometre coastal strip. Integrated planning and management of coastal and marine areas is, therefore, a crucial area of government activity. Israel has been a very active member of the Mediterranean Action Plan (MAP) since its inception in Barcelona in 1975, and it has played an active role in all of its components. In 1993, Israel submitted a proposal for a Coastal Area Management Programme (CAMP).
2. Growing threats to coastal environments have precipitated a world-wide move toward the integrated management of coastal areas. The Mediterranean Action Plan (MAP), in general, and the Coastal Area Management Programme (CAMP), specifically, have played a vital role in introducing this concept to Israel. Following a year of preliminary preparation, CAMP Israel was officially launched in November 1996 with the first meeting of the Steering Committee at which the programme was finalised. A CAMP Israel Agreement was signed by the Minister of Environment for the Government of Israel and by the Co-ordinator of MAP for UNEP-MAP in response to the growing recognition by national authorities and institutions in Israel that an integrated coastal area management (ICAM) programme should be implemented in Israel. The principles of the programme accord with the sustainable development approach defined in MAP Phase II and Agenda 21. The programme was prepared in close consultation with the experts from Israel and MAP, including the experts from all the Regional Activity Centres (RACs). The Priority Actions Programme Regional Activity Centre (PAP/RAC) of MAP was designated as co-ordinator of CAMP Israel. Ms. V. Brachya from the Ministry of the Environment was designated as National Co-ordinator for CAMP Israel.

Objectives of CAMP Israel

3. CAMP Israel was conceived as a catalyst for new ideas and concepts which could generate changes in the directions of policy making in the country. While the programme itself could not implement changes, its results are likely to bring about revisions of policies toward a more environmentally integrated approach.
4. The programme had two main objectives:
 - To encourage policy makers of economic development sectors to take responsibility for the environmental impacts of their decisions and to incorporate environmental considerations in their decision-making processes (sustainable development, capacity building, economic instruments); and
 - To improve the professional basis for policy making on issues not sufficiently covered in current coastal zone management (pollution control, beach erosion, cliff stability, climate change, biodiversity).

Programme of Activities

5. The programme was oriented to the creation and promotion of the process of integrated planning and management through 6 interrelated activities, as follows:

- First National Strategy for Sustainable Development;
 - Assessment and control of pollution;
 - Management of coastal resources and hazards;
 - Economic instruments;
 - Remote sensing; and
 - Coastal area management.
6. The proposed programme of activities for Israel CAMP has been prepared both to reflect those issues of relevance to a developed country and to reflect the new direction of activity as expressed in MAP Phase II. Some of the more traditional components of CAMP are already being undertaken in Israel (e.g., specially protected areas, environmental impact assessment) and have, therefore, not been included in the proposed CAMP activities.

Participation at the Conference

7. The CAMP Israel activities were presented at a final presentation Conference in Jerusalem, on May 24 and 25, 2000. The Conference was attended by: Mr. Y. Goren, Director General of the Israel Ministry of the Environment; Mr. L. Chabason, MAP Co-ordinator; Mr. I. Trumbic, PAP/RAC Director and MAP Co-ordinator for CAMP Israel; and Ms. V. Brachya, Director of Planning, Ministry of the Environment, and Israeli Co-ordinator for CAMP Israel. The Conference was also attended by two PAP/RAC consultants, Mr. G. Constantinides from Cyprus and Mr. E. Özhan from the Middle East Technical University, Ankara, Turkey, who prepared reviews of the two reports prepared within the frame of CAMP Israel, the representatives of the BP/RAC and ERS/RAC, a number of representatives of the Ministry of the Environment, Ministry of the Interior, the Hebrew University, NGOs, as well as by the Israeli experts who prepared the reports. The full List of participants is attached as Annex I to this report. The first day of the Conference was organised at the Lands Bible Museum in Jerusalem, and the second day in the premises of the hotel Ma'ale Hachamisha, in a kibbutz near Jerusalem. The Agenda of the Conference is contained in Annex II, the List of documents in Annex III, and presentations delivered at the Conference are contained in Annex IV-XII to this report.

Objectives of the Conference

8. The main objective of the Conference was to present the activities carried out within the frame of CAMP Israel, and to discuss the future activities relevant to coastal area of Israel. At the Conference, presentations were delivered by national and international experts, who prepared reports within the framework of CAMP Israel dealing with the following issues: management of coastal sand resources; risk of cliff instability: the case of the Sharon Escarpment; implication of climate change on the coastal region; conservation and sustainable use of biodiversity; identification of main sources of pollution of the Kishon River and determination of best available technology; remote sensing support for analysis of coasts; social and economic valuation of the Mediterranean coast; sustainable development strategy; evaluation and integration of CAMP results; and follow-up activities.

Agenda item 1: Opening of the Conference

9. The first day of the Conference was held in the premises of the Bible Lands Museum in Jerusalem, on May 24, 2000. Before the beginning of the Conference, Ms. Brachya addressed the participants giving them a warm welcome, both in English and Hebrew.

Agenda item 2: Introductory Greetings

10. The floor was then given to Mr. Y. Goren, Director General of the Israel Ministry of the Environment who opened the first session of the Conference, which dealt with the Coastal Zone Management. He welcomed the participants on behalf of the Ministry of the Environment, and of his own, pointing out that Ms. D. Itzik, Minister of the Environment, was unable to attend due to events in the north of the country (withdrawal of forces from Lebanon) and sent her apologies. At the very beginning of his greeting, Mr. Goren expressed his delight in having the opportunity to hold that day of discussion on coastal management, which is of increasing concern to the public in Israel, pointing out the coast as a critical aspect of the Agenda. He mentioned that one of the tasks of the Ministry was to arrange the coast (i.e., develop the leisure and entertainment facilities at the beach, make the beach a public asset, take steps towards managing the cliff erosion, etc.), raising hopes that presentations to be delivered at the Conference would promote the coastal management. In conclusion, Mr. Goren took the opportunity to point out that the Mediterranean Action Plan (MAP) had, over the years, put important issues on the table and that the Ministry should like to express a sincere appreciation of their work. Finally, he wished all the participants an interesting seminar.
11. After having welcomed the Director General of the Ministry of the Environment, experts, consultants and participants, Mr. L. Chabason, MAP Co-ordinator, reviewed coastal issues in the context of the Mediterranean as a whole. He related to the conflicts arising from growing pressures of urbanisation, tourism and infrastructure along some 46,000 km of the Mediterranean coastline, which has high value from an ecological and cultural point of view, but is among the most populated coastal zones in the world. Mr. Chabason spoke of CAMP Israel as a laboratory of the new approach of sustainable development. He surveyed the new directions undertaken by the Mediterranean Commission on Sustainable Development (MCSD), especially with regard to the urban context. While MCSD first concentrated on issues of water scarcity and coastal management, issues of urban management are now emerging. Mr. Chabason stressed that he had no doubt that the Israel experience would be most relevant to the discussions of the working group of the MCSD. He also expressed his belief that the results of CAMP Israel would be integrated into future activities in Israel, in future activities of MAP and the MCSD and CAMPs in other countries around the Mediterranean. Finally, Mr. Chabason took the opportunity to acknowledge the work of all those who had been involved in CAMP Israel, namely, the Israeli experts, Ms. Brachya, the Israel CAMP Co-ordinator, the Centres of MAP, PAP, BP, RAC/ERS, SPA, Medpol, Mr. Trumbic, Co-ordinator of Israel CAMP, and the international consultants of MAP. Concluding his speech, Mr. Chabason wished all the participants a very interesting day.
12. Mr. I. Trumbic, PAP/RAC Director and Co-ordinator of Israel CAMP, greeted the participants giving a brief information on the activities implemented by PAP/RAC within the frame of MAP. He then explained the notion of MAP CAMP, pointing out its role of a promoter of Integrated Coastal Area Management (ICAM) as a major tool that brings a variety of activities towards achieving sustainable development of coastal areas. Mr. Trumbic surveyed the various generations of CAMP since its introduction. Israel is in the third generation of CAMP and is the first developed country in which the studies relate to the entire area of the country, based on the realisation of the wide impact of coastal activities. CAMP Israel also stressed new components, such as sustainable development and sand resources, which were not previously included in CAMP activities in other countries. Mr. Trumbic also surveyed the importance of the process in Israel, which began in 1996. It included 8 activities, 5 MAP Centres, more than 100 experts and 23 reports. Finally, he raised hopes that CAMP exercise had brought ideas and concepts,

which could generate changes in directions of policy making for sustainable management of coastal areas in Israel, and that the process, which has successfully started, would be continued in the future.

Agenda item 3: Coastal Zone Management: Presentations by National Experts

13. Mr. Y. Cohen, Director of Israel Oceanographic and Limnological Research Ltd. (IOLR), delivered his lecture on Coastal Sand Balance. Mr. Cohen stressed the importance of sand management in Israel based on the lack of sand supply to the beaches and growing scarcity of sand for building and its demand as fill material. He underlined that CAMP Israel provided important new findings on the sand reserve in Israel, on the one hand, and a comprehensive review and analysis of studies undertaken over dozens of years of research, on the other. He surveyed sand sources, causes for loss of sand and current sand balance. The conclusions call for a national policy on sand management supported by a comprehensive database. Sand management policy requires an integrated system of decision making, implementation, monitoring, and ongoing assessment.
14. Mr. G. Almagor, the Geological Institute, spoke about the Coastal Cliff of Israel. Mr. Almagor surveyed the results of studies on the coastal cliff from the 1980s, on which, principles of cliff management have been formulated. He related both to the benefits and risks of the coastal cliff and outlined a series of recommendations, including prohibition of building within a 50-meter strip, use of protective seawalls, and prohibition of roads perpendicular to the cliff.
15. The above presentations were followed by response of Mr. E. Özhan, Chairman of MEDCOAST and PAP/RAC Consultant, who reviewed the findings of the Israeli report on the "Management of the Israeli Coastal Sand Resources", noting that the methodology and results could be used in other parts of the Mediterranean. The reviewed report is a comprehensive treatment of the coastal sedimentation processes along the Israeli coast, based on scientific information and using up to date methods. The value of the study is reflected by the very important coastal management implications and recommendations presented. Mr. Özhan's presentation is contained in Annex IV to this report.

Agenda item 4: Coastal Law: Presentations by National Experts on Coastal Legislation

16. The introduction to the second session of the Conference dealing with the Coastal Law was given by Mr. U. Landau, Member of the Israeli Parliament, and proponent of coastal law, who pointed out that there are currently two draft laws on the coastal environment in deliberation in the Parliament with the intention that they will be unified into one law. Mr. Landau submitted a private member's bill on coastal conservation that sets operative procedures and directives on protecting, managing and preserving the coastal environment. He related to such issues as loss of open space along the coastline and growing urban encroachment. Mr. Landau raised questions relating to quality of life and nature protection and called upon the public to take part in environmental issues. He presented the coastal protection bill as an educational process aimed at the general public, non-governmental organisations, the media and the political system, and hoped it would contribute to paving a new path of social justice and commitment.
17. Ms. D. Katz of the Israel Union for Environmental Defence addressed some of the successes in halting or minimising major development projects along the Mediterranean

coastline, such as the Haifa and Yarkon river mouth marinas. She surveyed some important judicial rulings and precedents that have prohibited private use of the coastline. She also surveyed the major principles underlying the proposed coastal law, most of which are derived from the central principle of recognising that the coast is a public resource. The draft law forbids private use and ensures free and easy public access and sea view. It relates to a 500-meter strip on both the land and seaside and establishes planning restrictions for each strip of coastline according to the character of the plan and the natural resources of the area. Major attention is accorded to public participation in planning and enforcement.

18. Ms. R. Rotenberg, Legal Advisor to the Ministry of the Environment of Israel, reviewed the process of preparing government legislation on protection of the coastal area. She noted that the Ministry's proposed coastal bill includes the phrase "sustainable development" for the first time as a declaratory principle in Israeli legislation. The original version of the law proposed by the Environment Ministry was formulated in declaratory and normative terms, but is currently undergoing revision to make it more "focused" and "action oriented" through the inclusion of specific directives, prohibitions and penalties.

Agenda item 5: Posters and Presentation of RESSAC

19. During the lunch break, the exhibition of posters and presentation of RESSAC, which was held in the entrance-hall of the Bible Lands Museum, arouse the great interest of the participants. The Remote Sensing Support for Analysis of Coasts (RESSAC) is a shared cost project funded under Area 3.3 (CEO Programme) of the Environment and Climate Programme of the European Commission (DGXII) sponsored by UNEP/MAP in the framework of CAMP Israel. The RESSAC Project was conceived with the aim of introducing methodologies and techniques based on satellite remote sensing to the Israel Ministry of the Environment, in order to provide it with new tools and updated information on coastal (marine and terrestrial) dynamics and transformations, to support its activities related to environmental planning. The project was developed from February 1997 to April 1999 by: ERS/RAC, Italy, Project Co-ordinator; the Ministry of the Environment of Israel, Planning Department, User; ARGOSS, The Netherlands, Partner; MeteoMer, France, Partner; Telespazio, Italy, Partner; NLR, The Netherlands, Partner; GSI, Israel, Associated Partner to the Ministry of the Environment; and IOLR, Israel, Associated Partner to the Ministry of the Environment. The project was focused on the monitoring and study of particular topics, in the coastal area stretching for about 100 km from South to Haifa (Hadera) to Ashdod (central part of Israeli coast), and including the urban area of Tel Aviv. For each of these applications, the close work of all the partners with the Planning Department of the Israeli Ministry of the Environment and its associated partners, allowed to make them more confident with the potentialities of remote sensing, as well as to properly review and refocus activities, in order to better meet planning- and decision-making requirements. In conclusion, RESSAC as a whole, relying on a multi-disciplinary partnership and applying to a wide range of satellite sensors, contributed to take a step forward in setting up an Earth Observation system devoted to improve, on an operational basis, knowledge and understanding of a broad spectrum of Mediterranean coastal dynamics in both marine and land environments.

Agenda item 6: Economic Evaluation of Coastal Resources: Presentations by National Experts; Response

20. The afternoon session of the Conference was devoted to economic aspects of Coastal Zone Management. Mr. Z. Tropp, ZENOVAR Consultants, presented the activity on Economic Evaluation of the Shoreline. He reviewed statistics regarding hotels along the water front and the added value for coastal use for leisure and recreation and its economic valuation, and willingness to pay. He estimated that the added value derived by the Israel economy from the seashore was \$500 million per year based on hotels, vacationing and leisure, property for housing and willingness to pay. In addition, he presented the assessment of the estimated value of the coastal impact of the Herzliya marina. He concluded with a recommendation that levies should be imposed on property development in the vicinity of the seashore that would internalise the value of the damage and would divert the revenues to environmental protection. Mr. Tropp's presentation is contained in Annex V of this report.
21. Mr. A. Shapira from the Society for the Protection of Nature in Israel (SPNI) presented an ancient Roman law that related to the prohibition of building along the seashore. He reviewed the process whereby many buildings are constructed along the seashore in areas allocated for tourism under the guise of "holiday apartments" or "apartment hotels." He cited the proposed coastal law as providing a possible solution to the problem and called for more protection of urban beaches and more public participation. He stated that current plans allow for building along another 40 km of the coastline.
22. In response to Valuation of Coastal Resources, Mr. G. Constantinides, PAP/RAC Consultant, focused on the review of the Report prepared by Mr. Tropp, within the context of CAMP Israel on "Economic Instruments for Internalising Environmental Externalities: The Social Value of the Mediterranean Coast of Israel". Mr. Constantinides reviewed the importance of coastal resources to the national economy, though there are frequently no market prices to measure such values as biodiversity. He reviewed different methodologies for determining the social benefits of keeping the coast as open space rather than a developed area, including "willingness to pay." He stated that through environmental economics, it is possible to begin a dialogue between the corporate sector and green organisations. He contended that it is possible to demonstrate that ecology has value, both economic measurable value and biodiversity value. Since there is a non-use social benefit of landscape value and open space, it is essential to tax those that benefit and compensate those who lose by coastal development.

Agenda item 7: Presentation of RESSAC

23. Ms. M. Viel, ERS/RAC, presented the results of the RESSAC project in Israel, especially in relation to urban expansion modelling. At the beginning of her presentation, Ms. Viel described briefly the RESSAC project as a shared-cost project supported by MAP/UNEP being a contribution to CAMP Israel. The RESSAC project was conceived with the aim of applying methodologies and techniques based on satellite remote sensing to provide new tools and up-dated information in support to activities related to environmental planning, in particular to coastal (marine and terrestrial) dynamics and transformations. In conclusion, Ms. Viel said that the selection and suitable combination of the factors and constraints' layers was interactive and made by the user through a tailored interface. The final output is a map showing new built-up areas in the studied area taking into account the number of km² to be built to respond to new population

growth and the different planning scenarios (factors and constraints). Thus, these final maps showing the impact of different scenarios of urban expansion on a specific area could provide a useful tool to land-use planners, also helping them to illustrate the results of different planning decisions to the public. Ms. Viel's presentation is contained in Annex VI of this report.

Agenda item 8: Coastal Zone Management in Israel; Response

24. The floor was then given to Ms. Brachya who reviewed the problems Israel was facing along the Mediterranean coastline, such as loss of natural and cultural values, loss of open space, loss of public access and loss of views to the sea. Past and current activities in Israel in relation to coastal zone management included national coastal masterplans, policy documents and site specific projects and environmental impact statements. She noted the important role played by non-governmental organisations, who submitted their own policy documents and raised public awareness. She suggested some future activities needed, including management of the coastal sand reserves, regulations on urban shoreline development, prevention of limiting public access to the shore and better maintenance of the beaches in relation to litter prevention and collection.
25. Ms. D. Rachewski, Director of the Planning Administration, Ministry of the Interior, reviewed the process of formulating and adopting the Coastal Waters Policy Document. The Territorial Waters Committee adopted the policy document in May 1999 and its impact has already been felt in decision making during the past year. Furthermore, the Territorial Waters Committee decided to require that the plan for the expansion of Ashdod Port would require sand bypassing, monitoring and requirements for rehabilitation, if needed, according to monitoring results. She cited the lack of follow up as the greatest drawback in coastal management today. This is now being changed, as evidenced by the case of Ashdod, which includes specific procedures and timetables for monitoring and follow up. Ms. Rachewski reviewed the conclusions and recommendations of the Coastal Waters Policy Document with regard to setting up a database and amendments to the National Masterplan for the Coast. She questioned the value of coastal legislation in protecting the coastal environment.
26. In response to Ms. Brachya's presentation, Mr. Trumbic found the studies conducted within the CAMP framework to be impressive, especially in light of the expertise in Israel that has the capability to tackle coastal issues. Nonetheless, much is left to be done from the point of view of coastal management. He endorsed the importance of coastal legislation as an important means of increasing coastal management beyond land-use planning which is a sectoral approach. Even coastal legislation is not sufficient, however, in protecting the coastal strip since laws are frequently well written but poorly implemented. It is essential to introduce effective instruments for implementation and to set up effective integrated institutions. The question today is how to spread the message and results of coastal management studies to decision makers. It is also essential to disseminate the results to the local level. Finally, Mr. Trumbic expressed the hope that co-operation between Israel and MAP will continue in the future, including such institutions as MCSD. The response of Mr. Trumbic is included in Annex VII to this report.

Agenda item 9: Towards Sustainable Development in Israel

27. The second day of the Conference, which was convened in the premises of the Hotel Ma'ale Hachamisha, was dedicated to Sustainable Development. The session started with the opening greeting by Ms. Brachya, who welcomed the participants at the second-day's session thanking in particular Mr. Chabason for his coming to the Conference. She delivered the greetings of Mr. Goren, Director General, Ministry of the Environment, who was unable to come because of the events in the north of the country.
28. The floor was then given to Mr. Chabason, who after having greeted the participants, expressed his thanks to Israeli authorities for a perfect organisation of the Conference which will allow the participants to become familiar with the issue of Sustainable Development in Israel. Mr. Chabason called for a bridge between national activities and the Mediterranean Commission on Sustainable Development (MCSD). Sustainable development has been introduced five years ago as a new domain of MAP through the establishment of the MCSD whose mandate is to facilitate its implementation in the Mediterranean. Most of the problems Israel is coping with are part of the agenda of the MCSD. Therefore, the Israel CAMP experience and input can be of major interest for the work of MCSD. In conclusion, Mr. Chabason pointed out the need for a more integrated work between the national level and local level and moving from strategy and policy to activity and implementation. Finally, he thanked the Israeli authorities, and in particular Ms. Brachya and PAP/RAC, for their efforts made to organise the Conference.
29. After having thanked Mr. Chabason for his kind words, Ms. Brachya described the process of preparing a strategy for sustainable development in Israel, including the preparation of initial papers by experts, round table discussions on economic sectors including relevant stakeholders from government, NGOs and academic institutions, and the publication of documents summarising the discussions. The target groups concentrated on discussing the implications of sustainable development for industry, energy, agriculture, tourism, transportation and the urban sector. In the future, the results of these discussions will be the basis for integrating sustainable development into the policies of government ministries and other public and private institutions.
30. Mr. E. Feitelson, Hebrew University, presented the conceptual basis of a comprehensive strategy for sustainable development in Israel. Mr. Feitelson related to inter and intra generational equity and enlarging the pie as the meta-goals. He identified more specific goals and targets, such as keeping options open for future generations to make their own mistakes, maintaining minimal standards and ensuring the environmental quality of weaker sectors of the population. He called for the internalisation of externalities, resource efficiency, the promotion of environmental awareness and public participation. He suggested that the challenge today was to change trends which were clearly not in accordance with principles of sustainability and to identify sustainability indicators and appropriate institutional structures, which are currently inadequate.

Agenda item 10: Sustainable Development in Economic Sectors

31. Mr. U. Marinov, Environmental Consultant and Co-ordinator of the energy group, spoke about sustainable development in economic sectors, noting that sustainable development calls for an efficient, reliable and decentralised energy economy, based on local and clean energy sources, in which the price paid by the consumer would reflect the real cost of energy to the economy and not be supported by subsidies. He presented

the externalities of alternative conventional sources of energy and recommended that greater attention be given to the development and promotion of renewable energy sources. He emphasised the importance of energy conservation and that the sustainable approach to energy should include integrated resource planning, comparisons of different technologies, an assessment of environmental effects, and reliability of supply.

32. Mr. Y. Goldsmidt, Environmental Consultant, introduced to the participants the issue of industry in relation to sustainable development, pointing out that sustainable development in the industry sector will require significant decreases in pollution and the use of resources. The following activities are recommended:
- The government should encourage the development of industrial plants complying with the principles of sustainable development;
 - Information concerning the environmental impact of goods and production processes should be made available to the public;
 - A major research effort should be launched to develop clean and resource-saving processes, to replace existing ones, where risky and wasteful;
 - A joint committee of industry and government should be set up and empowered to formulate a policy, amend guidelines and supervise actual implementation of sustainable development in the industrial sector; and
 - Limits should be set to the exploitation of natural resources – in order to assure their continuation for future generations.

The presentation of Mr. Goldsmidt is contained in Annex VIII to this report.

33. Mr. M. Kaplan, Environmental Planner, addressed the issue of sustainable development in the tourist sector, growth of tourism in Israel, urban tourism, etc. stressing that development in the tourism sector has to be integrated with the protection of tourism resources: landscape, nature, and cultural heritage. These values are needed for the present and the next generation as social, cultural, and economic values. Israel has a limited quantity of open space, recreation areas and nature values, and cannot supply the large areas for wild life, as available in other countries. On the other hand, it has its own uniqueness of cultural heritage, mainly as the cradle of world religions. Tourist policy principles should include:
- Building on Israel's relative advantage – the religious, cultural, historical atmosphere;
 - Encouraging metropolitan or urban tourism;
 - Limiting recreational tourism and preserving the landscape as a fitting setting for cultural sites; and
 - Conserving scenic and natural resources for the benefit of resident and domestic tourism.

Mr. Kaplan's presentation is contained in Annex IX to this report.

34. Mr. P. Fein, Vulcan Institute, introduced the issue of sustainable agriculture, pointing out that discussions on sustainable agriculture took place in six sub groups: allocation of production factors in sustainable agriculture, sustainable use of water, hazardous substances for agriculture, agriculture as a pollution remover, prudent use of pesticides, agriculture as a conserver of the environment. The groups concluded, that it is crucial to maintain agricultural vitality and to maintain and even enhance the role of agriculture as a mean for preserving the environment. The main conclusions can be summarised as follows:
- Preserving irrigable land is crucial for agriculture and the water economy. Agricultural activity, mainly in the crowded central areas is essential for maintaining open space for the urban population and is important as infiltration

areas for aquifers. There should be on-going follow up on the quality and quantity of land available for agricultural use.

- Waste water can and should be used in agriculture in all regions of the country; therefore, its quality and treatment should be designed accordingly.
- The use of pesticides poses a potential hazard to ground water. There is still a need for further research on this subject.

Mr. Fein's presentation is contained in Annex X to this report.

Agenda item 11: Sustainable Development in the Urban Sector

35. Mr. Sh. Hasson, Hebrew University, spoke about social aspects of sustainable development. During the course of formulating the sustainable development strategy, it was recognised that the social component should be added. This includes social justice and accessibility to environmental benefits as well as public participation in decision making. One of the central questions is how to harmonize between the different components of sustainable development: economics, society and the environment. This is a question of ethics, politics and environmental justice. Means must be found to tackle the question at source, and not at the end of the line. It is essential that the public participates actively in the decision-making process and in implementation of the decisions. Questions that must be asked include the following: does a particular plan increase or decrease social justice through its impact on accessibility to services by different strata of society? Capacity building is also an important element as well as aid in the creation of urban coalitions, in the promotion of dialogue with local authorities and in the creation of partnerships between local government and NGOs. It is important to enact legislation, which includes a strong component of public participation. Development projects must be preceded by public hearings. Procedures such as arbitration and mediation should be encouraged.
36. Mr. H. Brandt, Architect, addressed the sustainable development in the urban sector, informing the participants about the two main objectives in sustainable urban development, namely:
- Saving resources: land, water, raw materials and energy from non-replaceable sources; and
 - Environmental protection: prevention of air pollution, noise abatement, prevention of water pollution, prevention of soil pollution, protection of micro climate, refuse disposal, visual quality (see tables attached to M. Brandt's presentation contained in Annex XI).
- The recommendations for sustainable urban development include:
- Integration of environmental consideration in planning briefs for specific projects initiated by government ministries;
 - Integration of environmental considerations in the planning guidelines issued by the Ministry of Housing;
 - Re-examination of public area programmes and multiple uses of infrastructure corridors; and
 - Preparation of a shadow plan for underground space as part of the urban space plan.
37. The presentations were concluded by Mr. I. Solomon, Hebrew University, representative of the transport sector, who explained that the transportation discussion group included participants with a wide range of views, reflecting the varied interests involved in discussions on sustainable transport. Participants shared the same views concerning the negative impacts of the transport sector on the environment and the need to find a

way to reach sustainable transport. Two fundamental questions were raised: what could be done and how the right policy could be formulated. The report of the group's discussions includes basic definitions and a brief description of the environmental problems caused by transport, and the variety of tools to confront these problems. Mr. Solomon suggested that we should move to a policy of predicting and managing demand instead of increasing supply. Transport policy should be concerned not only with transportation issues but also with the social and environmental effects of transport. Mr. Solomon's presentation is contained in Annex XII to this report.

Agenda item 12: NGO Comments on Sustainable Development in Israel

38. The final session of the day was devoted to hearing the opinions of public bodies, some of whom were involved in the process of formulating the sustainable development policy for Israel.
39. Mr. E. Schwartz, Director of the Heshel Centre, remarked that not enough time had passed to digest the results of the process, but he was impressed by the seriousness of the process. Nevertheless, he noted that there should be constant tension between the three components of sustainable development - environment, economics and society. In reality, however, the economic model is the only one that seems to make a difference. A real change is needed to give full consideration to all three components. This may require affirmative action. In order to engage in a "fair game", people must be made aware that there is a global environmental crisis. He called for an orientation, which goes beyond materialism. This necessitates a significant change in public participation in processes whereby the general public is a central player, not only professionals or NGOs. He called for a new vision of economics that goes beyond consumption and materialism. It is essential to find an educational, value-oriented approach that involves the public and is based on mutual responsibility and commitment.
40. Mr. A. Tal, Director of the Aravah Institute and Chairman of Life and Environment, contended that the sustainable development document accords too much emphasis to technological advancement. He stated that so far, technology has helped reduce oil pollution of the sea, has reduced sulphur dioxide concentrations in the air, and has led to a reduction in lead concentrations. All these are the results of cleaner production. He believed that we must find ways of reaching specific goals through more stringent requirements in such areas as water pollution, transportation, and urbanisation. He called for the implementation of economic tools such as green taxes, fees. He said that pollution sources are currently more dispersed and small, and therefore we need a new policy that takes this into account.
41. Ms. A. Vardi, Shatil, said that Shatil provides aid to green organisations and accords major importance to relations between environment and the community and to public participation in planning. Ms. Vardi expressed her disappointment at the presentation of economic growth as an important component of sustainable development and called for stronger public participation. This must be incorporated in legislation, and should not only be a voluntary act.
42. Ms. N. Zur, Society for the Protection of Nature, Jerusalem, informed the participants that the "black hole" of sustainable development in Israel is the absence of participation by local authorities. In Israel, 90% of the population is urban. Ms. Zur addressed a number of planning proposals in Jerusalem that were rejected through public

opposition. She called for transforming public participation from "reactive" to "pro-active." She related the experience of the "Sustainable Jerusalem Charter" in which 35 non-governmental organisations joined together in a coalition for sustainable urban growth and planning in the city. In addition, several neighbourhoods in Jerusalem have successfully drafted alternative plans and have succeeded in introducing composting and plastic recycling programmes in their neighbourhoods.

43. Ms. B. Givon, Sustainable Negev NGO, pointed out that not enough government ministries were present in the discussion. She stated that the Negev, the southern desert area, encompassing 60% of the area of the country and only 8% of the population, provides a once-in-a-lifetime opportunity to introduce and implement sustainable development strategies at the out set. She presented the goals of the Sustainable Negev Association, which serves as a mouthpiece to the population in changing policy. The Association works along with research institutes of Ben Gurion University in formulating principles for sustainable development for the Negev.

Agenda item 13: Concluding Remarks

44. Following some comments by the participants, Ms. Valerie Brachya concluded the meeting by thanking MAP for providing the "push" necessary to continue the process of sustainable development in Israel. She noted that this is not the end of the process but rather the beginning. The challenge now is to introduce and assimilate the concept in the Ministry of the Environment and in other ministries and to work along with local authorities and the general public.

ANNEX I
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10. Tel-Aviv University
11. Haifa University
12. Green Peace
13. Aravah Institute
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15. Man, Nature and Law, Israel Union for Environment Defence
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17. The Public Forum for Environment in Ashdod
18. The Hadera Corporation Cities for Environment
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22. The Environment Quality Unit – Herzliya
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25. Haifa Municipality
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27. Private sectors
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ANNEX II

AGENDA

Wednesday, May 24	Coastal Zone Management
9:00 – 9:30	Registration.
9:30 – 9:45	Introductory greetings (Mr. Y. Goren, Director General, Ministry of the Environment; Mr. L. Chabason, MAP Co-ordinator; Mr. I. Trumbic, PAP/RAC Director).
9:45 - 11:00	Management of Coastal Sand Resources (Mr. Y. Cohen, Director IOLR). Management of Cliff Erosion (Mr. G. Almagor, Geological Institute). Response (Mr. E. Özhan, PAP/RAC Consultant).
11:00 - 12:00	Proposed coastal law and impacts (Mr. U. Landau, Member of Parliament; Ms. D. Katz, Advocate, the Israel Union for Environmental Defence; and Ms. R. Rotenberg, Legal Advisor, Ministry of the Environment).
12:00 - 13:00	Posters and presentation of RESSAC during the break.
13:00 - 14:15	Economic Evaluation of Coastal Resources (Mr. Z. Tropp, ZENOVAR). Public opposition to recreation homes (Mr. A. Shapira, SPNI). Response (Mr. G. Constantinides, PAP/RAC Consultant).
14:15 - 14:30	Remote Sensing and GIS: An Application to Coastal Urban Expansion Analysis and Modelling (Ms. M. Viel, ERS/RAC).
14:30 - 15:30	Coastal Zone Management in Israel (Ms. V. Brachya, Director of Planning, Ministry of the Environment). Future steps in coastal planning (Ms. D. Rachewski, Director of the Planning Administration, Ministry of the Interior). Response (Mr. Trumbic).
15:30 - 16:00	Discussion.
Thursday, May 25	Sustainable development
9:00 - 9:20	Registration. Opening greetings (Ms. Brachya, Mr. Chabason)
9:20 - 10:00	Preparation of a national strategy for sustainable development (Ms. Brachya). Goals and aims of sustainable development in Israel (Mr. E. Feitelson, Hebrew University).

- 10:00 - 11:00 Sustainable development in economic sectors:
Energy (Mr. U. Marinov, Environmental Consultant);
Industry (Mr. Y. Goldsmidt, Environmental Consultant);
Tourism (Mr. M. Kaplan, Environmental Planner); and
Agriculture (Mr. P. Fein, Vulcan Institute).
- 11:00 - 12:00 Sustainable development in the urban context:
Social aspects (Mr. Sh. Hasson, Hebrew University);
Urban aspects (Mr. H. Brandt, Architect); and
Transportation aspects (Mr. I. Solomon, Hebrew University).
- 12:00 - 13:00 Public action for sustainable development:
The Heshel Centre (Mr. E. Schwartz);
Aravah Institute (Mr. A. Tal);
Shatil (Ms. A. Vardi);
Society for the Protection of Nature (Ms. N. Zur); and
Sustainable Negev NGO (Ms. B. Givon).
Concluding remarks.
- 13:00 Closure of the Conference.

ANNEX III

List of documents

1. Constantinides, Glafkos: *Review Report on Economic Instruments for Internalising Environmental Externalities: The Social value of the Mediterranean Coast of Israel*. PAP, 2000.
2. Dayan, Uri and Koch, Jean: *Implications of Climate Change on the Coastal Region of Israel*. Jerusalem, 1999.
3. Gabbay, Shoshana: *Coastal Zone Management in Israel*. Ministry of the Environment, Jerusalem, 1999.
4. Golik Abraham and Rosen, Dov S.: *Management of the Israeli Coastal Sand Resources*. Israel Oceanographic and Limnological Research, Haifa, 1999.
5. Özhan, Erdal: *Consultant's review of the Report: Management of the Israeli Coastal Sand Resources*. PAP, 2000.
6. Tropp, Zvi and Zaban, Shaul: *The Mediterranean Coast in Israel – Social and Economic Evaluation*. 1999.
7. UNEP/MAP/PAP: *Coastal Area Management Programme (CAMP) Israel: Final Integrated Report*. Split, Priority Actions Programme, 2000.

LIST OF PROJECT OUTPUTS

- Arlozorov, Saul: *Present Problems and Future Goals in Water Management*, 1999
- Avnimelech, Yoram: *Present Problems and Future Goals in Solid Waste Management*, The Technion, Israel Technological Institute, Haifa, 1999
- Brandt, Harry: *Sustainable Urban Sector Development*, 1999
- Dayan, Uri and Koch, Jean: *Implications of Climate Change on the Coastal Region of Israel*, Jerusalem, 1999
- Fein, Pinchas: *Sustainable Agricultural Development*, 1999
- Feitelson, Eran: *Proposal for a Sustainable Development Strategy for Israel*, Hebrew University, 1999
- Gabbay, Shoshana: *Coastal Zone Management in Israel*, Ministry of the Environment, Jerusalem, 1999
- Goldshmidt, Yehuda: *Sustainable Development in Industry*, 1999
- Golik Abraham and Rosen, Dov S.: *Management of the Israeli Coastal Sand Resources*, Israel Oceanographic and Limnological Institute, Haifa, 1999
- Hasson, Shlomo: *Background Document on Social Aspects of Sustainable Development*, 1999
- Kaplan, Moti: *Sustainable Tourism Development*, 1999
- Luria, Menahem: *Present Problems and Future Goals in Air Quality Management*, Hebrew University of Jerusalem, 1999
- Marinov, Uri: *Sustainable Development in Energy*, 1999
- Ministry of the Environment: *Towards Sustainable Development in Israel – Background Document for a National Workshop on Sustainable Development*, 1996
- Ministry of the Environment: *Towards Sustainable Development – Preliminary Documents*, 1999
- Nehme, Mouna (Noufi): *Identification of Main Sources of Pollution to the Kishon River and the Determination of the Best Available Technology (BAT) for Them*, Haifa District Association of Municipalities for the Environment, 1998
- Perath, Itamar and Almagor, Gideon: *The Sharon Escarpment (Mediterranean Coast of Israel): Stability, Dynamics, Risks and Environmental Management*, The Ministry of National Infrastructures, Geological Survey of Israel, Jerusalem, 1997
- RESSAC: *Remote Sensing Support for Analysis of Coasts*, CTM-UNEP/MAP, Palermo, Italy, 1999
- Safriel, Uriel N.: *Present Problems and Future Goals in Biodiversity Conservation*, Ben-Gurion University of the Negev and Hebrew University of Jerusalem, Jerusalem, 1999
- Salomon, Ilan: *Sustainable Transport Development*, 1999
- Tropp, Zvi and Zaban, Shaul: *The Mediterranean Coast in Israel – Social and Economic Evaluation*, 1999

ANNEX 1

COASTAL ZONE MANAGEMENT IN ISRAEL



UNITED NATIONS ENVIRONMENT PROGRAMME
MEDITERRANEAN ACTION PLAN



PRIORITY
ACTIONS
PROGRAMME



Coastal Area Management Programme (CAMP) for Israel

Coastal Zone Management in Israel

Report prepared by
Shoshana Gabbay in co-operation with Valerie Brachya



Priority Actions Programme
Regional Activity Centre
Split, 2000

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Scientific material on the geological and geomorphological features of Israel's Mediterranean coastline is largely based on publications of the Geological Survey of Israel (by G. Almagor, D. Gill, I. Perath, and Y. Nir) and publications of Israel Oceanographic and Limnological Research (by A. Golik and D. Rosen). Scientific literature on nature, landscape, open spaces and archaeology is largely based on material provided by the Nature and National Parks Protection Authority, Society for the Protection of Nature and Israel Antiquities Authority. Material on litigation is mostly based on material provided by the Israel Union for Environmental Defense.

Written and edited by Shoshana Gabbay in co-operation with Valerie Brachya, Director of Planning, Ministry of the Environment.

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FOREWORD

Growing threats to coastal environments have precipitated a world-wide move toward the integrated management of coastal areas. The Mediterranean Action Plan (MAP), in general, and the Coastal Area Management Programme (CAMP), specifically, have played a vital role in introducing this concept to Israel. In 1996, a CAMP Israel Agreement was signed in response to the growing recognition by national authorities and institutions in Israel that an Integrated Coastal Zone Management (ICZM) programme should be implemented in Israel. The principles of the programme accord with the sustainable development approach defined in MAP Phase II and Agenda 21.

The purpose of this document is to describe and analyse Israel's coastal resources, development pressures on the coastal environment, and current and proposed policies and tools for coastal planning and management. The review focuses on the major coastal issues which face Israel, on the institutions involved in tackling these issues, and on the tools available for coastal zone management, today and in the future. It covers such sensitive issues as impact of marine structures, public access to the coast, beach and cliff protection and pollution prevention. Furthermore, it concentrates on the conflicts which have emerged in this area and presents new initiatives and policies which are expected to move Israel along the path of integrated coastal management in accordance with world guidelines.

Israel's 188-kilometre long coastal strip has been subject to ever-growing pressures and conflicts. The need to formulate specific policies to protect this sensitive and dynamic environment has been recognised by the Ministry of the Environment for more than two decades. Therefore, the Ministry is especially pleased to see the shift toward wise management of the coastal zone which has emerged in recent years and wishes to express its appreciation to MAP for its continued guidance and support. Hopefully, the experience which has been accumulated in Israel in the area of ICZM will be of interest and use to all who are concerned with this important issue, both in this country and elsewhere.

Valerie Brachya
Director of Planning, Ministry of the Environment

INTRODUCTION

Long and narrow in shape, Israel makes up for its small size with a wide range of physical features. Within its small land area, Israel embraces landscapes that are normally separated by thousands of kilometres in other countries. Mount Hermon in the north boasts snowy slopes and alpine fauna and flora, while the Gulf of Eilat, in the south, harbours spectacular coral reefs and colourful fish that represent the tropical zones. Lying between these two extremes are arid desert areas, lush oases, green Mediterranean woods and forests, and the lowest point on earth - the Dead Sea.

Geographical Features

Israel may be divided into four geographical regions: three parallel strips running north to south and a large, mostly arid zone in the southern half.

The coastal plain runs parallel to the Mediterranean Sea and is composed of a sandy shoreline, bordered by stretches of fertile farmland extending up to 40 kilometres inland. In the north, expanses of sandy beach are in places backed by low sandstone cliffs. The coastal plain is home to over half of Israel's population and includes major urban centres, deep-water harbours, most of the country's industry and a large part of its agriculture and tourist facilities.

Several mountain ranges run the length of the country. In the north-east, the basalt landscapes of the Golan Heights, formed by volcanic eruptions in the past, overlook the Hula Valley. The hills of Galilee, largely composed of limestone and dolomite, ascend to heights ranging from 500 to 1,200 metres above sea level. The Jezreel Valley, separating the hills of Galilee from those of Samaria, is Israel's richest agricultural area. The rolling hills of Samaria and Judea feature rocky hilltops and fertile valleys, dotted with groves of olive trees.

The Negev, comprising over half of Israel's land area, is inhabited by only 8% of its population, living mainly in the northern part. Further south, the Negev becomes an arid zone characterised by hills and plains, abounding with canyons and wadis in which winter rains often produce flash floods. Even further south, the region gives way to an area of bare craggy peaks, craters and gravel plateaux. The Negev desert contains unique features such as erosional craters (*makhteshim*) which cut deep into the earth's crust, displaying a range of colours and rocks. At the tip of the Negev, near Eilat on the Red Sea, sharp pinnacles of grey and red granite are broken by dry gorges and sheer cliffs, with colourful layers of sandstone.

The Jordan Valley and the Arava, running the length of the country in the east, are part of the Syrian-African Rift which split the Afro-Arabian continent millions of years ago. Its northern stretches are fertile, while the southern portion is semi-arid and arid. The Arava begins south of the Dead Sea and extends to the Gulf of Eilat, Israel's outlet to the Red Sea. The sub-tropical Gulf of Eilat, noted for its deep blue water, coral reefs and marine life, lies at the southern tip of the Arava.

Israel's location at the meeting point of four phyto-geographic and zoo-geographic zones - the Mediterranean, the Irano-Turanian (steppe), the Saharo-Sindic and the Sudanese - gives the country a rich variety of plant and animal life. Israel's water bodies are also varied. To the west lies the Mediterranean Sea; to the east, the salt-laden Dead Sea with its unique attributes;

in the north is the freshwater Lake Kinneret (Sea of Galilee); in the south, the Gulf of Eilat and the Red Sea.

Population Growth

The most outstanding characteristic of Israel's population is its rate of growth. Since its establishment in 1948, the country's population has increased more than seven-fold, mainly as a result of large-scale immigration—and now numbers about 6 million residents. Decreased immigration in recent decades was dramatically reversed at the end of 1989 as a massive wave of immigrants arrived in Israel from the former Soviet-bloc and from Ethiopia. Since 1990, Israel's population has grown by over 30%. The average rate of growth in recent years has been about 2.5% annually as compared to 3.5% in 1990-1995.

About 90% of the population lives in some 200 urban centres. The three largest cities are Jerusalem (620,000 inhabitants), Tel Aviv (350,000) and Haifa (260,000). Over 2.5 million people reside in the greater Tel Aviv metropolitan area alone—nearly 44% of the total population. The population along the coastal plain has grown from about 100,000 in the beginning of the century to over 4 million today.

From a sparsely populated country with 800,000 residents spread over 21,000 square kilometres in 1948, Israel today has become a densely populated country, in which 92% of its 6 million inhabitants reside in 40% of the total land area (north of Beersheba). In the area north of Beersheba, Israel is now one of the developed world's most densely populated countries. In the Tel Aviv region, population density exceeds 6,680 per square kilometre as compared to just over 1,000 in Jerusalem and only 57 in the southern district.

In the thirty-year period between 1960 and 1990, Israel's population more than doubled and its built-up area quadrupled. According to Israel's long-range masterplan (Israel 2020), the country's population will reach about 8.5 million in 2020 (nearly doubling the 1990 population) and its built-up area will more than double. Increased stress will be placed on a diminishing pool of land resources.

COASTAL RESOURCES – NATURAL

Geological and Geomorphological Features

Israel's Mediterranean coastline extends about 188 kilometres from north to south. With the exception of Haifa Bay, it is a smooth coastline which gradually curves from Northeast-Southwest in the south to almost north-south in the north. The coastline is largely smooth and sandy, in places with a back-shore cliff. It can be divided into the following five geomorphological units:

- 1) *Rosh Hanikra to Acre*, a region of abraded rocky platforms and pocket beaches with local sand backed by a low cliff;
- 2) *Haifa Bay*, a region of wide sandy beaches backed by dunes and bounded by the Acre promontory on the north and the Carmel mountain range on the south;
- 3) *The Carmel coastal plain*, a region between Haifa and Hadera consisting of three low parallel ridges of calcareous sandstone, parts onshore and parts offshore, with sandy beaches and, in places, small embayments;
- 4) *The Sharon coast*, a region of narrow beaches (up to about 30 metres) backed by cliffs up to 50 metres high between Hadera and Tel Aviv; and
- 5) *Southern coast*, a region of wide sandy beaches (30-50 metres wide) backed by a low bluff and wide dune fields between Tel Aviv and the Gaza strip in the south.

Kurkar Cliffs and Ridges

The continental shelf and coastal plain of Israel are built of a series of shore-parallel carbonate-cemented quartz sandstone (locally termed kurkar) ridges, separated by longitudinal shallow depressions. The kurkar ridges are a lithification product of windblown sands that were piled up into shore-parallel dunes during the Pleistocene. The sharp drop in the global sea level and regression during the last glacial period exposed the continental shelf to sub-aerial processes, erosion and dune movement. The subsequent Holocene transgression drowned the westernmost kurkar ridges and filled the depressions between them with delta-derived sand and clayey silt reaching 20-40 metres.

On land, up to eight shore-parallel kurkar ridges are discernible, the easternmost lying 25 kilometres inland. The number of these ridges diminishes northward. Opposite Mount Carmel only three ridges remain, of which only one reaches the Carmel Cape.

Offshore, the shelf's ridges are of low relief, with irregular upper surface, suggesting that they are the abraded cores of ridges which have passed through the high energy zone of the advancing Holocene transgression.

The broadly concave Israeli shoreline cuts this ridge-and-depression system at a slight angle. Consequently, Israel's northern shoreline includes stretches of unabraded back-shore ridges, whereas the coastal ridge along the central shoreline is abraded, forming a prominent back-shore cliff. In this 50-kilometres long stretch, known as the Sharon Escarpment, the cliff and ridge are at their highest. Southward, the ridges are not clearly aligned, causing irregular and widely spaced cliff sections.

Sand Supply

Israel's littoral zone is a part of the Nile littoral cell which extends from the Nile Delta in Egypt to Acre at the northern tip of Haifa Bay, a distance of some 650 kilometres. This cell consists of input of quartz, sand, silt and clay sediment from the Nile Delta by longshore drift, transport of sand by waves and currents eastward along the Sinai coast to Israel, wind-blown sand from the beach landward and a sediment sink in Haifa Bay. The flow of sand by longshore sediment transport has been estimated at 170,000-540,000 m³/year, but can vary significantly depending on the severity of winter storms. The highest sediment flow is found along the southern beaches (estimated at 300,000 m³/year north-east flow), diminishing to 200,000 m³/year north of Tel Aviv, and ending in Haifa Bay. The pattern of sand movement along the northern section of the coast between Tel Aviv and Haifa is still not clear. North of Acre, the sand is meagre in quantity and largely biogenic in origin, consisting mostly of crushed shells, calcareous algae, carbonate pebbles and granules and a very small percent of quartz grains.

Studies have shown that sand migrates seasonally in the on-offshore direction down to 10-15 metres (the offshore limit of substantial sediment transport by wave action known as the "closure depth"). With increasing distance from the shore, the sediment gradually becomes finer, progressing from medium sand to fine sand, silt and clay.

Based on the longshore and the onshore/offshore sediment transport of the Israel coast, most experts agree that any disturbance, such as sand dredging, in depths down to 30 metres should be avoided because its removal may divert an equal volume of sand from the shoreline, thus enhancing shore erosion. On the other hand, a recent survey on fill material sources (undertaken within the framework of the artificial islands feasibility study) has revealed that some 1.3 billion m³ of sand are buried under the mud in the continental shelf beyond the 30 m depth in the area between Hadera and Zikim. The survey discovered four zones (where the relative ratio of sand thickness to mud thickness is greater than one), in which 400 million m³ of sand are buried beneath a cover of 120 million m³ of mud. This sand contains silt and clay and may therefore not be appropriate for fill material. The economic feasibility of dredging this sand for other purposes, such as beach nourishment, requires further study and analysis.

The sand balance along Israel's coastal zone is a product of natural processes and human intervention. Sand losses due to the outgoing longshore transport, seaward escape and landward wind transport exceed the natural gains from the incoming longshore transport and the abrasion of the coastal cliffs. This deficit was aggravated by use of beach sand for construction from the beginning of the century until 1964 when sand mining was outlawed and by the construction of seaward-projecting structures that trap sands on the upstream side, and offshore detached breakwaters that trap sands between themselves and the coast. It is estimated that since the beginning of the century some 10 million m³ of sand have been mined from Israel's beaches, 4 million m³ of which were quarried from 1948 to 1964. This uncontrolled mining caused narrowing of the beach and seasonal sand stripping, and several of the damaged beaches have not yet recovered. It is estimated that the total volume of sand trapped by coastal structures is also close to 10 million m³, thus bringing to 20 million m³ the total volume of sand removed from the coastal system due to human activity (see p.18).

Based on an estimated rate of sand supply by natural longshore sediment transport of some 330,000 m³/year, it may be said that the coastal system has lost about 60 years of sand supply from the beginning of the present century as a result of human intervention alone.

Landscape and Natural Values

Israel's geographic location at the junction of three continents coupled with the climatic changes throughout the history of this region have been largely responsible for its diversity of landscapes, habitats and species. Thus, species widely distributed over the entire Mediterranean climate region reach their southern limit of distribution in Israel and Saharan or Asian desert species reach their northern limits of distribution here.

The coastal landscape consists of several components. They include rocky shoals and nearshore islets, abrasion platforms and vermetid terraces, swash zone (mostly sandy, rarely rocky), sand berms, back-shore escarpment or truncated shore ridge (often with a shallow trough behind the shore ridge), shore hillocks, crescentic baylets, river gaps, maritime plain and coastal hummocks. The shoreline is more varied north of Haifa Bay; from Haifa southward, uniformity prevails over longer distances. Wind-blown sand becomes common toward the south.

The kurkar ridges, shifting and semi-stable sand dunes, rocky shore habitats, limestone ridges and sea caves, hamra (red sands distinctive for their orange-red colour) soils, remnants of former coastal swamps, rivers, and carob and pistachio woodlands support different associations of vegetation and animal species.

The sand and kurkar landscape of the coastal strip is especially important as a unique ecosystem in global terms which supports a relatively large number of endemic species and a wide variety of fauna.

Rocky shores which are characterised by abrasion platforms, tidal pools and shoals provide a substrate for a rich assemblage of invertebrates.

The central and northern coastlines, particularly in the Western Galilee and Carmel regions, are important sites for turtle nesting, mostly of the loggerhead sea turtle (*Caretta caretta*), but are otherwise relatively poor in species. On the other hand, migrating and semi-stabilised sand dunes serve as habitats for a variety of species including numerous reptilian species. One of the last remaining reserves of active sand dunes on the coastal plain is near Ashdod. This sand dune, ranging between 600 metres to 3 kilometres in width and reaching up to 35 metres at its highest point, was recently granted protected status as a landscape reserve.

The coastal system also comprises about 10 rivers and their tributaries. All of Israel's coastal rivers have been rechanneled over the years in order to supply urban and agricultural demand under conditions of water scarcity. They were then transformed into receptacles for urban and industrial sewage and agricultural drainage. In an effort to restore the coastal rivers, a National River Administration was set up in 1993 to co-ordinate the restoration of the country's rivers and the preservation and renovation of natural and historic sites along riversides. A model for river rehabilitation was formulated and ecological surveys implemented in order to pave the way for actual restoration.

The importance of river mouths has also been recognised in recent years based on their ecological, physical, landscape, and human use aspects. These coastal landscape units are characterised by wide physical changes within short time frames, as a result of floods, flows, storms, runoff and tides. River mouths, which are usually plugged by sand in summertime, are a meeting point between saline and freshwater and support a unique population of flora

and fauna. They serve as a “gateway” for species which require both types of water and habitat for their survival and development.

Various factors affect the distribution of coastal vegetation, especially proximity of the vegetation to the sea, topography and substrate. Thus, along the shoreline, salt spray and strong winds result in vegetation belts which can tolerate harsh conditions. Other types of vegetation are adapted to the high coast, where the coastal cliff is in close proximity to the water line and low coast, where the coastal cliff is interrupted by rivers and wadis. Primarily, vegetation is influenced by the presence of the kurkar-hamra-sand complex.

Offshore, the Mediterranean environment is an important and active site of bio-geographic interaction between the marine biota of the globe. The inauguration of the Suez Canal in 1869 launched a migration of hundreds of Red Sea species into the Mediterranean. Thus, the strong impact of the lessepsian migration from the Red Sea creates a unique environment in the south-eastern Mediterranean from the point of view of both flora and fauna. As a result of the continuous growth in the number of Red-Med migrants, modification of the composition and structure of the Levantine biota has already begun. One of the adverse consequences of lessepsian migration was the discovery of large aggregations of jellyfish along the Israel coast in the 1980s. The jellyfish was identified as a new species, *Rhopilema nomadica*, originating in the Red Sea. Mass swarming of the jellyfish in the summer has exerted adverse impacts on fisheries, coastal installations and tourism.

Israel's Mediterranean coastline is also distinguished by its vermetid reefs, small-rimmed intertidal structures which only developed in the subtropical marine water of the southern Levant and the Atlantic (Bermuda) coasts. These reefs support a diverse and rich intertidal fauna.

More than two dozen small islets (totalling over 0.15 km²), which represent remnants of kurkar ridges, are preserved in close proximity to the shore. None of the islets are currently inhabited or subject to human use, and vermetid reefs are well preserved in these islets. These micro-ecosystems provide nesting sites for marine birds and an important winter roost for thousands of great cormorants (*Phalacrocorax carbo*).

Coastal Open Space

In a country with high density urban development and scarce land resources, the coast and seashore serve a vital role as open spaces. The scarcity of open space is especially evident along the coastal plain since the country's settlement tradition has primarily concentrated on the seashore. This has led to encroachment on and loss of scenic landscapes, nature and agricultural land. Today, coastal agricultural lands serve to break up stretches of built areas and prevent the formation of a megalopolis throughout the coastal plain.

Out of Israel's 188-kilometre shoreline, 50 kilometres are used for national infrastructures and defense uses and are closed to the public. The remaining coastline has been designated as follows: 59 kilometres as municipal shores (adjacent to urban settlements), 43 kilometres for preservation as nature reserves and national parks, and 36 for open space (free of all infrastructures and facilities). A recent survey has revealed only two areas of continuous undisturbed beaches along Israel's Mediterranean coastline: the area between Ashdod and Ashkelon (in part) and the Carmel Coast. These stretches, along with the few additional

stretches of open land available along the coastline, have special social value for the country's population and provide opportunities for recreation, leisure and nature protection.

Fisheries

The Eastern Mediterranean is relatively poor in nutrients and fish, especially since the construction of the Aswan Dam. Therefore, fishing is small scale and is not a major component in the coastal environment.

Three coastal fish farms and one cage farm currently produce seawater fish in significant quantities on Israel's Mediterranean coast. The contribution of Mediterranean mariculture to fishery harvests has grown significantly in recent years and reached nearly \$5,000,000 in 1997. Based on current proposals for additional mariculture projects, marine farming may increase significantly in the future.

COASTAL RESOURCES – CULTURAL

Coastal Archaeological and Historic Sites

Alongside its natural and environmental resources, Israel's coastal plain includes a rich cultural heritage. Intensive human activity has characterised this Mediterranean coastline for thousands of years. This activity has left numerous archaeological remains along the shoreline and shallow water.

Several ancient coastal cities dot the Mediterranean coastline. Acre, situated on a promontory at the northern end of the Bay of Haifa, is first mentioned in Egyptian texts dating back to 1800 BCE. As a result of its geographic position, this port city served as an important military and naval base through the centuries. The earliest remains show that the beginnings of Acre were built a few kilometres east of its present seashore location where the Phoenicians manufactured and traded in glass and in purple dye. During the reign of Ptolemy II, the name of the city was changed to Ptolemais, by which it was known until the Arab conquest. The city became the Crusader capital from the 1191 until 1291 and reminders of Crusader times include the great Crypt of St. John of Acre and the Knights Halls. The city was fortified and rebuilt during Ottoman rule when it became a political and military centre strong enough to deter Napoleon, who in 1799 unsuccessfully besieged the city. Efforts have been made to preserve the oriental character of the Old City of Acre and to excavate and restore the archaeological remains. The ancient remains largely date back to the Crusader and Ottoman periods and include the harbour, the double walls of the city, the citadel, two caravanserais, a mosque, a bath and the Pisans and Venetian quarters.

Atlit, an ancient port on the Mediterranean coast, lies about 31 kilometres south of Cape Carmel. Excavations have shown that the site was inhabited in the Iron Age, probably by Phoenicians. In the early 13th century, Crusader pilgrims built a castle which was held by Templar knights. The castle was built on a promontory, jutting out into a bay which served it as a harbour. It was defended by a flooded fosse, an outer wall and an inner wall with two towers. Inside are vaulted store rooms, the foundations of an octagonal church, a vaulted refectory and other ruins. The castle served through most of the Crusader period as an absorption and clearing station for newly arrived Knights of the Cross. Despite repeated

sieges and attacks, it was never captured in Crusader times. Atlit was finally evacuated in 1291, a few months after the fall of Acre, and its fall marked the end of the Crusader presence. Near Atlit are the ruins of the Destroit fort, constructed about 100 years prior to Atlit, to protect passer-by and caravans from robbers.

Further south, between Haifa and Tel Aviv, the ancient port city of Caesarea, built by Herod the Great about 2000 years ago on the ruins of a Phoenician anchorage known as Straton's Tower, is world renowned. It served as the capital of the Roman Empire in this part of the world for about 500 years. Herod enlarged the city, surrounded it with a wall and built a deep sea harbour. Caesarea was also an important Christian centre fought over and conquered alternately by Crusaders and Moslems until it was finally razed at the end of the thirteenth century. During Crusader times, the city was fortified by a deep moat and high walls. Remains of several periods may be seen at the site. The Herodian period is represented by the remains of a harbour, a vault and the remains of a wall with round towers. The Roman and Byzantine cities are represented by a city wall, hippodrome, aqueducts, theatre and a paved square, with staircase and mosaics, where Roman statues were set up, in secondary use in Byzantine times. Remains of the Crusader period include the wall of Louis IX, with its sloping fosse, gateways and towers. Numerous remains of sculptures and hundreds of inscriptions have been found at the site and the Roman amphitheatre is now used for concerts and other art performances.

In the country's central region, Jaffa has been identified as one of the world's oldest coastal cities. Archaeological remains show that Jaffa existed as far back as the 16th century BCE. Jaffa changed hands many time in the ensuing centuries as empires rose and fell as witnessed by remains dating back to the Hellenistic, Roman, Arab, Crusader, Mamluk and Ottoman periods. In the 19th century, the anchorage and its installations were enlarged and improved and a lighthouse was built. In the 20th century, Jaffa served as the gateway for new immigrants into the country and its port, which was expanded during the mid-1930s, served as the main exit for citrus fruit. Today, the city boasts historical buildings along narrow streets, mosques, city walls, towers and an inner citadel. The port is now only used as a mooring berth for recreation and fishing vessels.

Further south are the ancient cities of Ashdod and Ashkelon, two of the five city-states of the Philistines, one of the so-called Sea People. Although the city was situated on the *via maris*, the trade route near the city, it was not directly on the coast but possessed an ancient port which was called Ashdod Yam ("Ashdod-on-the-Sea"). Remnants of the Byzantine and Moslem periods were discovered in the fortress of Ashdod Yam. Excavations at Ashdod have uncovered remains of Canaanite and Israelite fortifications and a Hellenistic plant for extracting purple dye from murex (shells). Stratigraphical evidence shows nearly continuous occupation from the seventeenth century BCE until the end of Byzantine times. Ashkelon was inhabited long before the Philistines and was the site of one of the oldest settlements in the area. It is first mentioned in the Egyptian Execration Texts of the 11th dynasty (about 20th-19th century BCE). In the Middle Ages, Ashkelon was a Crusader city, and the remains of a church, walls, statues, columns, inscriptions and an ancient dyke are still standing.

Number of visitors to selected National Parks in Israel is given in Table 1.

Table 1: Number of Visitors to Selected National Parks in Israel

National Park	Number of Visitors in 1996	Percentage of Israelis
Caesarea	550,000	25%
Achziv	60,000	98%
Ashkelon	35,000	majority

Several other ancient coastal cities dot the Mediterranean coastline. They include, among others, Yavne-Yam, Appolonia, and Dor.

Marine Archaeology

The deficit in Israel's sand budget which has resulted from quarrying and from coastal and offshore construction in recent decades has revealed thousands of buried artefacts. Countrywide underwater rescue surveys have been carried out in Mediterranean waters for the purpose of discovering the remains of shipwreck assemblages, cargoes, anchorage sites, and submerged prehistoric settlements. Of special interest are remnants of prehistoric settlements on the sea floor off the Carmel coast, north of the Crusader fortress at Atlit, 250-400 metres from the coastline at a depth of 8 to 12 metres. Remnants of prehistoric settlements and facilities were discovered dating back to the pre-pottery Neolithic period, some 8000 years ago. Excavations at the site have revealed foundations of stone dwellings, burial grounds with human skeletons, ritual installations, water wells (the oldest known in the world), animal and fish bones, flint and stone tools, bone implements, and a large quantity of plant remains (mostly charred or waterlogged seeds and branches).

The waters of the Eastern Mediterranean were one of antiquity's most travelled routes, and shipping dates back to the Middle Bronze period (4000 BCE). It is assumed that the sailing vessels and equipment used at that time, coupled with the physical characteristics of the Israel coastline (lack of natural shelters) and the frequency of unexpected storms, led to hundreds of shipwrecks throughout the centuries. As a result, shipwrecks and cargoes have been discovered in the breaker zone near the shoreline and adjacent to such ancient coastal cities as Ashkelon, Ashdod, Yavne, Appolonia, Caesarea, Dor, Atlit, Acre, and others. A 4th century BCE shipwreck was found in the sands of Kibbutz Ma'agan Mikhael in 1985 and the full cargo of a Roman ship was discovered in Ashkelon during the course of a survey in the 1990s. It may be assumed that hundreds of sites are still left to be excavated including ancient towns and countless wrecked ships buried under silt and sediment.

DEVELOPMENT PRESSURES ON COASTAL RESOURCES

The combination of urban and economic pressures for development, coupled with the attraction of the coastline for tourism and recreation, has exacerbated the conflicts along Israel's Mediterranean coastline. Moreover, reduced profits in the agricultural sector are likely to trigger pressures for the conversion of agricultural lands along the coastline into built-up areas, especially in the central region of the country. Development pressures have accelerated in recent years along with the increase in population, standard of living and leisure time. The greatest pressure for development is along the central section of the coastline where population and industrial activity are concentrated.

Urban Development

Problems of urban sprawl and sub-urbanisation are especially acute in the central section of the coastal strip. As a result of the steep rise in demand for residential areas on the coastal plain, property values in this area are 50% higher than their equivalent inland. Today, the population in the country's major coastal cities is already high: about 260,000 in Haifa, 150,000 in Netanya, 84,000 in Herzliya, 350,000 in Tel Aviv-Jaffa, and 138,000 in Ashdod. Based on present trends, it is expected that demands for additional residential, employment and infrastructure areas will continue to grow as a result of the rise in standard of living and population.

The population in the Greater Tel Aviv metropolitan area (encompassing the central region of the country and the municipality of Ashdod), already exceeds 2.5 million residents, nearly 44% of the total population of the country. Based on an annual rate of growth of 1.2% to 1.4% annually, the population of this metropolis is expected to reach about 3.5 million in 2020. This growth will bring about a demand for an additional 70-75 million square metres of floorspace for residential purposes in this area of the country alone.

Tourism

Israel's tourism potential is largely based on its religious-historic heritage. Therefore, tourism to and within Israel has largely focused on historic and pilgrimage sites, tourist cities and familiar tourist routes. Although Israel's natural resources, including its beaches, are not presumed to be key elements in tourism potential, coastal tourism is a complementary part of the vacation package. Beach resources may be used for creating tourism packages which combine site visits and excursions with recreational tourism.

Israel's coastal strip is divided into tourism sections from north to south, based on their natural features, types of accommodation and target audiences. By far, the most highly developed section, in terms of tourism and recreation, is the central coastal stretch which includes Israel's most densely populated cities of Tel Aviv, Netanya and Herzliya.

The annual number of tourists to Israel in recent years stands at about 2.4 million, of which about 14% (some 330,000) include coastal recreation in their visit. About 10,000 hotel rooms, nearly 30% of the total number of hotel rooms in Israel, are distributed along the Mediterranean coastline.

Table 2 shows the number of hotel rooms in the metropolitan area of Tel Aviv in 1995 as well as the forecast for 2010. The forecast shows an anticipated growth rate of 255% in this areas alone, as compared to 1995 figures.

Table 2: Hotel Rooms in the Tel Aviv Metropolitan Area – 1995 and 2010

City	Rooms – 1995	Rooms – 2010 Forecast
Netanya	2,500	6,000
Herzliya	750	2,250
Tel Aviv	6,300	13,300
Bat Yam	800	1,800
Rishon Lezion		1,000
Ashdod	100	2,100

Tourism is a powerful economic and social force and promises to be a primary export and business sector in the future. Optimistic forecasts by the Tourism Ministry anticipate a constant and steady growth in tourism to about 5 million tourists annually by the year 2010 and 7 million tourists by 2020. These forecasts require suitable preparations to adequately absorb the visitors. An important planning principle calls for determining the optimal balance between population needs and the capability of tourist areas, sites, regions and centres to withstand the pressures of the visits. Planning of tourist sites requires in-depth reviews of the carrying capacity of tourist sites.

Internal Tourism and Recreation

About 70% of Israel's population live within 15 kilometres of the Mediterranean coastline, and the population of the coastal plain has the highest rate of growth. During the warm months, millions of Israelis flock to dozens of official bathing beaches which are supervised by lifeguards (about 27 kilometres) and to other "undeclared" beaches which are open to the public but do not include lifeguards or sanitary and public services. The local population is by far the greatest "user" of the beach for leisure and recreation.

Over the past three decades, public demand for coastal recreation has grown significantly. Calls for new beaches, shoreline restaurants and cafes, berthing spots for yachts and small boats, gliders, all terrain vehicles and scooters have grown concomitantly, thereby increasing the conflicts between the different components of recreation - water sports for the few versus swimming and recreation for the many.

Marinas

Israel's coastlines have eight marinas, of which three (Herzliya, Ashdod and Ashkelon) were constructed in recent years. Israel's first marina was built in 1972 in Tel Aviv to serve small vessels. The others have largely been integrated with fishing harbours (Acre, Kishon, Jaffa) and another small harbour serves an adjacent naval academy (Mikhmoret). Today, the marinas in Acre, Jaffa, Tel Aviv, Herzliya, Ashkelon and Ashdod "consume" some 13 kilometres of coastline - 7% of the total length of the coast.

In the 1970s, a massive rise in demand for moorings of small sports and recreational boats was forecast, and consequently the coastal masterplan designated 14 sites for marinas along

Israel's coastline. It was also decided that an adequately large hinterland would be made available for the development of tourist and commercial activity in order to make such plans economically attractive. As a result, new marinas were built in Ashkelon, Ashdod and Herzliya. Plans for additional marinas in Nahariya, Haifa, Acre, Caesarea, Netanya, Tel Aviv and Bat Yam have already been advanced. All the plans, with the exception of Nahariya, involve land reclamation and construction of multi-story buildings for residential and tourism purposes.

Israel currently has 2,350 berthing sites in its marinas (excluding the Ashdod marina which will shortly be inaugurated for 550 berthing sites). In practice, only 1,350 vessels utilise these marinas (57%) – see Table 3. Clearly, the original forecast of 20,000 berthing sites was grossly exaggerated. Pressures for additional marinas have been attributed to purposes having little to do with providing new berthing sites. The underlying aim of the marina plans may well be to obtain building approval on the shoreline.

Table 3: Vessel Capacity and Actual Utilisation in Israel's Marinas

Marina	Number of Vessels in Practice	Vessel Capacity/ Berthing Sites
Acre	155	160
Haifa-Kishon	200	200
Herzliya	280	800
Tel Aviv	280	300
Jaffa	215	220
Ashkelon	170	600
Caesaria, Sedot Yam, Mikhmoret	50	70
Total	1,350	2,350

Industry and Energy

A large portion of the country's economic and commercial activity is concentrated on the coastal stretch. This is especially evident in the Tel Aviv and Herzliya areas which are at the hub of the country's industrial (especially high-tech), commercial and financial activities, producing some 45% of the GDP. The number of people employed in this area of the country reached 955 thousand in the mid-1990s, out of a total of 2 million in the country as a whole. It is expected that the Tel Aviv metropolitan area will preserve its share of total employment in the future, some 47.5% of the total - reaching 1.55 million in 2020. Economic growth in this region is expected to reach an average of 4% per year. To accommodate this rate of growth, some 40 million square metres of additional floorspace will be required.

Energy facilities are also scattered along the Israeli coastline. The country's oil refineries operate around the commercial ports of Haifa and Ashdod. Its three oil fired power plants are situated in close proximity to the coastal cities of Haifa, Tel Aviv and Ashdod, and its two coal-fired power plants are adjacent to the cities of Hadera and Ashkelon. These power complexes were sited on the Mediterranean Sea in order to use its seawater for cooling purposes.

Israel is currently considering importing large quantities of natural gas for electricity production as a substitute for petroleum-based fuels and designating sites for central storage systems and primary transmission and distribution systems for liquefied petroleum gas (LPG). One possibility is acquiring natural gas supplies from neighbouring countries through a marine pipeline system. Thus, the coastal strip may be subject to additional pressures including an infrastructure for the distribution and transmission for natural gas and LPG which will link with central points of consumption such as coal and oil-powered plants and gas turbines.

Furthermore, in light of water scarcity in Israel, desalination will become imperative sometime in the next century and sites for desalination facilities on the coast will have to be allocated.

Ports and Marine Transport

Modern construction of coastal structures in Israel began in 1932 with the establishment of Haifa Port. In the early 1960s, the new deepwater port of Ashdod was constructed to service the southern parts of the country. Plans are currently being made to expand Israel's existing port facilities to keep pace with the country's needs.

Crude oil storage facilities are distributed throughout the country and are connected by a pipeline system to the unloading ports and to the oil refineries in Haifa and Ashdod. These activities are carried out by the Eilat-Ashkelon Pipeline Co. and Petroleum and Energy Infrastructure Ltd. The Eilat-Ashkelon pipeline system has a throughput capacity of 45 million tons of crude oil per year. In addition to catering to the Israel oil sector, it can also serve as a land bridge for oil shipment between the Red Sea and Mediterranean ports.

Coal for the purpose of electricity production is unloaded directly at Hadera (where the ships dock at the north end of the off-loading jetty, built some two kilometres from the shore), and at the port of Ashdod. A coal terminal is also under construction at the Ashkelon power plant.

Finally, two other ports exist along the Mediterranean coastline which served as commercial ports in the past: Jaffa Port and Tel Aviv Port.

Defense Requirements

Large sections of coastline are used by the military. It is estimated that about 50% of the coastal area south of Tel Aviv is not accessible to the public.

CONFLICTS AND EMERGING SOLUTIONS IN COASTAL AREAS

Urban growth, industrial development, sand management, offshore structures, erosion and instability of the coastal cliff are critical issues in the densely populated coastal plain of Israel. The following major conflicts have been identified in the area between the shoreline and coastal waters:

- Marine and coastal pollution from land and marine based sources which conflict with recreation, and tourism activities, with ecological processes and with infrastructure.
- Interference with longshore sediment transport and coastal and cliff erosion and retreat as a result of marine structures such as ports, marinas and detached breakwaters.
- Development of the coastline and the adjacent shallow water strip for leisure, recreation, tourism and urban development versus conservation of historic, archaeological and natural values.
- Closure of access to sea and coast by defense and infrastructure uses versus water sports, fishing, diving, bathing and recreation for the public.

The primary coastal issues which are currently on Israel's agenda include the following: pollution prevention, balancing development and conservation, protecting the sand balance and preventing damage to the shoreline and coastal cliff, conserving the diversity of species and their ecosystems, preserving the archaeological, historic and cultural heritage, and protecting the coastline as an open space for the enjoyment of present and future generations.

Marine Pollution

Oil Pollution

Pollution accidents on the Mediterranean coast are mostly due to oil discharge from vessels and tankers, leaks from marine fuelling facilities and discharge from land-based sources. Ports and oil facilities along the Mediterranean coastline of Israel present a major oil pollution threat. Since the number of cargo and passenger ships arriving in Haifa and Ashdod ports is on the increase, as is the loading and unloading of oil near coastal installations, the risk of major spills is considerable. Moreover, a major accident at the northern entrance to the Suez Canal may well cause damage to the long and straight coastline of southern and central Israel.

All Israeli ports have reception facilities for oily bilge and ballast waters. In the event of a major spill, these facilities can be utilised to store "clean" recovered oil prior to its transfer to refineries for treatment.

The Ministry of the Environment has issued guidelines on the use of advanced (third and fourth generation) dispersants. Use of such dispersants requires the prior, written authorisation of the director general of the Ministry of the Environment and must be carried out under the supervision and guidance of the ministry's marine pollution control inspectors.

Contingency Plans for Large-Scale Oil Spills

While Israel is equipped to effectively combat small and medium-scale oil spills in the Mediterranean, the country has long lacked the capability to effectively respond to large-scale oil spills. Capability is now being strengthened as a result of regional co-operation to prevent and minimise the environmental and economic damage that may be caused by large-scale marine pollution. A sub-regional agreement between Cyprus, Egypt and Israel on preparedness and co-operation in response to medium and large-scale oil spills was signed in 1995 within the framework of the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC) and the International Maritime Organisation (IMO). The agreement requires each state to prepare a stockpile of marine pollution abatement equipment which will be available to its partners in case of a spill in open waters. Using their joint forces, the states (which will also join forces in a co-operative task force, common exercises and common training) will be able to deal with a spill of up to 15,000 tons. Israel's own oil combating capability has been significantly boosted with the preparation of two oil pollution combating centres in Haifa and Ashkelon, which will be capable of dealing with spills of up to 4,000 tons. An inter-ministerial steering committee has been appointed to establish strategic principles and guidelines for preparation of a National Contingency Plan for Preparedness and Response to Combating Marine Oil Pollution. The plan is slated for completion in 1999.

Dumping of Waste

Dumping of waste into the sea from a vessel or aircraft is regulated through a strict permit system, instituted in 1984. The regulations list categories of substances prohibited or permitted to be dumped to sea and establish procedures and considerations for issuing permits. A special inter-ministerial committee decides on each permit application. Permits are granted or refused according to criteria stipulated in the regulations and only when the committee is convinced that there are no reasonable land alternatives for disposal and treatment of the waste and wastewater and that the best available technological means have been implemented to prevent the pollution. The applicant must reasonably prove that no damage to the marine environment will be caused. Even when permitted, dumping must comply with detailed regulations specifying maximum level of heavy metals in the residue, distance from shore, sea depth at the dumping site, and type of vessel used to transport the waste. In addition, a monitoring programme must be implemented around the dumping site.

By the end of 1998, in line with changes to the Dumping Protocol of the Barcelona Convention, sea dumping was stopped in Israel with the exception of dredged material (sand) from maintenance dredging in Haifa and Ashdod ports and in the cooling ponds of Israel's coastal power plants, brines (following pre-treatment) from food plants, and vessels to serve as artificial reefs and diving sites.

Land-Based Sources of Pollution

Land-based sources of marine pollution are the most serious environmental problem in the Mediterranean Sea area. A few coastal municipalities and a number of industries continue to sporadically discharge partly treated sewage into the Mediterranean Sea. Consequently, major efforts are being made to eliminate all land-based sources of sea pollution. Israel supervises and enforces all land-based sources of marine pollution within the framework of an inter-ministerial permits committee.

In recent years, substantial progress has been made in preventing pollution from land-based sources, including domestic and industrial waste, agricultural runoff and river discharges. This is largely attributed to increased supervision and enforcement of the Prevention of Marine Pollution (Land-Based Sources) Law and its regulations coupled with better information and guidelines to industrial plants and municipalities. In 1998, efforts were increased to prohibit indirect marine pollution through coastal streams, especially in the Haifa Bay area which has been identified as one of Israel's pollution "hot spots."

A pilot project was recently launched to install sensors on pipelines which discharge effluents to the sea. The sensors will relay on-line information on everything spewed into the sea from land-based sources to a computerised control system in Haifa. It is anticipated that all plants which discharge, or may potentially discharge, waste to the sea or to a river, will eventually be connected to the system - about 30 plants or potential polluters in all. The system will eventually become a comprehensive computerised environmental surveillance system of the marine and coastal environment.

Bathing Water Standards

According to the Israeli standard for seawater quality, public bathing is prohibited in the following circumstances: epidemiological evidence of infectious disease connected with bathing in the sea; discharge of sewage in the vicinity of the bathing beach; detection of excrement on the beach or in the sea; conditions which may endanger the health of bathers; and water which does not meet strict water quality standards.

Routine microbial tests at Israel's authorised beaches are conducted by the regional public health laboratories of the Ministry of Health. Local authorities are required to test water quality in authorised beaches in their jurisdiction and to transfer the samples to the Ministry of Health. Samples are taken once each week during the bathing season (May through October) and once a month during the winter.

If test results indicate potential public risk, the Ministry of Health consults with the local authority and with the regional bathing supervisor of the Ministry of the Interior on the advisability of closing the beach to bathers. Although beaches have at times been temporarily closed, Israel's authorised beaches generally comply with bathing water standards and meet stringent international criteria.

Beach Cleanliness

Solid waste, including plastic, bottles and driftwood, is a major blight on the country's shorelines. While current and wind regimes in the eastern Mediterranean are known to deposit significant quantities of waste from other countries on Israel's shores and therefore require international co-operation, at least half the litter on the beaches is left behind by vacationers.

Local authorities are responsible for the regular cleaning of all authorised bathing beaches in Israel, but these beaches constitute only a small percentage of the Mediterranean coastline (less than 30 kilometres). Since 1984, the Ministry of the Environment has financed the cleaning of all open beaches twice during each bathing season. Beginning in 1997, the Ministry initiated an experimental project whereby dozens of kilometres of shoreline are cleaned by local environmental units on a weekly basis. The project was expanded in 1998 in

the hope that in future years local authorities will take responsibility for the cleanup of all of Israel's open beaches for the benefit of the entire population.

Beach cleanliness has also been targeted as a priority for public awareness and involvement. Over the years, several large-scale volunteer cleanup campaigns have been undertaken, to assist in actual beach cleaning and to increase public awareness. In addition, thousands of young people participate in cleaning coastal stretches within the framework of camps run by the Society for the Protection of Nature in Israel. Other projects promote the participation of soldiers in cleanup activities within the framework of an army-sponsored educational campaign. In recent years, Israel has participated in volunteer coastal cleanups within the framework of International Beach Cleanup Day in September and has initiated underwater cleanups, by hundreds of volunteers, to rid the water of unsightly and environmentally harmful waste.

A recent study has shown that partial beach cleanups have only short-term impact due to the dynamics of the waste. Continuous cleanups along the entire stretch of the Mediterranean coastline are necessary in order to assure a litter-free coastal environment.

Economic Instruments for Marine Pollution Control

Monetary resources for combating marine and coastal pollution, purchase of equipment, law enforcement, monitoring and research activities and beach and shore cleanups are generated by the Marine Pollution Prevention Fund. Income is from fees collected from all oil terminals and ships calling at Israeli ports and from fines collected from individuals and bodies convicted of transgressing marine legislation. In addition, a Cleanliness Fund helps finance a wide array of environmental activities including beach cleanups. Income is derived from fees imposed on manufacturers and importers of disposable beverage containers and fines imposed on violators of environmental laws.

Impacts of Marine Structures

The damage caused to beaches by marinas and other offshore structures is a matter of serious concern. Fifty-five seaward-projecting and offshore structures, including harbours, marinas and anchorages, intake and cooling ponds for power plants, and groins and detached breakwaters were identified in a coastal study conducted about a decade ago. Since then, additional structures were added to the list: the coal terminal at the Ashkelon power plant and the marinas at Ashkelon, Ashdod and Herzliya. Studies confirm that these marine structures intercept the longshore sand transport, causing sand accumulation on the upstream side of the structure and beach erosion downstream. It is estimated that the total volume of sand trapped by offshore coastal structures has reached 10 million m³.

The effects of manmade structures have been quantitatively recorded at several localities including the Ashkelon-Eilat Pipeline Company, Ashkelon marina, Ashdod Port, Herzliya marina and Netanya. The cases of Herzliya and Ashdod are reviewed in greater detail below, but damages have been recorded at each of the sites as follows:

- The cumulative effects of the anchorage breakwaters of the Ashkelon-Eilat Pipeline Company, built in 1972-1974 south of Ashkelon, were analysed by several researchers. All confirmed beach accretion to the south of the breakwater and shoreline retreat to the north of the anchorage.

- Erosion of the coastal kurkar cliff north of the Ashkelon marina began in 1994, two years after the start of construction. In just four years, the cliff to the north of the marina retreated by more than 10 metres. Moreover, substantial sand loss exposed the underlying kurkar rock and uncovered archaeological remains.
- In the Netanya area, where longshore currents flow southward rather than northward during some periods, damages were discovered following the construction of two detached breakwaters opposite the coast in 1969-1970. Beach accretion has occurred north of the breakwaters and shoreline retreat to the south.

A 1998 study conducted by the Geological Survey of Israel on marine sand resources offshore Israel notes the following: the sand balance at many localities along Israel's shoreline has been negative, at least during the last 40 years, and is likely to worsen as coastal development increasingly intervenes with the natural sand replenishments. The report concludes that "the Mediterranean coast of Israel has reached a state where its future depends largely on human actions. An integrated coastal management policy that emphasises environmental protection concerns must be urgently adopted to secure well-balanced and sustainable development."

The Case of the Herzliya Marina

The marina in Herzliya is one of the foremost examples of coastal damage as a result of offshore construction. This marina was the first to be built within the framework of the coastal masterplan, and was only approved for construction following an Environmental Impact Assessment (EIA) and a physical model (see Appendix). The studies showed that construction of the marina, with measures for coastal protection to its north, is not expected to cause coastal degradation. Coastal protection measures, detached breakwaters and sand nourishment were incorporated into the marina plan. The regulations also required monitoring and inspection, including aerial photographs, bathymetric mapping and a follow-up report.

Construction of the Herzliya marina was completed in 1992. By June 1994, it became clear that the impacts of the marina did not match those anticipated in the EIA. Monitoring indicated coastal damage and significant erosion north of the three detached breakwaters. Swimming beaches along some 15 kilometres north of the marina lost about half of their original width in just five years due to the reduction of sand supply from the south.

The case raised many issues for reconsideration. Most specifically, the realisation that physical and mathematical models cannot accurately predict the environmental impacts of a project led to a re-evaluation of Israel's policy on offshore marine structures and sand management. In 1995, the Minister of the Environment wrote to heads of local authorities along the coast, asking them not to advance plans for marine structures which may threaten coastal resources before the mechanisms of coastal damage are determined.

The issues related to marinas were reviewed in a recently published Territorial Waters Policy Document (see p. 36). Based on the adverse impacts of existing marinas and the surplus of berthing sites, the document proposes a freeze on the construction of new marinas on the Mediterranean coast until the subject is re-examined for the purpose of establishing long-term policy. The document recommends that the scope of berthing sites should be based on updated demand data, that the tourist character of marinas should be protected, and that the special character of the ancient ports of Jaffa and Acre should be preserved. The Ministry of the Environment and the Society for the Protection of Nature in Israel will shortly submit a

document on marinas to the National Planning and Building Board which will require, *inter alia*, cancellation of new marina plans.

The Case of Ashdod Port

Sand management is an essential consideration in plans to expand Ashdod Port. This massive deepwater structure, constructed in the southern part of the country in the early 1960s, has partly blocked the movement of sand from south to north. To ensure that port expansion will not bring about adverse results, the Environmental Impact Assessment (EIA) guidelines, which were issued by the Environment Ministry for the Ashdod breakwater extension plan, called for an investigation of the harbour's impact on sand supply over the past 30 years.

The resulting studies revealed that approximately 4.5-5 million m³ of sand were trapped by the port. While Ashdod's beaches gained 0.12 km² of sand, the offshore seabed and beaches to the north suffered substantial sand loss. A subsequent review of these figures by an independent expert confirmed these findings. Its conclusion, which related not only to Ashdod Port but to the impact of other offshore structures as well, may be summed up as follows: construction of harbours, marinas, and detached breakwaters along the Israel Mediterranean shore has disrupted and will continue to disrupt the littoral system.

To minimise these adverse impacts, the following solution is advocated: making offshore structures "transparent" to the sediment transport system by artificial bypassing, through sand dredging and transport. The accreted sand, particularly the large volumes accreted south of the structures should be passed from the south to the north side of the structure, using dredges, by sea or overland.

Therefore, as part of the Ashdod Port expansion project, discussions were initiated on bypassing 120,000 m³ of sand annually from south to north. Additional deliberations focused on potential sources for the fill required for the new wharves, an issue which is also relevant to expansion plans for Haifa Port. The Ports Authority intended to dredge the sand which had been trapped in the port for deepening the approach channel and to utilise this sand for fill material. The Ministry of the Environment, on the other hand, regarded the sand as a resource that belongs to the marine system of the country. If used for fill, the ministry required a further bypassing of 120,000 m³ annually as compensation.

In a January 1999 decision, the Territorial Waters Committee adopted the bypass principle. It called for bypassing 120,000 m³ of sand every year for the lifetime of the structure in order to ensure transparency, but for only bypassing another 60,000 m³ as compensation for the sand used for fill. Quantities would be re-evaluated by the Territorial Waters Committee after five years. Discussions now focus on how these principles should be implemented.

The decision of the Territorial Water Committee is an important breakthrough in sand management policy in Israel. It is now understood that the sand debt must be repaid - not only by Ashdod port but by all marine structures that have damaged the country's coastline.

Risk of Cliff Instability

Scientists have calculated that the coastal cliff along central Israel retreats landward at an average annual rate of 15-22 cm. Since cliff abrasion shows no signs of abatement or of attaining topographic stability, it is expected to continue actively in the future.

Given the consequences of sudden collapse of a section of cliff and the value of land at the top of the cliff, a study was carried out on the stability, dynamics, risks and environmental management of the heavily-populated Sharon Escarpment in the central coastal plain. The escarpment forms a sharp dividing line between the coastal plain to the east and the beach and upper shelf to the west. It rises up to about 40 metres above the beach and usually slopes about 75-90° in a laterally variable profile.

The report notes that the escarpment moves evenly eastward by discontinuous collapse on the seaward side. The main driving force behind cliff retreat is wave-shore interaction. The multi-annual rate of cliff retreat is controlled by the rock's overall strength and the frequency of apron clearance by wave swash (a climatic constant), and cannot be slowed or accelerated without modifying these constants. No rockfalls occur as long as the talus protects the cliff's foot. The frequency of rockfalls, averaged on a multi-annual basis and along the entire length of the escarpment, is uniform and independent of cliff height or rock properties.

While cliff retreat is periodic, with each cycle beginning with the undercutting of waves at the bottom of the cliff, additional factors that impact on cliff retreat and collapse include run-off from the top of the cliff and washing away of the hamra (loam) layers beneath the porous kurkar cliff. Human interference, in the form of drainage, road-building and quarrying of sand, calcarenite and hamra in back-cliff areas and construction of offshore structures and removal of beach sand, beachrock and talus aprons along the beach, has also impacted on cliff destruction.

Geologists believe that non-intervention with cliff retreat may be the cheapest and surest way to conserve the cliff. Nevertheless, safety requires a belt of no-development along the cliff's rim and a safety strip on the beach, in sections where the cliff is bare of talus. To help protect existing cliff top structures, several options are proposed including, among others, buttressing of the cliff's base (which will protect private property but reduce width of beach available to the public), beach nourishment and measures to reduce drainage and irrigation from the top and back of the cliff.

Impacts of Sea Level Rise

Sea level rise, as a result of global warming, threatens to increase the rate of shoreline migration although its effects on Israel's coastal region are as yet unstudied. The main risks associated with sea level rise are believed to include: loss of the width of beach where the slope is relatively gentle (in the southern beaches), infiltration of seawater into the coastal aquifer and aggravation of the salinization problem. In addition, global warming may bring about an increased frequency of extreme conditions, such as storms and floods. Extreme conditions should therefore be taken into account in developing efficient coastal management practices.

Loss of Areas for Tourism, Recreation and Public Access

Israel's existing institutions and legal instruments have been successful in preserving the Mediterranean coastline outside urban areas but have not succeeded in protecting coastal stretches alongside Israel's major cities from persistent and powerful development pressures, particularly for exclusive residential development. Massive pressures by both developers and

municipalities for coastal sites have led to repeated breaches of the coastal masterplan, particularly in relation to construction within 100 metres of the coastline.

As most land in Israel is under national ownership, the problem of public access and use of the coastline for recreational purposes should not have been acute. The Israel Lands Administration is responsible for managing national land, both rural and urban, which accounts for more than 90% of the total land in the country (including the submerged offshore continental shelf). By law, this land cannot be sold and can only be provided to developers for specific projects on long-term leases. The object is to ensure wise use of the land and to prevent abuse of one of Israel's most valuable and irreplaceable assets. In reality, however, the Israel Lands Administration has joined with local authorities to privatise much of the coastal land.

In such urban centres as Tel Aviv, Haifa, Herzliya, Ashdod, Ashkelon, Netanya and Nahariya, developers have joined with municipalities, their economic development companies and the Israel Lands Administration to transform coastal resources into real estate destined for high-income residents. Local planning committees have often approved developments on the water's edge as exceptions to the coastal masterplan, allowing public beaches to become the exclusive domain of those with the financial resources necessary to purchase the view. In the centre of the country, inflated rights have been given for construction as an incentive for building hotels. In practice, as a result of the decrease in coastal tourism and the rise in demand by Israelis for coastal accommodations, new high-rise developments have emerged along the coast. Constructed under the guise of "apartment hotels" or "resort apartments." These luxury buildings block sea views and sea breezes and interfere with public access to the shore.

Since the term "holiday apartment" is not specifically defined by law, it has come to include a wide range of accommodations that fall into the "grey" area between hotel accommodations and residential dwellings. The term has also been used to allow luxury apartments in areas that are designated for hotels. Today, it is clear that holiday apartments along the coast interfere with the public's right to the beach, both in terms of physical access and open view to the beach, deplete future land reserves for tourism purposes, and allow for the development of residential areas in locations and building standards which are unsuitable for residential purposes.

In order to stop the growing phenomenon of new residential units along coastal stretches designated for tourism, the Society for the Protection of Nature in Israel and the Israel Union for Environmental Defense, two of Israel's foremost non-governmental environmental organisations, published a position paper on the subject in 1988.

The position paper proposes the following guidelines:

- Holiday apartments, in any form, should not be constructed on open coasts and rural areas.
- Holiday apartments, especially for residential areas, should not be permitted on reclaimed land or in the hinterland of marinas. Based on the scarcity of coastal resources and the negative impacts of marine structures, marinas should only be permitted for tourism purposes while minimising the scope of development and environmental damage.

- Holiday apartments may be permitted in urban and suburban areas, in the second strip from the coast and further. In these cases, clear and recognised definitions for such terms as recreation and residence should be used instead of vague definitions in order to prevent misguided planning.

The position paper maintains that areas with high landscape and environmental value, which are designated for tourism and recreation in the national tourism masterplan and other masterplans, should be preserved exclusively for these allocations and protected from over-development. Clear guidelines must be formulated to distinguish between permitted and prohibited uses in these areas. At all times, private use of coastal areas designated for tourism and recreation should be prohibited in order to ensure the original purpose of public use and enjoyment.

Sustainable tourist development should help to preserve coastal open space and to conserve natural and historical resources. A cautious development policy is called for which will serve the needs of modern tourism and provide site accessibility while reducing to a minimum the impacts of tourism on landscape and open spaces.

Alternatives to Urban Development

The high demand for construction along the shoreline and the attractiveness of housing and tourism along the beach suggest a number of alternatives: *building up* by means of high-rise buildings to allow for more building on less space; *building out* into open landscapes which will lead to urban encroachment; *building underground* which is not yet fashionable; and *dispersion* to the periphery in the north and south of the country, which has not yet been successful. Yet another possibility raised for discussion is sea reclamation. Coastal conditions in Israel are potentially suitable for artificial islands, and experts have argued that artificial islands opposite Israel's shores will significantly alleviate land pressures in the central coastal strip.

The idea of erecting artificial islands off the Israel Mediterranean coastline, first raised in the 1960s, has been revived during the last decade when it became clear that the central Mediterranean coastal plain of Israel (Greater Tel Aviv and its surroundings) is one of the densest regions in the world in terms of population, commerce, industry and tourism. This region is expected to reach an expected population of some 5 million in an area of 1,250 km² (4,000 per km²) by the year 2020. Demand for land is rising precipitously with current land prices at prime sites reaching \$ 4,000/m².

The subject of artificial islands is currently investigated by a joint Israeli-Dutch team. Two main subjects were targeted for evaluation during the first phase of a feasibility research and development study which was initiated in mid-1997:

- 1) Effects of artificial islands on the coastline: environmental and morphological changes.
- 2) Appropriate fill material: availability, quantities, costs and environmental effects.

Case Study: Tel Aviv Coastal Stretch

Tourism facilities first sprang up along Tel Aviv beaches in the 1920s, and building and development subsequently sprawled northward, parallel to the shoreline. When the state was

established in 1948, Tel Aviv's beaches became public land, and private entrepreneurs built the city's largest hotels there. During the 1960s and 1970s, the narrow sand beaches of Tel Aviv were widened by means of detached breakwaters. A 50-metre wide bathing beach, the longest declared swimming beach in the country, was created, and a promenade was constructed alongside the beach.

Some 150,000 people congregate on the city's beaches on summer weekdays and 250,000 on Saturdays. According to the national coastal masterplan, the capacity of the beach area in Tel Baruch (central Tel Aviv) is 78,000 people per day.

The 13.5 km long Tel Aviv-Jaffa coastal stretch is divided into several sections, each of which is characterised by different natural features, history, land use and future plans. Following is a short description of the coastal stretches, from north to south:

North Tel Aviv (from the city boundary to the Yarkon River Mouth): A 3 km long area, most of which is undeveloped. Beach access is restricted by a cliff and two areas that are closed to the public: the Reading Power Station, near the Yarkon River Mouth, and Sde Dov Airport. There is a developed bathing beach at Tel Baruch, with an offshore detached breakwater. The rest of this coastal stretch is mostly natural and is characterised by a relatively narrow strip of sandy beach backed by a cliff. The area east of the cliff offers a wide variety of nature and landscape values.

Yarkon River Mouth: A small area which is the only place on the Tel Aviv coast where a river enters the sea. Today, the north side is occupied by the Reading Power Station. There is no bathing beach south of the river mouth. The area is situated in the meeting point between two main axes of open public space: the Yarkon River and park and the coastline, and therefore holds major potential for coastal development.

Tel Aviv Port Area: The historic port of Tel Aviv ceased functioning as a commercial port with the opening of Haifa Port. Development plans call for turning the port into a tourist attraction, which will be integrated with the Yarkon Park and Yarkon River Mouth area and will offer a wide range of seaside leisure and recreation activities.

Tel Aviv Bathing Beaches: This is the "main segment" of Tel Aviv's bathing beaches, largely consisting of sandy beaches and short sections of coastal cliff. Facing the beach are detached offshore breakwaters. Another marine structure is the Tel Aviv Marina. Behind the sandy beach is the beach promenade, a string of hotels, public parks and the main thoroughfare. The width of the sand strip varies and reaches dozens of metres in some areas.

Jaffa Port: Since Jaffa Port fell into disuse as a commercial port in 1966, it has functioned as a mooring berth for pleasure and fishing vessels. Jaffa Port is one of four ports used for fishing in Israel. Some 30% of the mooring area is allocated for fishing and the port capacity is for 220 vessels.

Jaffa Slope, South Jaffa to Giv'at Aliyah: In the past, the Jaffa coastline from south of the port to the Giv'at Aliyah Beach, was a rocky beach cove, supporting a variety of flora and fauna. The residential area of Jaffa was in close proximity to the shoreline. Over a 20-year period, the buildings were destroyed and the area was transformed into a disposal site for building debris. The refuse heap now reaches some 20 metres above sea level, and lies 200

metres westward of the original shoreline. The garbage heap has destroyed the area's natural and landscape features.

Development plans exist for each section of Tel Aviv's coastline - whether residential, tourist or commercial development - and each has engendered its own set of conflicts.

Conflicts Revolving Around the Yarkon River Mouth

An assessment of conflicts related to coastal development was undertaken within the framework of an International Workshop on Conflict Resolution held in Israel in January 1999. The case of the Yarkon River Mouth was used to illustrate the difficulties encountered in coastal planning, in general, and in the central area of the country, in particular.

A municipal company owned by the Tel Aviv Municipality first proposed construction of a marina in an area encompassing 0.536 km² at the site of the Yarkon River Mouth. Out of this total area, some 0.490 km² were to be at sea, of which 0.225 km² were allocated for land reclamation. The aim of the plan was "to develop the Yarkon River Mouth as a zone of tourism, special accommodations, and recreational and marine sport activities." The marina was planned for 630 mooring berths, 330 for public use and the remainder for private use.

The plan was submitted to the planning authorities in 1992 and an environmental impact assessment was presented by the developer in 1995. Since the scale of damages caused by marine structures was being re-examined at the time with relation to the Herzliya marina, environmental bodies contested the decision of the planning commission to deposit the plan. They asked for a postponement, pending completion of the Herzliya marina study. Subsequently, the Israel Union for Environmental Defense (IUED) petitioned the Tel Aviv District Court, and a temporary injunction was issued preventing deposition of the plan.

After publication of the Herzliya marina report, the Ministry of the Environment demanded supplementary material for the Yarkon marina plan. At the same time, the Society for the Protection of Nature in Israel, the country's largest environmental NGO, prepared a legal opinion showing that the marina plan contradicts the provisions of the coastal masterplan.

The country's environmental organisations objected to the plan on several grounds including potential beach erosion to the north of the plan area and sand accumulation to the south. Other objections related to obstruction of an open sea view at this meeting point of river and sea, land uses for which proximity to the seashore is not essential, wide scope of private space on reclaimed land, and planning procedures which run contrary to the coastal masterplan and EIA requirements. These arguments were presented to the Tel Aviv District Court with a request that the planning proceedings for the marina be halted.

In a November 1997, the District Court ruled that the Tel Aviv District Planning and Building Commission had no authority to decide on plan deposition without a full EIA and that construction of residential buildings within the 100-metres zone contradicts the coastal masterplan.

This decision, coupled by the strong public protest elicited by other development plans along the Tel Aviv coastline, led the Tel Aviv municipal council to freeze all building plans along the shoreline until a special committee, with representatives of environmental organisations and the general public, re-examines coastal development policies and presents its

recommendations. The decision reflects a significant change in the relation of local authorities to the coast and to the rights of the public to it.

The case of the Yarkon River Mouth illustrates the conflicts that are often evoked by a coastal plan. Stakeholders in this case included private and public planners and developers, government representatives at the local, district and national level, non-governmental organisations (both environmental and other) and nature conservation and environmental bodies. The critical issues included: the coast as a public asset, construction of marine structures and environmental damage, tourism development and residential building. The case highlights the complexity of the coastal system in which the multiplicity of stakeholders and institutions makes compromise difficult. On the other hand, it accentuates the need for new forms of conflict resolution, whether through the participation of all stakeholders at earlier stages of planning or through a negotiation-based planning process with the possible aid of mediators or facilitators, to reconcile competing demands.

Damage to Natural and Cultural Resources

The conversion of open spaces into built areas is an irreversible process: a “natural” area once transformed into a built area can never be recreated. In a small country such as Israel, pressures for development and urbanisation along the highly sensitive coastal area threaten natural and cultural resources. These damages are further exacerbated by disturbances caused by vehicle traffic along the sandy coasts for recreation purposes -by jeeps, all-terrain vehicles, motorcycles and other modes of transport. In addition, offshore structures increase shore erosion and disrupt the littoral system along with its natural values. All have taken a toll on the sand and kurkar ecosystem of the coastal strip, which was identified as one of Israel’s most endangered ecosystems in a recent assessment of open space landscapes.

Similar threats loom over Israel’s cultural resources, on both land and sea. Until recently, for example, Israel’s ancient harbours were not modernised, and new ports (Haifa and Ashdod) in different locations took the place of such ancient ports as Acre and Jaffa. However, new development initiatives now threaten the country’s ancient ports. Moreover, the accelerated rate of cliff retreat has led to the destruction of cliff top archaeological and historic sites and the exposure of an ancient city (Ashkelon).

Underwater, sand depletion has led to the exposure of archaeological remains that were previously protected by layers of sand. The exposure of many findings simultaneously, after hundreds or thousands of years in which they were safely protected by the sand layer on the seabed, threatens to destroy these remains since authorities are unable to deal with a large number of findings simultaneously. Further changes in the shoreline threaten to destroy remnants not yet discovered. Thus, if development continues at its present pace, important findings of the marine heritage of 3000 years may be lost to residents and tourists alike. The Marine Archaeology Branch of the Israel Antiquities Authority is trying to tackle these challenges through a variety of means including: underwater surveys and excavations, mapping of sites to form a national database, declaration of protected underwater archaeological sites, supply of data to planning authorities, follow-up of development plans, research and publication of discovered material, creation of underwater archaeological parks for divers, and information and education designed to raise public awareness of the importance of preserving the underwater heritage.

Protection of Coastal and Marine Ecosystems

The coastal masterplan has for the most part prevented scattered development along the coast and protected open coastal areas from development. Moreover, nature reserves along the coastline have been allocated to help preserve unique natural assets. Efforts are currently focusing on accelerating the declaration of designated coastal and marine reserves and parks, assessing the possibility of expanding the boundaries of protected areas and proposing new reserves based on new and cumulative data on natural values on coast and sea.

The Nature and National Parks Protection Authority (NNPPA), as the government agency in charge of nature conservation in Israel, oversees 444 nature reserves (proposed and declared) which span over 6,240 km². It is also responsible for 14 Mediterranean coastal parks (landside only), amongst 129 national parks which encompass 376 km². Nature reserves are defined as areas containing unique and characteristic animal, plant and mineral forms which must be protected from undesirable changes in their appearance, biological composition or evolution. National parks are defined as areas of natural, scenic, historic, archaeological or architectural value which are protected and developed for recreational purposes. Israel's coastal parks play an important role in protecting the country's natural beauty from rapidly-encroaching urbanisation and restoring and maintaining antiquities that have been lost or neglected for centuries.

There are four types of nature reserves along the Mediterranean: marine reserves (proposed and declared), coastal reserves (proposed and declared), islet reserves, and protected natural asset belts. Declared reserves have full legal protection while proposed reserves have a limited level of protection until they are declared.

Israel has 14 proposed marine reserves, with a total area of about 25 km². In addition, it has 20 coastal reserves with an area of about 35 km², 16 of which are proposed and 4 declared. Marine reserves are declared up to the mean high tide level, while coastal reserves are declared down to the mean low tide line, providing overlap at the waterline. Because the cross-shore borders of the two types of reserves are not always congruent, only about 2/3 of the shoreline of the marine reserves has a parallel coastal reserve. Nevertheless, coastal reserves are important for the preservation of both the aquatic and the littoral environments, as they prevent shoreside development.

The third type of reserve is the islet reserve. Israel currently has two islet reserves comprised of small islands with a total area of about 0.33 km². These islet reserves will be incorporated within the proposed larger marine reserves in order to enlarge the number of protected islets along the Israel coast. Most of the islets are in proposed marine reserves and five islets are already declared as nature reserves.

There are more than two dozen small islets (totalling over 0.15 km²) which represent tiny remnants of kurkar (sandstone with calcite matrix) ridges. Although little ecological research has been carried out on the islets, they are considered to be unique and important micro-ecosystems.

The fourth type of reserve is the protected natural asset belt. There are two such belts with a total area of about 12 km², most of which will be included in the proposed marine reserves (i.e., 8.7 km out of 11 km of the natural assets belts). One is between Rosh HaNiqra and Akhziv and the second between Atlit and Dor. All fish, molluscs and most marine

invertebrates are fully protected in these belts (See Appendix for a full list of Israel's coastal and marine nature reserves.)

Case Study: Protection of the Carmel Coast as a Coastal Reserve

The Carmel coastal area, spanning from Atlit (south of Haifa) to Caesarea, represents Israel's longest continuous undeveloped coastline. This 32 km long and 4 km wide coastal stretch is characterised by a high level of ecological diversity and archaeological treasures: partially submerged fortresses at Atlit, Tel Dor and Caesarea, and ancient boats at Nahsholim and Ma'agan Michael. The Dor-Habonim Nature Reserve, the only declared coastal nature reserve in the Carmel Coast, is located at the centre of this area. It includes a unique rocky beach, home to a broad array of flora and fauna, both on land and in the sea. The beach is also of crucial importance to an endangered species of turtle which lays its eggs there.

A national survey of open coastline areas, which are as yet unoccupied by construction, military facilities, and infrastructures, has revealed only two areas of undisturbed beaches along the Mediterranean coastline: the area between Ashdod and Ashkelon (in part) and the Carmel coast. The importance of conserving this region in its natural state has been confirmed in natural asset and landscape surveys performed by the Society for the Protection of Nature in Israel (SPNI). As a result, a map was produced which ranks areas according to five levels, based on their sensitivity to development and importance for preservation.

Yet, in contradiction to survey results and to the provisions of national masterplans, individual local councils in the area have submitted plans for tourism development which maximise their immediate profits while ignoring the sensitivity and uniqueness of the region as a whole. The number of rooms planned by local developers exceed demand forecasts by hundreds of percentages. One of the foremost proposals was for a recreation village on the Habonim Coast.

To help promote a sustainable planning approach for this area in the face of growing development pressures, the SPNI prepared a position paper on the subject in 1997. Two primary goals are at the basis of the sustainable tourism planning approach which is advocated for the Carmel coast: conservation of ecosystems along the coastline and preservation of the continuum of open spaces along the seashore. Measures to achieve these goals include: linking development plans to existing centres according to the principles of the coastal masterplan, comprehensive review of development plans, concentration of rights of property owners in regional focal points, prohibition of residential and recreation apartments along the coastline, preservation of the rural character of the area, prohibition of tourist attractions in the midst of environmentally sensitive areas, and promotion of rural tourism. Finally, the paper objects to establishing a recreation village on the Habonim Coast and advocates instead that the Dor-Habonim Nature Reserve be expanded and that a management plan for the area be prepared.

The public protest against tourism development in the Habonim coast has led to a withdrawal of the recreation village scheme. However, building initiatives in sensitive areas along the Carmel coastline continue. The SPNI has recently completed the preparation of yet another position paper laying out guidelines and principles for the sustainable development of this entire area based on the sensitivity of coastal resources.

EXISTING INSTITUTIONS AND RESPONSIBILITIES

A wide range of stakeholders are involved in issues related to the coastal and marine environment in Israel. They include local authorities, government ministries, independent authorities and private and public bodies. Table 4 gives is a general description of the institutions involved in coastal planning and management today.

Table 4: Existing Institutions and Responsibilities

Institution	Responsibilities
Ministry of the Interior Territorial Waters Committee National Planning and Building Board District Planning and Building Commissions Emergency Services, Special Duties and Bathing Beaches Administration	national planning and building, declaration of new protected areas. approving offshore structures. national masterplans. regional masterplans. supervision of bathing beaches, bathing safety and instruction.
Ministry of Transport Shipping and Ports Administration	testing, licensing and supervision of vessels and anchorages.
Ministry of the Environment Marine and Coastal Environment Division Environmental Protection Control	marine pollution prevention, supervision of environmental legislation.
Ministry of Agriculture Fisheries Division	inspection and supervision of fishing and of fishing vessels.
Ministry of Health	inspection of bathing beaches.
Ministry of Tourism	development of tourism and recreation.
Ministry of Education	diving schools, clubs, Diving Authority.
Ministry of National Infrastructures Israel Oceanographic and Limnological Research Geological Survey of Israel	gas and oil infrastructures. monitoring and research on coastal and marine resources. investigation of Israel's geology, coastal studies.
Ministry of Defense	marine and coastal security, closed military areas on the coast.
Ministry of Internal Security Coast Guard	law enforcement at sea, search and rescue operations.
Ministry of Police Naval Operations Border Police	security, registration of entrances and exits.
Ministry of Foreign Affairs	international marine conventions.
Ministry of Justice	marine legislation and conventions.
Local Authorities	coastal planning, business licenses, maintenance of public areas.
Israel Land Administration	management of national land in Israel.
Nature and National Parks Protection Authority	nature protection and administration of coastal national parks and nature reserves.
Antiquities Authority	coastal and marine archaeology.
Ports Authority	commercial ports, loading and unloading facilities.
ilat-Ashkelon Pipeline Co.	fuel loading, unloading and storage.
Natural Gas Authority	marine pipeline for natural gas.
National Coal Supply Corp.	coal supply to power plants.
Israel Electric Corporation	power plants.
Petroleum and Energy Infrastructure Ltd.	bank far and fuel pipeline along the coast.
Water Commission	infiltration of seawater to groundwater.
Artificial Islands Committee	advancement of planning for islands.
National Sewage Authority	marine outlets.

EXISTING POLICIES AND TOOLS FOR INTEGRATED COASTAL MANAGEMENT

Coastal Legislation

Israel's environmental legislation uses all forms of legislative instruments - laws, regulations, administrative orders, decrees and bylaws - and is linked to an international legislative system which includes international conventions. A comprehensive coastal law does not yet exist in Israel (a draft law has recently been drafted and is presented on p. 56), but marine and coastal issues are included in a wide variety of legislation. Moreover, the Lands Law of 1969 includes the seashore in the framework of "designated land" which is "public land designated for public use."

Following is a brief description of the laws which directly impact marine and coastal area management in Israel:

- *Prevention of Sea Pollution by Oil Ordinance (New Version), 1980*: This law provides the legal basis for controlling marine oil pollution. It prohibits discharge of oil or oily substances into territorial and inland waters from any shore installation or vessel, and makes any such act a criminal offense. The Minister of the Environment is empowered to appoint inspectors to discover or prevent violations. The law establishes maximal fines for oil spills and liability for cleanup expenses. Other salient features of the law and its regulations include an obligation to keep oil record books on vessels, measures to be taken in case of oil discharge, and requirements for vessels to use port reception facilities for oily wastes. Regulations promulgated within the framework of the ordinance establish a Marine Pollution Prevention Fund to generate income for preventing and combating marine and coastal pollution, cleanup operations and purchase of equipment. The major sources of the fund are fines collected from court convictions and fees levied on owners or operators of vessels calling at Israeli ports and on shore facilities handling oil.
- *Prevention of Sea Pollution (Dumping of Waste) Law, 1983*: This law prohibits the dumping of any waste from vessels and aircraft into the sea, except under permits which may be issued by an inter-ministerial committee, headed by a representative of the Minister of the Environment. A court convicting an offender under this law may require, in addition to the fine levied, payment of cleanup expenses or of locating the waste dumped into the sea. The law provides for the appointment of inspectors to carry out inspections, investigations and searches to prevent or discover offenses. Regulations under the law, drafted according to the Dumping Protocol of the Barcelona Convention, include lists of substances which may or may not be dumped and conditions for issuing permits.
- *Prevention of Sea Pollution from Land-Based Sources Law, 1988*: This law forbids the discharge of waste, including wastewater, into sea in all cases where practical and economic alternatives for treatment or reuse exist on land, under the condition that such processes are less harmful from an environmental point of view. An inter-ministerial permits committee, chaired by a representative of the Minister of the Environment, determines what may or may not be discharged into the sea and under what conditions. The conditions and criteria for granting permits, and the types of waste which may not be discharged at sea were

established according to the provisions of the Land-Based Protocol of the Barcelona Convention. The law provides for the appointment of inspectors to carry out investigations and searches for the purpose of preventing or discovering offenses. Israel has initiated steps to broaden the prohibitions on land-based sources of pollution to discharges from rivers, coastal establishments, outfalls or any other land-based sources and activities.

- *The Ports Ordinance, 1971*: This ordinance provides for the operation and management of ports in Israel. It contains a specific section on handling hazardous substances in ports. Regulations promulgated under the law cover such matters such as collection of waste, bilge and ballast water from vessels. Regulations on Loading and Discharging of Oil, promulgated in 1975 under the Ports Ordinance, control all procedures for safe loading and discharge of oil and contain specific instructions on the following: entry into territorial waters and ports; vessel operations during their stay in terminal; measures for fire prevention and fire fighting; conditions of oil terminals; transfer of oil from road tankers; and other regulations aimed at ensuring environmentally-safe practices. While most of the regulations are supervised and enforced by the Ministry of Transport, provisions concerning environmental issues are administered by Environment Ministry inspectors.
- *Fisheries Ordinance, 1937*: This ordinance is enforced by the Fisheries Board of the Ministry of Agriculture. The ordinance requires a license to fish with the exception of fishing from shore with hook and rod. It sets conditions and restrictions on a wide range of subjects including prohibitions on use of explosives or poisons to catch or kill fish, prohibitions on fishing methods which may damage or threaten the survival of fish species, prohibitions or limitations on fishing in certain areas or during certain seasons, size limits for species of fish, and mesh size and calibre of fishing nets. Other regulations prohibit fishing of marine turtles and restrict fishing of sponges.
- *The Bathing Places Law, 1964*: The law permits local authorities to formulate bylaws for maintaining beach cleanliness. It empowers the Minister of the Interior, in consultation with the Minister of Health, to close bathing beaches for the protection of bathers.
- *Prohibition of Vehicle Driving along the Coast Law, 1997*: This law was specifically enacted to stop the growing use of vehicles, especially all-terrain vehicles, along the coastline.

In addition to the above, the following legislation is also relevant to the coast:

- *Planning and Building Law, 1965*: This law sets the legal framework for development and land use in Israel and serves as the basis for environmental policy. All development is subject to the approval of statutory planning boards, on the national, regional and local levels. The law has major significance for all development activities on the coast.
- *Planning and Building Regulations (Environmental Impact Statements), 1982*: These regulations under the Planning and Building Law mandate the preparation of an environmental impact statement when the planning authority considers that significant impacts may occur as a result of a plan or project. The regulations can be utilised as an important tool in protecting and using Israel's coasts. Any proposed project which is liable to adversely affect Israel's coast may be subject

to the preparation of an environmental impact statement according to specific guidelines issued by the Ministry of the Environment.

- *National Parks, Nature Reserves, Memorial Sites and National Sites Law, 1998*: This law, first enacted in 1963 and revised in 1992 and 1998, provides the legal structure for the protection of natural habitats, natural assets, wildlife and sites of scientific, historic, architectural and educational interest in Israel. It establishes systems for declaring nature reserves, marine protected areas and national parks and for listing protected natural assets which include many families and species of flora and fauna. This legal protection extends to many taxa, originating within or outside of Israel. The law establishes a new and united Nature and National Parks Protection Authority (NNPPA) which replaces the previous Nature Reserves Authority and National Parks Authority as separate entities. A National Parks, Nature Reserves and National Sites Council, composed of all relevant stakeholders and appointed by the Minister of the Environment, advises the relevant ministers on implementation of the law.
- *Antiquities Law, 1978*: This law, which is enforced by the Antiquities Authority, protects all artefacts of human civilisation prior to the year 1700. No collecting, selling or disturbing of such artefacts is permissible anywhere in Israel, including territorial waters.
- *Zifzif Law, 1964*: This law prohibits beach sand quarrying and sand removal.

Additional environmental laws which impact on the marine environment are listed in the Appendix.

Litigation and Court Decisions

The heightened awareness of coastal management issues is reflected in a number of court decisions against coastal development plans which violate environmental laws and masterplans in Israel. The Society for the Protection of Nature in Israel (SPNI) and the Israel Union for Environmental Defense (IUED), two of Israel's foremost NGOs, have been especially effective in initiating these cases. (See p. 51-53).

Following are some relevant rulings:

- *Tel Aviv*: The IUED petitioned the District Court to prevent the deposition of plans to construct a marina at the mouth of the Yarkon River, since, *inter alia*, a complete EIA was not available to the Tel Aviv Planning and Building Commission at the time of deposition and since the plan violates provisions of the coastal masterplan which prohibits the construction of residential building along the coastline. The judge ruled as follows: "We must also leave something to our children. In this case, the issue relates to public property and therefore the growing trend of reaping financial profits must make way for other needs which are for public benefit. In this case, the matter relates to a river outlet into the seashore. Planning which is not based on an EIA, which takes account of all restrictions, may endanger the northern part of the seashore and damage the area beyond the plan. Therefore, in these circumstances, top priority must go to a comprehensive EIA." (For further information on the proposed marina at the Yarkon River Mouth, see p. 25).

- *Tel Aviv*: IUED has filed suit against two companies responsible for a residential development (Sea and Sun) on the beach just north of Tel Aviv. Contrary to the stipulation in the coastal masterplan which limits seashore construction to tourism, the apartments are marketed unconditionally as regular apartments for the exclusive use of their owners. Furthermore, the landscaped gardens go beyond the boundaries of the property and encroach on the public beach. The petition is limited to the section at the front of the complex where the apartments have not yet been sold.
- *Ashkelon*: Utilising its legal status to represent the public in court on environmental issues, the IUED negotiated in the Ashkelon District Court for a halt to the extensive building project in its final stages on the Dalila beach. Local residents claimed that the development dramatically alters the shore and in effect destroys the town's last open stretch of beach. In view of the lateness of the complaint, the court called for construction to cease temporarily in order to allow the parties to reach a compromise.
- *Nahariya*: IUED along with a local NGO petitioned the Haifa District Court against a "holiday apartment" project which intruded into the 100-metres prohibition on building near the shoreline. In a precedent-setting ruling, the court ruled that the fence which was erected on the shoreline is illegal since it blocks entrance to the shore and encloses an additional private area in the project area. Moreover, the judge ruled that since the coastal area is designated for tourism, some of the apartments must be made available for rental every few months to ensure free access.
- *Herzliya*: The IUED joined Herzliya residents in protesting a multi-story building complex in the hinterland of the Marina-Li area. The court ruled that the approval procedure for the plan was void since the planning institutes ignored the fact that about half of the area of the plan was to serve as public open area according to the coastal masterplan.
- *Haifa (marina project)*: The SPNI and IUED appealed to the Haifa District Court in 1996 against plans to deposit the Haifa marina project, Israel's largest ever coastal development project which includes land reclamation and large-scale residential, tourist and commercial development. Moreover, planners and scientists argued that if built, the marina would cause severe destruction to the coastline and underwater flora and fauna. The petitioners claimed that prior to any efforts to push the proposed marina plans forward through the planning commissions, the coastal masterplan should undergo a full review at the national level. The court agreed to delay deposition of the plan until the Territorial Waters Committee discusses it. The Committee, in turn, transferred the matter to the National Planning and Building Board. In May 1999, the National Board unanimously decided to open the marina plan for re-evaluation. The Board called for amendments to the masterplan for the coasts of Haifa to be made within half a year. These are likely to include limits on residential areas, hotels and land reclamation areas which are included in the original plan. The editors of the plan are called upon to re-examine existing planning material including the original guidelines of the National Board for the marina in Haifa which date back to 1991. It was also decided that the principles of full public access, open sea view to the

sea, and preference for recreation activities will be reflected in the amended masterplan.

- *Haifa (Carmel Towers Project)*: In June 1998, the National Board accepted the position of the IUED that construction of the Carmel Towers Project violates the instructions of the coastal masterplan. The hearing took place as a result of a direct order handed down by the Haifa District Court which ruled that additional hearing must be held against the Carmel Towers Development Co. and the local Haifa district planning commissions. The Carmel Towers Project is one of Israel's largest coastal development project including massive residential towers and hotels which make use of public space for private use. The ruling of the district court is now on appeal in the High Court of Justice.

In all of the above cases, the petitioners claimed that coastal development plans blatantly violate the letter and the spirit of the coastal masterplan. The court rulings represent an important precedent in the protection of Israel's coastline from encroaching development. Moreover, the decisions, coupled with strong public protest, are leading to reassessments of coastal development plans in Haifa and Tel Aviv.

Nevertheless, Israel's environmentalists are aware that the court challenges have not put an end to plans for marinas and beachfront high-rises. Many of the decisions have already been contested and are now heading for appeal in the High Court of Justice. Therefore, both the Ministry of the Environment and Israel's non-governmental bodies are continuing their vigilance, informing the public of new coastal plans, supporting public protest, preparing position papers on coastal development and drafting coastal bills (see p.56).

Planning Institutions and Instruments

Coastal zone management in Israel uses the land-use planning system established under the Planning and Building Law of 1965. The law establishes a comprehensive legislative framework which regulates all building and land-use activities in Israel, public and private, within a three-level hierarchy: national, district and local. The Ministry of the Environment is represented at all levels of planning in the country.

The National Planning and Building Board (the National Board), at the top level of national planning, is composed of representatives of government ministries, local government, and public and professional organisations, including nature protection bodies. The National Board provides a broad and extensive forum for deliberation by all concerned bodies and allows for the mobilisation of professional input and expertise from a wide variety of disciplines.

The primary responsibilities of the National Board are to enact masterplans, review regional masterplans and serve as an appeal board for decisions of the District Planning and Building Commissions. National masterplans (mostly sectorial masterplans which lay down the planning structure for the entire area of the country) are prepared for issues of national planning significance or for land uses that serve national interests. Masterplans are commissioned by the National Board and then submitted to the government for final approval. Once approved and announced in the official gazette, they have the status of legally binding plans. Recently, the National Board has commissioned non-statutory national policy documents to guide its decisions.

The national level of the hierarchy includes two statutory committees: the Committee for Protection of Agricultural Lands and Open Spaces, responsible for protecting lands of agricultural value and open spaces and minimising their loss to building, and the Territorial Waters Committee, responsible for approving all offshore structures (see p.43). No plan or building permit regulating agricultural lands or offshore projects may be endorsed without prior approval of these committees.

The regional level of the planning hierarchy is the responsibility of six District Planning and Building Commissions, five of which include coastal sections. The District Commissions are composed of regional representatives of government ministries and representatives of local authorities within the district.

The local level consists of about a hundred Local Planning and Building Commissions, serving one or more local authorities and composed of the elected members of the municipal councils. Some 25 local authorities are dispersed along the Mediterranean coastline.

National Masterplans

National masterplans are prepared for land uses and projects of national significance. Environmental aspects are integrated into all relevant national schemes and, in some cases, they are the dominant considerations. National planning requires the integration of environmental considerations from the earliest stages of planning until final formulation of the planning documents which are presented for approval to the statutory planning agencies.

Several national plans are targeted at protecting specific natural resources considered to be of high value as part of the natural and cultural heritage, such as plans for nature reserves and national parks and forested areas. Other plans address particularly sensitive areas warranting special attention such as plans for the Mediterranean coastal area. Following is a short review of masterplans which relate to coastal zone management in Israel:

The National Masterplan for the Mediterranean Coast (NOS 13) was approved in 1983. It is based on two underlying principles: preference to recreational activity on the coast and land use as a function of the carrying capacity of the coastline. Based on these principles, the plan determines land allocations along the coastal strip for the purpose of managing, preserving, developing and using them for such purposes as: swimming, recreation and sport; tourist facilities; protection of antiquities, nature reserves, national parks, forests and coastal reserves; ports and other essential uses which require a coastal location. The plan aims to prevent development which is unrelated to the coast and to resolve conflicts of interest among land uses which require a coastal location. It includes a clause prohibiting development within 100 metres of the coastline and requires environmental assessments as prerequisites for all coastal plans (specification of local conditions including coastal impacts, surveys and analysis of plan proposals, environmental impact statements, detailed coastal surveys, surveys and proposals on access routes, surveys of infrastructure systems and their impact on the proposed site). The masterplan also allocates sites for several ports and fourteen marinas.

The National Masterplan for Ports and Marinas (NOS 13B) was commissioned by the National Planning and Building Board to regulate use of marine and land areas for seaports, which include ports for tourism and sport activities. The discussions of the steering committee on marinas revolved around such issues as distribution of marinas, scope and type of development in the hinterland of marinas, anchorage spaces, and allocation of coastal and

marine areas based on the number of vessels. The proposals have not yet been presented to the National Board.

The National Masterplan for the Resource Management of the Mediterranean Coastline for Tourism and Recreation (NOS 13C) was commissioned by the National Planning and Building Board to help provide a comprehensive long-term guide to planning policy. The coastal management plan, prepared by the Environment Ministry and approved in principle by the National Board, bases development policies on principles of suitability and sensitivity of coastal resources. Suitability for tourist and recreation development was assessed on the basis of geological, vegetation, landscape and archaeological surveys, and levels of development were then defined for each site along the Mediterranean coastline in relation to resource sensitivity. Multidisciplinary teams of land use planners, geologists and ecologists prepared surveys of coastal resources and guidelines for some of the main resource management issues, as follows:

- *Sand supply*: Because sand supply along the shore is limited, existing wide sandy shores should be designated only for those activities that require such natural shores. Other activities should be directed to non-sandy shores.
- *Offshore structures*: Offshore structures change nearshore sand and water flows and may result in sand accumulation and/or shore erosion. Any proposal for offshore structures should therefore be evaluated carefully. The development of offshore structures should be limited to certain designated sections of the coast.
- *Cliff erosion*: Because cliffs are in an active state of erosion, structures should be set back far enough from the cliff edge to reduce risk to property and eventually to enable measures to stabilise the cliff. This will also help preserve open seascape view and cliff top archaeological and historic remains. Offshore structures along the cliff shore may influence the rate of cliff retreat.
- *Special geological features*: Special features should be protected from development (e.g., active sand dunes, rock formations).
- *Natural coastal processes*: Planning and construction proposals should be consistent as far as possible with natural coastal processes. Those which require an engineering solution to prevent damage by natural coastal processes should be avoided.

The multidisciplinary teams also prepared ecological guidelines for the resource management plan, including the following principal recommendations:

- *Rare and unique habitats*: As a result of heavy human disturbance, habitats once typical are becoming rare. Thus representative habitats (kurkar ridges, sand dunes, carob and pistachio woodlands) should be protected from the impacts of development.
- *Rocky shore habitats*: These habitats are rich in invertebrate life and need both onshore and offshore protection measures.
- *Important biotic features*: Restrictive conditions on activities and development may be sufficient to enable important biotic features and habitats to survive outside the boundaries of nature reserves. These may include breeding and nesting grounds of migrating and non-migrating birds (particularly near fishponds and around river mouths) and egg-laying habitats of sea turtles.
- *Areas adjacent to nature reserves*: Recreation areas adjacent to nature reserves or sensitive habitats should be designated for low intensity activities.

The overall national policies proposed for resource management of the coast include:

- Development other than for essential coastal uses should not be permitted along the coast and its immediate hinterland;
- Policies for recreation and tourist development should ensure that opportunities for a variety of daytime activity and overnight accommodation experiences are made available to the entire population;
- Recreation and tourist development of the hinterland should be confined to centres. In order to protect as much open space as possible, linear development along the coastline should not be permitted;
- Highly intensive uses should be confined to existing urban centres;
- Sites not previously developed, where resources were identified as having recreation potential, could be designated for low intensity levels of development;
- Offshore construction for recreation and water sport activities should be restricted to urban centres; and
- A public footpath should be designated along the coastline to ensure public access by foot to and along the coastline.

The dominant principle adopted for resource management of the coast was the definition of intensity of development. Four levels of development were defined for beaches and their immediate hinterland, four levels of intensity for overnight visitor accommodation, and three levels of development for hinterland day-visitor areas. Detailed regulations were then defined for each site, including measures for resource protection within areas allocated for development, location of beach facilities and height of built structures in relation to landscape features.

Special regulations were proposed for river mouths to differentiate between natural conditions which should be protected and approvals for man-made changes in hydrology.

Significantly, these principles were also incorporated into the newly revised National Masterplan for Tourism (NOS 12).

The National Masterplan for Tourism (NOS 12) was first prepared in the early 1970s and approved by the government in 1983. It determined, *inter alia*, coasts designated for extensive development, recreation villages, numbers of hotel rooms, and spaces in bathing beaches based on a population forecast of five million residents. An amendment to the masterplan was prepared in the 1994 and is now in the final stages of approval. Prepared by the Tourism and Interior Ministries, in close co-operation with green organisations, the amendment incorporates many of the principles of the coastal masterplan. It recognises the importance of maintaining sufficient land reserves for tourist accommodation and services, in the face of development pressures, in order to help realise the country's long-term tourism potential. The amendment will strengthen the measures for preserving land reserves for tourism purposes, especially along the coastal strip, and will protect important open space landscapes for tourist activities.

The National Masterplan for National Parks, Nature Reserves and Landscape Reserves (NOS 8), approved in 1981, is a legally binding national plan setting aside specific areas as national parks or nature reserves. The purpose of the plan is to designate areas for nature conservation, protect areas of high scenic value from unsound development and preserve

areas with high recreation and tourism potential. The scheme constitutes an initial safeguard and is backed by another legal procedure - declaration of areas as nature reserves or national parks through the Nature Reserves Law. Over one-quarter of the country's land area is designated for these purposes in the masterplan.

The National Masterplan for Forests and Afforestation (NOS 22), in force since 1996, grants certain areas legal status as forested areas, and thus protects them from development. The main purpose of the scheme is to protect existing "man-made" and natural forests and to designate areas for future afforestation to meet ecological and recreation goals. It designates 1620 km² for the development and conservation of forested lands in Israel and includes eight categories of forest including coastal park forests and riparian plantings. Some 42 km² of coastal parks are allocated along the shoreline. Tree planting along rivers for recreational purposes is also an important component of this masterplan.

The National Masterplan for Building and Development (NOS 35), now nearing completion, is an integrated development plan which gives strong emphasis to environmental management principles and to the protection of areas of high natural and landscape value. Among other provisions, it calls for the protection of open space both in the periphery and in the densely populated central area of the country where "buffers" along riverbeds will separate urban concentrations and where coastal protection areas will be designated.

Urban Coastal Planning: The Case of Greater Tel Aviv

The National Masterplan for the Coast designates many sections of the Tel Aviv shoreline as bathing beaches and identifies five marinas in Tel Aviv or its immediate vicinity (Herzliya, Yarkon River Mouth, Atarim Plaza, Jaffa Port and Bat Yam). The first strip alongside the beach is designated for tourism according to the principle that only uses for which a coastal location is necessary should be permitted adjacent to the coastline. The second strip (to the east) is designated for residential building and urban land uses.

Israel's Tourism Masterplan defines Tel Aviv's shoreline as an urban coast which should serve as a main reserve for urban tourist development. It proposes that the northern section of the coastline (between Tel Aviv and Herzliya) become the central "riviera" of the Israel coastline including a promenade bordering bathing beaches, high-class hotels, complementary tourist services and commercial activities. At Tel Baruch, the emphasis will be on luxury hotels while at the Yarkon River Mouth and Tel Aviv Port, intensive tourism will be encouraged. The masterplan notes that the existing municipal plan for the northern section of the beach does not place sufficient emphasis on tourism. Accordingly, tourism zonings should be increased, and optimum locations for tourism uses should be ensured.

In the central section of the Tel Aviv coastline, where there are no large-scale reserves for new hotels, the plan recommends that buildings worthy of preservation in old neighbourhoods be utilised for special tourist accommodations, such as small hotels. It recommends extending the promenade until Old Jaffa, and developing Jaffa Port as a tourist marina, which will include commercial, entertainment, cultural and other uses.

A district masterplan and a metropolitan masterplan for Tel Aviv are currently nearing completion. Both of the plans pay particular attention to the coastal area, which they define as a central axis of important contiguous open spaces, connected to "green fingers," particularly along riverbanks.

In the “open spaces” section of the Tel Aviv District Masterplan, the coastal area is defined as “the national and metropolitan riviera region.” This region is a focus for seaside entertainment, recreation and leisure both for the local population and for the population of the entire country. The planning policy proposes a comprehensive planning approach to the coastal area, distinguishing between different sections of coast, and addressing the structure of the coast, current state of development and potential for future development. It sets principles, guidelines and conditions for development on the sandy shoreline, the hinterland and adjacent offshore waters. Its guiding principle is “to protect the public interest and public rights in the development of the coast, while enabling economic and urban development with an affinity to the coast and ensuring sustainable development.”

According to the masterplan, the northern stretch of the Tel Aviv coast is designated for the expansion of bathing beaches through artificial nourishment of sand and construction of offshore breakwaters. The coast and a 100-metre strip from the foot of the cliff eastward are defined as a “Coastal Park,” a strip free of buildings. The area to the east of the park is defined as an urban building area. The plan proposes green strips and pedestrian routes in an east-west direction between the areas zoned for building. The point where the Yarkon River enters the sea is defined as a special planning area. The plan emphasises the importance of maintaining broad vistas at the nexus of the two main axes of open areas (the Yarkon Park and the coast).

The masterplan for the Tel Aviv metropolitan area (which includes the Tel Aviv and Central Districts and the municipality of Ashdod) is not a statutory plan but it outlines planning principles which will then be incorporated into district and sectorial plans for the metropolis. Alongside urban areas, the plan places special importance on recreational use of the coast while along non-urban routes, major emphasis is placed on the coastal resource itself.

The masterplan relates to the following components of the coastal strip:

- The shoreline where recreation is concentrated and where an open view to the sea should be preserved.
- The urban seashore which represents the most intensive open space in the urban area.
- The urban coastal promenade which provides pedestrians with leisure and enjoyment.
- The urban coastal road which provides for vehicle movement alongside the coast.
- The urban hinterland which provides for development near the coast. Its use dictates the character of the urban coast.
- The rural coast which provides for leisure and recreation in rural landscapes.

Both the metropolitan and the district plans note the importance of the coastal strip, both to the population of Tel Aviv and to residents of the entire country. Its importance is based on its natural and landscape assets, social, cultural and historic assets, national and economic assets, and urban assets. The guiding principle behind the planning approach is to allow for development/preservation of the coastal area while preserving the interests and the rights of the public within a sustainable development perspective.

Following are the planning policy recommendations which are presented both in the district and metropolitan masterplans for the Greater Tel Aviv area:

- Adapting comprehensive planning, development and protection of the coast to changing coastal conditions through the preparation of a comprehensive masterplan for the metropolitan coastal area and its division into representative sections.
- Adapting planning and development of sea-projecting projects, such as artificial islands, marinas, breakwaters, reclamation sites, to coastal and marine conditions, environmental impacts and land uses through the definition of planning conditions and requirements for future projects.
- Maintaining contiguous open space along the coastal strip and kurkar cliffs and creating a “Coastal Park.”
- Developing and expanding bathing beaches for the benefit of the public as a whole, through the use of appropriate marine technology in suitable areas.
- Ensuring that bathing areas are open to the entire population, and preventing private beaches.
- Protecting the kurkar cliff area through controls on development and setback of building.
- Creating green routes and pedestrian routes linking the built hinterland and the coastal promenades and connecting inland urban open areas to the coastal area.
- Allowing access to central areas along the coastal strip by cycling, pedestrian traffic and public transport in order to maximise public access and reduce dependence on private vehicles.
- Creating a variety of activities in the inland section of the coast, while respecting compulsory building regulations and restrictions.
- Controlling development of the hinterland and the seafront in order to prevent walls of high building and in order to maximise sea views from the hinterland and the adjacent urban area.
- Developing the coast with emphasis on the needs of the user population and the general public through the creation of public assets designated for public use.

NGO Position Paper on Comprehensive Planning of the Tel Aviv Coastline

The variety of plans for development of the Tel Aviv coastline have elicited both public interest and wide media coverage. Several meetings were dedicated to the subject in the Tel Aviv municipal council. To help clarify the variety of opinions, the Society for the Protection of Nature in Israel and the Israel Union for Environmental Defense prepared a preliminary position paper on comprehensive planning of the Tel Aviv coastline. The paper was submitted to the city council as background material for a comprehensive review of coastline development.

The position paper is based on the principles of Integrated Coastal Zone Management, in general, and on the principles for sustainable development of urban shores, in particular (see p. 54). It presents the following general guidelines for planning the Tel Aviv coastline:

- Comprehensive planning for the coastal strip on two levels: metropolitan and urban.
- Planning on the basis of environmental analysis which takes account of the major environmental issues (coastal cliff, beaches, and sand balance) and development

- of alternatives for comprehensive planning of the coastal area and the hinterland taking account of environmental issues.
- An open and transparent planning procedure based on joint discussions with all stakeholders and interaction between the public, planners and decision makers throughout the process.

The position paper discusses the problems and conflicts which are associated with each of the existing plans for the different sections of the Tel Aviv coastline and recommends planning guidelines for each section. It is expected to serve as a basis for joint deliberation of coastal development plans.

NGO Masterplan on Protection and Development of the Netanya-Tel Aviv Coastline

Growing concern over the scarcity of open coastlines, especially in the central area of the country, has prompted the Israel Union for Environmental Defense to initiate a plan for the protection and development of the coastline in this region. The plan examines the potential of preserving this coastal stretch as the “green lung” of the central region while giving special preference to the public interest vis a vis entrepreneurial and institutional activities.

The plan examines existing conditions along the shoreline and hinterland of the central coastal strip, surveys existing and future plans for each section, and presents specific guidelines for protection and development. Following are some of the principles which are advocated: protection of the shoreline for public use, preservation of the coastal strip, beach nourishment, prohibitions on building, maintenance of open access and views, review of existing structures, and development of promenades and green routes to the sea in the urban built section. At the same time, special attention is accorded to the preservation of a continuum of open space.

The masterplan recommends that certain stretches of the coastline be declared as nature reserves and national parks in order to protect archaeological, historic, natural and landscape values and to preserve agricultural areas as open green spaces or open rural landscapes. The main objective of the plan is to inform both the public and decision makers about different plans which threaten to increase urban sprawl while reducing open spaces and damaging natural and landscape resources. At the same time, it proposes specific strategies for protecting sensitive areas and developing others for the benefit of the entire population.

Territorial Waters Policy Document

The Planning and Building Law confers exclusive rights on the Territorial Waters Committee to prepare, approve, postpone, or approve with revisions or conditions, any plan connected with the coast and the territorial waters of Israel. In recent years, as a result of ever-growing development pressures and conflicts along Israel’s coastline and territorial waters, it has become increasingly clear that a comprehensive, multi-disciplinary and dynamic policy on the sustainable development of Israel’s territorial waters must be prepared.

In 1997, the Territorial Waters Committee initiated an integrated coastal zone management (ICZM) approach in a policy document which was completed in May 1999. The policy document is expected to guide the decisions of the committee on integrated marine and coastal planning and use.

The document is founded on the principles of Integrated Coastal Zone Management (ICZM) which bases decision making on clear *policy*, effective *organisation* for control and enforcement and accumulated and open *data*. The main objective of the document is to create an effective tool for management and planning of territorial waters. The proposed approach should provide the conditions necessary to facilitate sustainable development while protecting the environment.

The policy document includes the following components:

- The comprehensive policy, its aims and principles.
- The spatial policy which guides designations on the beachfront and the breaker zone.
- Thematic policy on specific subjects: marine structures, sand reservoir, infrastructures, transport, tourism, natural assets and archaeology.
- Measures for ICZM including organisational recommendations, assessment tools for reviewing initiatives and proposals on planning, enforcement, monitoring, databases and other subjects.
- Compilation of data.

Objectives of the Policy

The overall target of Israel's ICZM policy, as expressed in the document, is as follows: management of the coast and territorial waters as a primary national and public asset, integration of coastal management in comprehensive national planning objectives and policy, and careful development of this approach according to the sustainability principle.

The specific objectives are outlined below in hierarchical order according to their importance:

- Assuring maximal coastal accessibility to the general public and providing for a multiplicity of human uses on the beachfront and sea, both in the breaker zone and shallow continental shelf.
- According maximal and careful consideration to sand and marine resources, conserving ecological processes and archaeological and heritage resources and assuring a rich diversity of landscapes and species based on a comprehensive vision which is multidisciplinary, multi-spatial and multi-generational.
- Placing high priority on leisure and recreation uses which are directly linked to the coast and sea.
- Utilising with care the unique economic potential of marine resources including fishery, mariculture, mining, food, and energy.
- Providing for the development of public engineering infrastructures in cases in which there is clear advantage to a coastal or sea location, but with preference to disturbed areas.
- Allowing for the limited development of economic infrastructures while carefully protecting the public interest, in those cases in which there is a clear advantage to a coastal or sea location, while implementing all the objectives outlined above and creating appropriate tools for monitoring and controlling implementation.

The policy document is divided into two policy planes: thematic and spatial. Policy is partially assimilated in maps on intervention levels and partially in thematic recommendations which will be expressed, *inter alia*, in requirements for environmental impact assessments for coastal plans.

For the purpose of establishing the spatial policy, the area up to the boundary of the territorial waters (12 nautical miles) was mapped in strips parallel to the coast. The longitudinal division includes five strips according to major features:

- ***Shoreline***: from the water line to 100 metres eastward or more in cases where a direct impact on the water is anticipated.
- ***Breaker zone***: from the water line to a depth of 10 metres below sea level westward.
- ***Shallow continental shelf***: from a depth of 10 metres to a depth of 30 metres below sea level.
- ***Continental shelf***: from a depth of 30 metres to a depth of 200 metres.
- ***Continental slope***: from a depth of 200 metres to the limit of territorial waters.

Spatial Policy

For the purposes of collating, classifying and analysing the data, Israel's territorial waters were divided into strips and sections based on such primary parameters as natural processes and human activities, both existing and planned. Detailed spatial policy was drawn up for so-called field cells on the seashore, breaker zone and shallow continental shelf since these strips are subject to the most intensive development pressures. More general policy guidelines were set for the deeper longitudinal strips which are more distant from the coast and thereby from the impacts of coastal land uses and designations.

The value of the field cells was evaluated according to their features and land use allocations and in accordance with the following four criteria:

- ***Sensitivity***: Value and vulnerability of the cells from the environmental aspect based on the uniqueness, sensitivity and inventory of natural resources in the cell.
- ***Continuity***: Continuity of the cells from an environmental aspect (ecosystems, landscape units and public use) in terms of the east-west axis and north-south axis and in relation to the marine and coastal strips.
- ***Accessibility***: Proximity of the cells to different types of population concentrations (e.g., large cities, smaller or sparsely populated areas, or open or rural landscape) and ease of access.
- ***Importance***: Social importance of the cells based on heritage and archaeological sites and level of attractiveness to the public for purposes of leisure, tourism and recreation.

Alternatives to spatial policy were developed based on targets, demands, conflicts and general approaches. Four desirable levels of intervention were defined for the field cells: preservation of an open and natural coast, regulation for leisure and recreation, development for leisure and recreation, and infrastructure development, as follows:

- The first level, which includes marine and coastal nature reserves and archaeological sites, calls for preserving coastal and marine resources in their natural state for the benefit of the public. In these areas, activities which threaten the area's natural and landscape features will be prohibited and approach routes from both land and sea will remain open.
- The second level, which includes, *inter alia*, bathing beaches, marine parks for scuba diving, and sailing for leisure uses (exclusive of accommodation), allows for basic facilities for the comfort and safety of visitors.
- The third category includes development for public recreation (including accommodations) and marine activity in accordance with environmental reviews and site-specific environmental restrictions and conditions.
- The fourth level, designated for infrastructure purposes, is based on allocating coastal sections and marine areas for development according to considerations of maximum public benefit. The establishment of marine structures, such as ports, breakwaters and infrastructure facilities, will be accorded preference in these cells while giving special attention to pollution prevention.

Finally, the significance of these four intervention levels is analysed according to three different alternatives:

- *Environmental alternative*: priority to land uses and designations which conserve natural and landscape values.
- *Social alternative*: priority to land uses and designations which assure access for recreation and will meet a wide range of population demands.
- *Economic alternative*: controlled development of land uses which are related to the sea and unique added value which derives from proximity to the sea for purposes of public access and well-being.

The spatial policy that is proposed in the document is based on the application of policy alternatives and intervention levels to the geographical features of the field cells of the Mediterranean shoreline, break shelf and shallow continental shelf.

Thematic Policy

Thematic policy relates to the policy which is proposed for each of the issues relevant to the territorial water, both natural processes relating to oceanography and marine geology, and anthropogenic activities such as marine transport and fishing. Principles and guidelines are formulated for each of the issues based on coastal zone management principles.

Thematic principles and guidelines are set for three major categories:

- 1) The environmental realm which includes natural and landscape values, marine archaeology, and marine pollution.
- 2) The economic realm which includes human uses such as infrastructures, urban shores, tourism, marine transport, defense uses, and fishing.
- 3) The physical realm which includes factors impacting on the sand balance such as waves, currents, marine structures, marine mining and the interrelations between these and other components.

Thus, the document relates to all of the major issues which impact on the coastal and marine environment. The thematic policy on marinas and offshore structures is particularly important since it accepts claims that were previously not considered valid.

Environmental Impact Assessment

One of the most important tools for evaluating individual projects in the land-use planning process is environmental impact assessment (EIA). EIAs have been used in Israel from the mid-1970s although regulations governing the requirements of EIA documents were only promulgated under the Planning and Building Law in 1982. The regulations have been fully integrated into the planning system, ensuring that at all stages and at all levels of the planning process, major development plans (as defined in the regulations) undergo environmental assessment.

The regulations call for EIAs to be prepared according to guidelines, formally issued by the planning authority but prepared by the Environment Ministry. The ministry invests special efforts in the preparation of appropriate plan-specific guidelines to ensure that the EIA, when submitted, will be a useful tool to decision-makers.

An EIA must include five chapters, as follows:

- 1) Description of the environment to which the plan relates prior to plan implementation.
- 2) Presentation of alternatives and specification of the reasons for preference of the proposed site and for planning principles.
- 3) Description of the plan and of the activities resulting from implementation of the proposed plan.
- 4) Assessment of anticipated environmental impact and the means necessary to prevent or abate negative impacts.
- 5) Conclusions and recommendations for integration in the regulatory provisions of the plan.

Projects expected to have significant environmental impact are subject to EIA requirements. In some cases, this obligation is explicitly defined in legislation and in statutory plans while in others it is subject to the discretion of planning authorities or to a representative of a minister in a planning authority.

Plans that are specifically enumerated in the EIA regulations include power stations, airports, seaports and hazardous waste disposal sites. Plans which, in the opinion of the planning authority, may have significant environmental impact include landing strips, marinas, national water supply arteries, dams and reservoirs, wastewater treatment plants, mines and quarries, waste disposal sites, and industrial plants situated outside designated industrial zones. Since 1983, the coastal masterplan requires environmental impact statements on all coastal development projects unless exempted by a decision of the planning authority. While this has not always been implemented, EIAs have been prepared for marinas, port expansion, breakwaters, and tourist and hotel projects along the coastline.

While the regulations do not specify how an EIA should be reviewed, the Ministry of the Environment has examined all EIAs since 1987. Experts at the ministry evaluate each EIA

and issue an opinion which includes a summary of the main findings of the EIA, the ministry's conclusions about the assessment, and a list of recommendations for the planning authority. The planning authority generally welcomes the ministry's professional advice and incorporates its recommendations in the decision on the plan. If the plan is to be deposited, the planning authority decides which instructions should be incorporated in the plan regulations. When the plan is deposited, both the EIA and the ministerial opinion are open to the public along with the plan documents.

An example of the EIA guidelines which were specifically prepared for the Herzliya marina is presented in the annex to this report.

Geographical Information Systems

The development of Geographical Information Systems (GIS) has led to major breakthroughs in the organisation and analysis of geographic data for environmental purposes. The Environment Ministry's Planning Division has developed a GIS which contains about 25 layers of information for the country, the average scale being 1:50,000 metres.

The first GIS project undertaken by the ministry was the Mediterranean coast database, which originally produced the maps included in the National Masterplan for the Mediterranean Coast. The coastal area is divided into 18 designated sections/maps, each of which includes the following layers of information: land-use features; areas including archaeological, vegetation, and natural landscape sites; and communication lines (i.e. roads, railroads). The Mediterranean coast database has been expanded to include information on monitoring sites and beach access.

The second database covers the entire country. It includes information, based on national masterplans, on areas exposed to airport noise, quarries, roads, and solid waste sites as well as areas of aquifer sensitivity. This information was combined, analysed and displayed in map form for use in national masterplans. Sites designated by the Israel Lands Administration for residential building and industrial development were compared with the database to identify areas where potential development may be subject to environmental degradation.

The third database deals with open spaces. It delineates national parks, nature reserves and landscape reserves which are included in national and regional masterplans; areas of special landscape value which were identified in a survey of open space landscapes; and areas proposed for afforestation in the afforestation masterplan. This database will provide a basis for open space policy and decision making.

In recent years, the GIS has been used for the following coastal projects:

- Maps pinpointing the locations of microbial and heavy metal monitoring stations along the Mediterranean coast and displaying coastal land uses along the Mediterranean at a scale of 1:100,000 were produced. Land use types include swimming beaches and industrial, municipal and defense uses.
- Oil spill sensitivity mapping of the Mediterranean coastline has recently been initiated in order to promote sound decision making on priority treatment in cases of large-scale oil spills.

- Maps on the built up area of the country for the purpose of ranking open spaces were produced in integration with the 2020 masterplan and in order to demonstrate ministerial policy on building in the country.

Remote Sensing Support for Analysis of Coasts

Another important development has seen the official launching of the Remote Sensing Support for Analysis of Coasts (RESSAC) project within the framework of the European Commission Programme on Environment and Climate. The programme, developed between 1997 to 1999, in co-operation with several European and Israeli institutions, aimed at demonstrating the usefulness and cost-effectiveness of multi-satellite based data in the assessment and monitoring of coastal dynamics in Israel.

The project focused on the monitoring and study of several topics, in the 100 km coastal stretch between Hadera (south of Haifa) and Ashdod (on the central part of Israel's coast). These included: offshore and coastal wind and sea-state data, seabed topography, sediment pattern, bathymetry, sand inventory, coastline changes, and land-use changes.

Monitoring and Research

Monitoring and research are vital for sustainable coastal development. It is imperative that national decisions on Mediterranean development are based on the results of sound scientific research.

Israel Oceanographic and Limnological Research (IOLR), a non-profit corporation affiliated with the Ministry of National Infrastructures, is the national institution dedicated to advancing knowledge about the aquatic world and developing methodologies and technologies for sustainable use of coastal, marine and freshwater sources. In fulfilling its mandate, much of the IOLR's scientific effort is directed to monitoring and assessing the status of Israel's sea areas and predicting their response to environmental perturbations. Research activities involve field observations, theoretical and modelling work and laboratory experiments. The broad range of questions considered include such diverse topics as ocean circulation and mixing; air-sea interaction; coastal erosion; bio-geochemical cycles; immunology, physiology and ecology of marine organisms and the dynamics of their populations; and impact of human activities on coastal and marine ecosystems and resources.

The research programme in marine biotechnology focuses on the development of innovative technologies for commercial exploitation of marine organisms. Areas of current research include production of biochemicals from marine algae for industrial, food and medical applications; cryopreservation of fish gametes and embryos for aquaculture applications; genetic engineering of fish; and control of crustacean reproduction.

Research and monitoring activities are also designed to provide a better understanding of the processes and phenomena involved in the complex mechanisms of pollution. Studies vary from such subjects as monitoring of marine pollution by nutrients from land-based sources to biological monitoring of the marine environment to development and assessment of monitoring and characterisation methods for marine pollutants. Studies include systematic monitoring of heavy metals along the Israeli coastline and monitoring of atmospheric pollution input into the Mediterranean.

The Geological Survey of Israel, also under the Ministry of National Infrastructures, is responsible for the systematic investigation of the geology of Israel and for providing geological information to the government and the public. Its geotechnical maps provide planners with essential data on the suitability of different areas or of different types of structures for certain types of development. The Geological Survey has carried out major studies on such topics as erosion of coastal cliffs and sand balance. The extensive range of disciplines covered by this institution include: paleoseismicity and earthquake risk assessment; geological mapping and geological risks; feasibility of artificial islands; climate change; building materials; paleoclimatology; aquifer pollution. geochemistry of rock, soil and water, hydrogeology and hydrochemistry, stratigraphy; and structural geology,

The Nature and National Parks Protection Authority carries out marine monitoring in the marine and coastal protected areas along the Mediterranean. The programme is carried out in shallow water (0-10 metres depth) and largely relates to human load in the coastal region. Additional monitoring relates to algal communities, ichthyofaunistic surveys, macroinvertebrate fauna in three representative reserves, surveys of marine turtle landings and nesting on the Israeli coastline as part of an action plan for turtle conservation, and long-term monitoring of the Israeli Cetacea by the Israeli Marine Mammal Research and Assistance Centre of Haifa University which includes monitoring of tens of dolphins living in the territorial water.

Public Education and Participation

Information and education are essential components of coastal management. Environmental subjects, including coastal zone management, have entered the school curriculum at all levels. This year, within the framework of activities associated with the International Year of the Oceans, a special booklet on the marine environment was distributed to intermediate grades in Israel's school system. This curriculum programme, as well as most of Israel's environmental education programmes, focuses on field work, observation and surveys in addition to studies within the school.

Moreover, each of Israel's institutes of higher learning offers programmes and courses in environmental science with a coastal perspective. Worthy of special mention is the Inter-University Institute for Marine Sciences which is affiliated with the Hebrew University of Jerusalem and the Centre of Maritime Studies in the University of Haifa. Israel's other universities - Tel Aviv, Bar Ilan, Ben-Gurion, Technion and Weizmann Institute of Science - also offer environmental courses on both the undergraduate and graduate level.

A great deal of non-formal environmental education is carried out by non-governmental organisations, foremost among which is the Society for the Protection of Nature in Israel (SPNI). This organisation has 24 Field Study Centres around the country, many located on the coastal strip, and offers students and visitors the opportunity to study the land and the environment at close quarters. In addition, SPNI Youth Clubs educate more than 9,000 teenage members about understanding and caring for their environment.

The Role of Non Governmental Organisations

Public awareness of coastal management issues is critical in the coastal conservation campaign. Over the past few years, the public has taken an active part in the struggle against

the privatisation of the coastline. Through such means as litigation, protests, coastal cleanups and dissemination of information, the issue has been accorded higher priority on the national agenda.

The country's non-governmental organisations, along with the local and national press, have played an important part in educating the public to take greater responsibility for coastal management. These organisations have placed the subject at the top of their priority list and have spearheaded numerous public campaigns and activities on behalf of coastal conservation. Perhaps more than any other organisation, the **Society for the Protection of Nature in Israel** (SPNI), Israel's largest environmental NGO, has been instrumental in raising public consciousness of coastal protection. During its forty-year history, the organisation has initiated dozens of campaigns against the destruction of unique ecological systems and scenic landscapes through unwise development. As a public representative on the National Planning and Building Board, it has also been a strong advocate of environmental interests. Its activities have been backed up by public protest and legal action, including petitions to the High Court of Justice. In recent years, campaigns have largely focused on protecting Israel's open spaces and coastlines.

The establishment of the **Israel Union for Environmental Defense** (IUED) in 1990, proved a milestone in the use of legal means to tackle environmental problems. Since its inception, IUED has emerged as Israel's only public interest environmental advocacy group using the courts, independent scientific analysis and a range of other strategies to address the country's mounting environmental challenges. Coastal conservation is of foremost importance in the organisation's current agenda and it has instigated several important court cases on the subject.

Other NGOs which have played an important part in increasing public awareness and participation, are **GreenAction**, an environmental activist group for social-ecological change, which was set up in 1994 and **Green Course**, a student environmental organisation which was launched in 1997. The latter now includes hundreds of activists in twelve university and college campuses around the country. **GreenPeace**, which inaugurated its Israeli office in 1995, has focused its initial campaigns on preventing pollution of the Mediterranean Sea.

The activities of these and other organisations have already borne fruit. Firstly, the issue has penetrated the media, and issues relating to coastal conservation are appearing in the daily press at a scope and frequency previously unknown. Secondly, the organisations have succeeded in mobilising support for the issue, both among decision-makers and the general public. Position papers have been prepared, information has been disseminated, and protests have been organised. Furthermore, preservation of open spaces along the coastline emerged as a central issue in Israel's November 1998 municipal elections. Staunch public support for this issue helped change the composition of municipal councils, especially in Haifa and Tel Aviv. The subject was also mentioned in Israel's recent national elections, but was not a major issue in the party platforms.

Public Review and Litigation

One of the goals of Israel's environmental administration is to inform and educate the public to become more active in enforcing environmental laws and to provide it with the technical data and legal tools necessary to fight for that right - whether through private criminal suits, civil proceedings, demonstrations or public pressure.

Within the framework of Israel's land-use planning system, the Israeli public is informed about schemes presented to regional and local planning authorities through public notices published in the legal gazette, in offices of the local authority, and in daily newspapers. Public bodies or individuals are free to inspect such schemes and to file opposition during the deposition period of any given plan. Plans are now being advanced to amend Israel's environmental impact assessment regulations to allow for greater public review and public hearing.

In addition to objections submitted to planning authorities, recent years have witnessed a number of important court cases which have been initiated by the public. Citizens and NGOs, especially the SPNI and IUED, have used their right to file oppositions to numerous development projects along the coast. These cases have significantly contributed to the enforcement of environmental standards, catalysed government agencies to initiate and implement more rigorous enforcement policies, and resulted in important court decisions and rulings on environmental matters. Notable examples of successful private suits against major industrial plants include court cases initiated by the IUED against major industrial polluters of Haifa Bay and the Kishon River. After a long and exhaustive legal battle, agreement was reached on comprehensive steps to prevent marine and water pollution in the future according to a strict timetable. As a result, dumping of sludge into the Mediterranean Sea by one of the country's major polluters of the sea was stopped in 1998. (See p.32).

Participation in National and International Campaigns

Since 1964, when the country's nature protection legislation was first enacted, Israel has celebrated Nature Protection Week. During this week, one important and relevant issue is brought to the attention of the public in an effort to raise environmental consciousness. This year (1999), the week was devoted to the marine environment, both as part of national activities dedicated to the International Year of the Oceans and in recognition of the importance of the coast as a national asset which must be preserved in the face of development pressures. Moreover, for the first time ever, the events of Nature Protection Week are taking place throughout the entire year and include production of information pamphlets and a poster on the marine and coastal environment, seminars, marches and cleanups along the coastline and a call to policy makers to voice their commitment to the protection of the marine environment (see p.59).

Israel also adopted an action plan within the framework of the International Year of the Ocean (1998). Its main aim was to promote public awareness of marine and coastal resources with special emphasis on education and youth activities. Activities included production of an educational kit for teachers and guides, new educational programmes on marine science, school competitions and prizes, conferences, lectures and workshops and coastal cleanups.

Volunteer coastal cleanups take place each year within the framework of International Beach Cleanup Day and on various occasions throughout the year. In recent years, underwater cleanup campaigns have been initiated as well. The major aim of these campaigns is to inform the public about the importance of the marine environment.

PROPOSED NEW POLICIES AND INSTITUTIONS

Principles for Sustainable Development of Urban Shores

Numerous position papers on integrated coastal zone management, which comply with the principles of sustainable development, were published in recent years by non-governmental organisations, foremost among which are the SPNI and IUED.

In March 1999, the Society for the Protection of Nature in Israel published a special booklet entitled "Principles for Sustainable Development of Urban Shores." The document presents planning principles which were collected from policy documents on integrated coastal zone management in various countries and from international conventions on coastal protection and biodiversity. The principles have already been applied to specific position and policy papers for coastal planning in municipalities along the Mediterranean coast.

Following is a summary of the principles presented in the document:

1st. The seashore as a public asset

- *Preserving the public designation of the coast:* coastal uses should be allocated for leisure and recreation of the local population and tourists rather than for residential or other uses which preclude the general public from fully enjoying the coast.
- *Preserving free public access to the coast:* special preference should be given to footpaths, bicycles and non-polluting transportation. In case of conflicts with existing uses, means should be found to improve land use systems and reduce conflicts to assure maximal access to the coast and alongside it.
- *Preserving a free and open view to the sea:* blockages by high and dense building should be avoided so as to provide for an open view to the sea.
- *Promoting a transparent, shared and open planning process:* planning should be shared by all stakeholders and common principles should be formulated for sustainable development policy on the coasts. Planning should be transparent to allow for public response and opposition during the process itself, utilising such means as public hearings, presentation of alternatives, etc.

2nd. Planning principles for urban coasts

- *Comprehensive coastal planning vision:* planning initiatives on the national, district and municipal levels should be examined from a comprehensive point of view. On the municipal level, masterplans should be prepared for the coasts in the jurisdiction of each local authority and an EIA should be prepared to review the cumulative impacts of all plans on the coast.
- *Coastal planning and development on the basis of comprehensive environmental analysis of the coast:* comprehensive planning must be based on the examination and treatment of all aspects the coastal system (e.g., cliff erosion, sand balance) in the different coastal strips.
- *Preservation of a building-free coastal strip:* this requirement should extend to 100 metres from the shoreline minimally and more, if necessary, according to the physical characteristics of the coast. Infrastructures should be moved as far away as possible from the shoreline.

- *Coastal locations reserved for uses which are vital to the coastline only:* uses such as industry, commerce, and defense installations, which are not inherently coastal dependent, should be moved elsewhere. Construction of residential neighbourhoods on reclaimed land or on the seashore should be prevented.
- *Distancing intensive building from the coastal vicinity:* massive and tall buildings should be avoided in the first and second strips from the shore in order to preserve open views and sea breezes and to link the seashore to urban open spaces.
- *Preservation of landscape and historic assets:* in order to maintain the special character and appearance of the city, open views to landscapes should be assured by providing public access to observation points.
- *Priority to reconstruction and renewal projects:* special attention should be given to waterfront reconstruction and renewal projects before initiating new buildings including promenades, restaurants, museums and public parks.
- *Promotion of environment-friendly public transport:* this should include footpaths and cycling paths and minimise private cars and allocation of parking areas along the coast.

3rd. Responsibility of the local authority for coastal management and operation

- *Routine maintenance of the shore:* this will include coastal access, facilities and cleanliness.
- *Rehabilitation of damaged shores:* this is of special importance for neglected coasts, coasts plagued by erosion and sand depletion due to marine structures, and coasts affected by pollution and litter.
- *Prevention of marine pollution by wastewater:* sources of land-based pollution should be treated.

Sand Management Policy

Based on the adverse impacts of Israel's offshore structures and in order to protect Israel's coasts against erosion and preserve and maintain sandy beaches for tourism and recreation, the Ministry of the Environment has advocated the adoption of a sand management policy in Israel. Following are some of the recommendations:

- Sand should not be removed from the littoral zone, and its movement along the coast should not be impeded. If this occurs as a result of engineering activity, sand of similar properties should be deposited on the beach as compensation for the missing sand or a mechanism should be found to allow the sand to bypass the artificial obstacle and continue on its natural course. Sand trapped artificially by coastal structures should not be used for land reclamation. Such sand should be used for artificial feeding of impoverished beaches or be returned to the natural sediment transport system;
- Sand should be recognised as a national resource, and therefore, sand dredged from a port or another marine installation should remain the property of the state which would then determine how best to manage this resource;
- Monitoring the bathymetric and sedimentological changes next to any coastal engineering project should be mandated both before and after implementation. Monitoring results should dictate the remedial steps to be undertaken to minimise the adverse effect of the project on the environment; and

- The country should search for sand deposits on the seabed as a potential source for dredging and beach nourishment, fill material and building.

Calculation of an accurate sand budget for the Israeli shoreline, based on past and present sources, natural and anthropogenic losses and estimates of future trends, will facilitate the development of a coastal sand management programme for the country.

Recommendations for Planning and Institutional Changes

The Territorial Waters Policy Document advocates several planning and organisational changes to implement the ICZM approach. These along with two new initiatives of the Ministry of the Environment (a coastal law and conflict resolution) are briefly described below:

National Masterplan: The preparation of a masterplan for territorial waters or for the breaker zone is recommended. Another option may be to revise or expand the existing National Masterplan for the Coastline (NOS 13) into an integrated masterplan for the coast and sea which includes the 100 m. realm. In all cases, the plan must relate to the entire range of coastal impacts and must ensure an open view to the sea, free access of the public to the sea and passage of sea breezes.

Further Power to the Territorial Waters Committee: The authority of the committee should be extended and broadened to include the 100 m area in which building is prohibited according to the provisions of the existing coastal masterplan. Additional observers should be included in the committee and regular meetings should be held to follow-up on the implementation of the recommendations set out in the document.

Environmental Impact Assessment: All marine and coastal plans should be subject to EIA requirements. This may be regulated within the framework of an amendment to the existing EIA regulations or through an addendum to NOS 13.

Inspection and Supervision: The Territorial Waters Committee should be entrusted with further inspection capabilities utilising the general inspection system of the Ministry of Environment or District Planning Commissions or alternatively, through a joint inspection and enforcement system which may include any or all of the following:

- Creation of a co-ordinating body and headquarters for field activities under the responsibility of the Ministry of the Interior or the Environment.
- Establishment of a Blue Patrol to unite the personnel, budgets and authority of the Ministries of Environment, Tourism, Education (Antiquities Authority), etc.
- Establishment of a Coastal Authority (lower priority).

Information and Monitoring: An updated and reliable database on territorial waters management should be established which would allow for the compilation and concentration of data. A professional advisory committee should be established to recommend means of completing the material and updating the data collected in the policy document.

Concessions: Land on the beach and territorial waters should not be sold to the public but should rather be developed by means of special concessions granted to private developers for

a limited period by means of a tender. The records of the developers which relate to services provided to the public should be subject to scrutiny and supervision.

Conflict Resolution: The consensus building approach to coastal conflicts should be promoted. This requires the participation of all stakeholders in a dispute resolution effort. The approach should increase the efficacy of decision making, avoid stalemates, and reduce the need for litigation while promoting integrated coastal management.

Changes in Legislation: The Territorial Waters Policy Document maintains that preservation of the shores and territorial waters may be accomplished by means of amendments to the coastal masterplan or by amendments to legislation within the framework of the Planning and Building Law. However, the Ministry of the Environment and Israel's non-governmental organisations have advocated a new Law for the Protection of the Coastal Environment.

Law for the Protection of the Coastal Environment

In 1998, in an effort to protect coastal resources in the face of mounting pressures for development, the Ministry of the Environment formulated a draft coastal law aimed at preserving and restoring the coastal environment and its fragile ecosystems, reducing and preventing coastal damages and establishing principles for the management and sustainable development of the coastline.

The rationale behind the law is aptly expressed in the memorandum which was recently distributed among government ministries. Following is a general translation of the preamble and major principles of the proposed law:

The seashore is a unique natural resource with importance to the entire public. The coastal environment and its natural resources serve the public for leisure and recreation purposes and constitute a national "green lung."

Israel's Mediterranean coastal strip is characterised by a rich diversity of natural assets, landscape and heritage, which are important assets of the state and its residents, and have intrinsic value and economic significance in various areas, especially for tourism. The Lands Law of 1969 includes the seashore within the framework of "designated land" which is "public land designated for public benefit."

Demand for this short and very limited coastal strip exceeds supply. Furthermore, the seashore attracts people and economic activities and includes important facilities and vital infrastructures such as ports and power plants.

As a result of activities and uses that do not take account of the significance and cumulative implications and long-term impacts, the coast is exposed to the risk of destruction and loss. Unwise economic exploitation of coastal resources may irreversibly harm its unique components - physical, ecological, marine and land.

One of the natural resources of the coast is the coastal sand, which grants the coast its special character and protects it from erosion. The coastal sand is nourished by longshore sand transport by means of wave movement and currents from south to north. Construction activities on the coastline have caused and continue to cause blockages to sand movement and lead to coastal erosion.

To prevent irreversible damage to coastal resources, including the coastal sand, the state must undertake every means possible - including legislation - to protect them and regulate the activities and uses permitted in them in a manner which will ensure conservation of coastal resources for the enjoyment and benefit of present and future generations.

Recently, a trend of intensive development and building along the coast and in its vicinity has been noted. This activity, which in many cases is not directly related or necessary to the seashore, has caused and continues to cause damage to the coastal environment, which is at times irreparable.

This damage is reflected, inter alia, in the following phenomena:

- Construction of marine structures blocks sand movement and causes a significant reduction in the width of bathing beaches.
- Construction of structures and erection of fences near the shoreline reduces the coastal area that is accessible to the public and restricts free passage of the public along the coast.
- Massive building on the seashore and its vicinity encroaches on bathing beaches that are available to the general public.
- Erection of tall and dense buildings along the seashore in the jurisdiction of municipalities blocks sea views and the flow of air.

These activities constitute a type of development which does not preserve or sustain, whose profits are enjoyed by the few, and whose adverse effects are borne by the public as a whole.

Existing legal tools, which are meant, inter alia, to protect the shoreline, do not provide a solution to the full gamut of problems. Thus, for example, within the framework of the Planning and Building Law, a Territorial Waters Committee was established, but its authority only relates to planning and building in marine waters. Similarly, the National Masterplan for the Coast, approved in 1983, established, inter alia, a prohibition on building within 100 metres of the shoreline but, in practice, fences and barriers are erected which prevent free access to and alongside the coast.

Furthermore, these legal tools, important as they are, are not based on a comprehensive view of the range of problems and do not succeed in affording a sufficient legal infrastructure for the protection of coastal resources from development pressures. Therefore, if the legal infrastructure is not strengthened and clear principles are not formulated, the system may continue to fail in fulfilling these objectives in the future as well.

Coastal damages resulting from unwise development activities are well-known phenomena world-wide and have led several countries, including Turkey (1990), Spain (1988), France (1986) and the USA (1972) to enact special legislation for coastal conservation. In addition, a model coastal law is currently being prepared by the European Community. The draft law is based on existing data and experience which have been adapted to the special needs and conditions of Israel. It should be noted that specific legislation on coastal conservation also exists in countries with planning and building laws. Its aim is to express the uniqueness of coastal protection and public rights to a proper marine environment and to improve and strengthen the legal tools for their protection. For this reason, such a law should be enacted in Israel as well.

Therefore, the purpose of this draft law is to establish in legislation the principles and legal framework which will ensure sustainable development of the coast, so that the public may enjoy and bequeath to future generations a coast whose value is no less than its present value.

The law is expected to determine, in the clearest and most explicit manner, that the State of Israel views its seashore as a public asset whose protection and conservation are of high national importance. Accordingly, its instructions, which are declaratory in nature, are meant to guide the activities of the general public as well as the consideration, activities and decision making processes of the authorities in carrying out their powers, implementing the laws, and undertaking administrative measures on matters related to the coastal environment.

Major Elements of the Draft Law

Objectives: The major objectives of the bill for the protection of the coastal environment are: to protect the coastal environment and its natural treasures, to prevent damage to the coastal environment and to establish instructions for management, development and sustainable development of the coast.

Coast as Public Property: The bill determines that the coast and the coastal sand are public property.

Definitions: The bill delineates the coastal area both on land and in the sea. The area was delineated in terms of floral and faunal systems which are representative of the coast and the coastal sand system. The borders of the marine area were established from the shoreline to a water depth of 30 metres in the sea or to a distance of one nautical mile, whichever is farthest from the land. The land border was established at 100 metres landward in built areas or areas designated for building in the coastal masterplan and 300 metres landward in other areas.

Protection of the Coastal Environment: The bill sets guidelines and principles for prohibited and permitted uses along the coastline. It proposes that only uses designated for public welfare, which are inherently coastal dependent (e.g., ports, coastal recreation, marine sport, swimming) will be permitted in the future. It also proposes that coastal areas will not be allocated for uses for which alternatives exist that are economically feasible and environmentally preferential. This principle is meant to prevent the privatisation of large coastal areas for the benefit of a limited public and to the detriment of large segments of the population which would be denied access and enjoyment of the beach.

Restriction of Activities which Endanger the Coastline: It is proposed to restrict and prohibit activities which threaten to damage the marine environment with the exception of activities which comply with the principles and provisions of the law. Accordingly, the bill specifies a long line of activities which are deemed to damage the coastal environment. Furthermore, the Environment Minister would be empowered to promulgate regulations on measures for the prevention of marine and coastal damage, on the one hand, and rehabilitation and restoration of damaged areas, on the other hand.

Right of the Public to Free Passage: Based on the principle that the coast is public property designated for public enjoyment and in order to ensure that this principle does not remain on the theoretical level only, the bill determines that the coast should be accessible to pedestrians, by means of access routes and passages along the entire length of the coastline

with the exception of areas which are restricted for safety or security reasons and ports, power plants other uses which will be determined by the Environment Minister.

Assuring Open Sea Views: The aim of this principle is to ensure that planning authorities adhere to this principle when deliberating on plans and buildings adjacent to the shoreline. An open view to the sea is part of the public right to the coast as a public resource. Therefore, neither the marine landscape nor the sea breeze should be blocked.

Responsibility of the Local Authority: Since local authorities are responsible for cleanliness, wise management of public areas for public benefit, and supply of environmental services within their jurisdiction, they must also be responsible for maintaining cleanliness along their shorelines.

Public Information: The importance of the marine environment and the complexity of the processes impacting it necessitate the compilation and concentration of data on marine protection. This information should be available to both public and private bodies. The Environment Minister should establish rules on data collection and on the means of distributing this information to interested parties and to the general public. This may require mapping of the natural, landscape and heritage values of the marine environment, mapping of concession areas, plans and existing uses, and mapping of free passageways to the public.

Additional principles which are included in the proposed law for the protection of the coastal environment relate to the integration of these principles and guidelines in the considerations of planning and licensing authorities. Moreover, it is proposed that the Marine Pollution Prevention Fund, which operates within the framework of the Prevention of Sea Water Pollution by Oil Ordinance, will include an additional objective, namely protection of the coastal environment. This will provide for the financing of activities to protect the coastal sand including coastal restoration. For this purpose, the Minister of the Environment may decide to impose fees for the protection of the coastal environment on owners or operators of marine installations which damage the coast or interfere with the free flow of sand.

It should be noted that the Israel Union for Environmental Defense, a non-governmental organisation, has also prepared a draft proposal entitled Law for the Protection of the Mediterranean Coastline which was presented as a private bill by over 30 Parliament members. It is anticipated that the two proposals will be promulgated as one integrated coastal law which will embody the main principles and obligations which are included within the two draft bills.

Covenant on the Protection of the Marine Environment

The proposed Law for the Protection of the Coastal Environment expresses the principles of coastal zone management in legal terms. In recognition of the importance of the coast as a national resource, Israel's nature protection organisations drafted the following covenant within the framework of Nature Protection Week. The covenant is being distributed to organisations, the general public and students and has already been signed by myriad organisations and individuals. It expresses, in clear terms, the commitment of the public and its representatives to the preservation of the coastline:

The sea and shoreline constitute one of humankind's most important ecosystems, both because of their central role in the formation of life and because they are the cradle of human civilisation.

In Israel, processes which have occurred throughout the years have damaged the marine environment, as reflected in the following areas:

- Coastal areas which are open to the public are dwindling, sand beaches retreating, kurkar cliffs collapsing, and quarrying threatens the few remaining sand dunes.
- Natural systems are facing extinction and some have totally disappeared.
- Coasts are being “trampled” by massive building and are closed to the general public by private developers who promote residential initiatives and facilities for “tourism” for a fee.
- Marinas are taking over public spaces and are disturbing the fragile balance of longshore sand transport necessary for beach nourishment.
- Sewage and litter pollute the sea and its environment and damage the ecosystem, health and wellbeing of vacationers on the coast.
- Uncontrolled fishing reduces fish stocks and harms the ecosystem.
- Polluted streams flow into the sea and contaminate its waters.

Therefore, we, as public representatives, environmental organisations, government authorities and citizens of Israel, who view the marine environment as a natural asset which is important to us and to future generations, do hereby commit ourselves to utilise every means to stop coastal destruction and to protect marine resources by:

- Declaring the sea and its coasts as a public asset for the welfare of the general public.
- Promoting the Law for the Protection of the Coastal Environment.
- Requiring coastal and territorial water development to be implemented according to the principles of preliminary planning and integrated coastal zone management (ICZM) while considering present and future needs.
- Utilising best available technologies to protect, preserve and rehabilitate the natural marine environment.
- Advancing educational and information activity among all sectors of the population in order to acquaint them with coastal and marine resources and their importance to humankind.
- Establishing databases which are accessible to the general public and encouraging research on the subject.
- Implementing activities to preserve coastal cleanliness.
- Preventing coastal degradation by irresponsible activity by field and all-terrain vehicles.
- Implementing activities to prevent river pollution and to rehabilitate and restore river life.

The coastal environment is a valuable asset to all residents of Israel. It is our responsibility to care for it and to preserve it for our own benefit and for the benefit of future generations.

APPENDIX

Directory of Marine and Coastal Reserves in Israel

Israeli Mediterranean Marine Nature Reserves

No	Nature Reserve Name	Area (ha)	Shore line (m)	Status	Comments
1	Yam - Rosh HaNiqra	446.2	2,825	proposed	limestone and kurkar rocks
2	Yam - Akhziv	217.1	1,367	"	kurkar (eolinite) ridges
3	Yam - Bustan haGalil	46.8	2,649	"	kurkar (eolinite) ridges
4	Yam - Shiqmona	163.4	630	"	kurkar and limestone rocks
5	Yam - Atlit	33.8	1,479	"	kurkar ridges and sandy beaches
6	Yam - Newe Yam	85.3	3,951	"	kurkar ridges and sandy beaches
7	Yam - Dor - Habonim	532.0	1,510	"	kurkar ridges and sandy beaches
8	Yam - Ma'agan Mikha'el	455.3	9,768	"	kurkar and sandy beaches
9	Yam - Gador	65.0	2,100	"	kurkar ridges and sandy beaches
10	Yam - Mikhmoret	29.9	1,489	"	kurkar ridges and sandy beaches
11	Yam - Poleg	119.6	1,611	"	kurkar ridges and sandy beaches
12	Yam - Yavne	58.8	1,761	"	sandy beaches
13	Yam - Evtah	137.0	4,527	"	sandy beaches
14	Yam - Shiqma	102.9	4,653	"	sandy beaches
	Total	2493.1	40,320		

Source: Ortal, R. 1998. Marine and Wetland Conservation in Israel. Internal Report. NNPPA.

Israeli Mediterranean Coastal Nature Reserves

o.	Nature Reserve Name	Area (ha)	Shore line (m)	Status	Comments
1	Hof Rosh HaNiqlra	23.0	1,641	proposed	limestone rocks and kurkar b.
2	Hof Bustan haGalil	20.0	2,220	proposed	kurkar (eolinite) beaches
3	Shefekh ha Na'aman	34.2	583	proposed	oligohaline stream and sandy b.
4	Holot Hamifraz	12.2		declared	kurkar ridge and limestone r.
5	Hof Shiqmona	4.5	630	proposed	kurkar ridges and sandy beaches
6	Hurvah Qarta	13.7	100	declared	small stream and kurkar ridge
7	Hof Atlit	43.0	3,734	proposed	kurkar ridge and sandy beaches
8	Hof Newe Yam	30.2	3,040	proposed	kurkar ridge and sandy beaches
9	Hof Dor-Habonim	42.3	4,825	declared	kurkar ridge and sandy beaches
10	Hof Ma'agan Mikha'el	67.2	5,791	proposed	sandy beaches
11	Shefekh N. Daliyya	37.2		proposed	oligohaline stream and sandy b.
12	Nahal Tanninim	32.6	75	declared	oligohaline stream and sandy b.
13	Hof Gador	73.3	2,073	proposed	sandy beaches
14	Hof Mikhmoret	3.0	500	proposed	kurkar ridges and sandy beaches
15	Nahal Poleg	50.0	1,271	declared	small stream and sandy beaches
16	Holot Rishon leZiyyon ¹	800.0	4,300	proposed	sandy beaches
17	Holot Yavne ¹	600.0	5,500	proposed	sandy beaches
18	Holot Nizzanim	765.0	2,103	proposed	sandy beaches
19	Holot Ziqim	286.0	1,843	proposed	sandy beaches
20	Holot Nativ ha'Ashara	698.9	1,631	proposed	sandy beaches
	Total	36,363.3	41,860		

Source: Ortal, R. 1998. *Marine and Wetland Conservation in Israel. Internal Report. NNPPA.*

Protected Mediterranean Natural Asset Belts

o.	Name	Area (ha)	Shore line (m)	Width at sea (m)	Status	Comments
	Yam Rosh HaNiqlra - Akhziv	590.0	5,964	1,120	declared	limestone rocks and kurkar ridges
	Yam Dor - N. Me'arot	600.0	9,615	1,000	declared	kurkar (eolinite) ridges
	Total	1,190.0	*15,579			

Source: Ortal, R. 1998. *Marine and Wetland Conservation in Israel. Internal Report. NNPPA.*

*8,700 m are also included in proposed marine nature reserves.

Mediterranean Islet Nature Reserves

o.	Name	Area (ha)	Status	Comments
	Iyyi Hof Rosh HaNiqlra	31.1	declared	kurkar islets and nesting sites
	Iyyi Hof Dor and Ma'agan Mikhael	2.1	declared	kurkar islets and nesting sites
	Total	33.2		

Source: Ortal, R. 1998. Marine and Wetland Conservation in Israel. Internal Report. NNPPA.

Israeli Mediterranean Islets

No.	Name	Area (ha)	Status	Comments
1	Tekhelet	0.40	proposed	Yam Rosh – HaNiqlra NR
2	Shahaf	0.60	declared	Iyyi Hof Rosh - Ha Niqlra NR
3	Nahlieli	0.80	"	Iyyi Hof Rosh – Ha Niqlra NR
4	Akhziv	0.30	"	Iyyi Hof Rosh – Ha Niqlra NR
5	Segavion	2.30	"	Yam Akhziv NR
6	Atlit	0.75	-	not included
7	“Melah 1”	0.62	proposed	Yam Newe – Yam NR
8	“Melah 2”	0.50	"	Yam Newe – Yam NR
9	“Melah 3”	0.25	"	Yam Newe – Yam NR
10	haMelah	0.80	"	Hof Newe – Yam NR
11	“Newe Yam 1”	0.25	"	Yam Newe – Yam NR
12	Newe Yam	0.75	"	Hof Newe – Yam NR
13	Tamnun	0.15	"	Yam Newe – Yam NR
14	Shehafit	0.75	-	not included
15	“Me’arot 1”	0.22	-	not included
16	“Me’arot 2”	0.32	-	not included
17	“Habonim 1”	0.50	proposed	Yam Dor – Habonim NR
18	“Habonim 2”	0.12	"	Yam Dor – Habonim NR
19	“Habonim 3”	0.70	"	Yam Dor – Habonim NR
20	“Habonim 4”	0.32	"	Yam Dor – Habonim NR
21	Dor	1.30	-	not included
22	Tefet	0.60	-	not included
23	Hofmi	0.60	declared	Iyyi Hof Dor and Ma’agan - Mikha’el NR
24	“HaYonim 1”	0.16	proposed	Yam Ma’agan Mikha’el NR
25	HaYonim	0.50	declared	Iyyi Hof Dor and Ma’agan - Mikha’el NR
26	“HaYonim 2”	0.50	proposed	Yam Ma’agan – Mikha’ NR
27	“HaYo3”	0.16	proposed	Yam Ma’agan – Mikha’el NR
	Total	15.22		

Source: Ortal, R. 1998. Marine and Wetland Conservation in Israel. Internal Report. NNPPA.

Supplementary Environmental Legislation Related to the Coast

- *Maintenance of Cleanliness Law, 1984*: This law forbids littering or disposal of waste, building debris and vehicle scrap into the public domain. The law prohibits the disposal of any refuse in public areas, including litter left on the beach or thrown overboard from a vessel into the sea within Israel's territorial waters. The law holds the skipper and owner of a vessel responsible for violations, and fines are imposed on them. The law establishes a Cleanliness Fund to finance a broad range of environmental activities. The major sources of the fund are fees imposed on manufacturers and importers of disposable beverage containers and fines imposed on violators of several environmental laws. An important and innovative enforcement feature of the law provides for the appointment of voluntary inspectors and cleanliness trustees, empowered by the Minister of the Environment to report on littering offenses.
- *Water Law, 1959*: This law establishes the framework for the control and protection of Israel's water resources. It states that all water sources are public property and that every person is entitled to use water, as long as such use does not cause the salination or depletion of the water resource. The law prohibits the pollution, or any act that is liable to cause pollution, of freshwater. The Water Commissioner is responsible for prescribing norms for the quantity and quality of water and for promulgating regulations concerning "protective strips" around water sources.
- *Local Authorities (Sewage) Law, 1962*: This law prescribes the duties of local authorities in matters concerned with the design, construction and maintenance of sewage systems. It requires local authorities to properly maintain sewage system and to have new systems approved by District Planning and Building Commissions and by health and environmental authorities.
- *Streams and Springs Authorities Law, 1965*: This law authorises the Minister of the Environment to establish authorities for the management of specific streams, springs or other water sources. Among a long and varied list of duties, a stream or spring authority is responsible for the protection of the stream and its banks, prevention of pollution, and reclamation, development and management of rivers and riverside parks. Two coastal river authorities, for the Yarkon and Kishon Rivers, were set up under this law.
- *Hazardous Substances Law, 1993*: This law provides for "cradle to grave" supervision and management of hazardous substances. The administrative enforcement means established by the law include a permit requirement for any premise dealing with a hazardous substance. In recent years, courts have imposed maximal penalties on individuals and corporations which have discharged toxic chemicals into water bodies.
- *Licensing of Businesses Law, 1968*: The law empowers the Minister of the Interior, in consultation with the Minister of Health and the Environment, to designate and define businesses requiring licenses in order to ensure proper environmental conditions including appropriate sanitary conditions and prevention of nuisances. Special environmental provisions may be imposed within the framework of the license.
- *Abatement of Environmental Nuisances (Civil Action) Law, 1992*: This law enables private citizens to bring environmental law suits on behalf of themselves or non-profit organisations of which they are members, in cases of environmental

pollution or nuisances, including marine and water pollution. The law places three types of legal remedies at the disposal of the citizen: restraining orders, prevention of recurrence orders and corrective orders. In addition, the law allows, for the first time in Israel, the use of class actions in environmental law suits.

EIA Guidelines: Herzliya Marina

Project-Specific Guidelines (June 1983)

(The guidelines are presented in condensed outline form for the purposes of this report)

Chapter I: Description of the Environment without the Proposed Activity

1. Mapping
2. Physiography
3. Hydrographic Regime and Wave Climate
4. Sedimentation Regime
5. Hydrology
6. Flora and Fauna
7. Land Uses
8. Noise
9. Visual Resources

Chapter II: Reasons for Preference of the Proposed Site

Chapter III: Description of the Activities Resulting from Implementation of the Proposed Plan

1. Plan Description
2. Stages of Construction
3. Operation and Maintenance

Chapter IV: Assessment of the Anticipated Environmental Impacts and of the Means Necessary for the Prevention of Negative Impacts

1. Impacts on the topographic and bathymetric structure of the coastal region in the area of the proposed activity and its environs (levelling of the area, stabilisation of slopes and cliffs, infilling, marine and land dredging)
2. Impacts on Waves, Currents and Sea Levels
3. Impacts on Drainage
4. Impacts on Marine and Water Pollution
5. Impacts on Flora and Fauna
6. Solid and Hazardous Waste
7. Noise
8. Visual Impacts
9. Land Uses
10. Prevention of Possible Impacts of Failures and Emergencies
11. Follow-up Plan

Guidelines for a Supplement to the EIA on the Herzliya Marina (February 1989)

Chapter I: Completions

Chapter II: No Supplementary Material

Chapter III:

1. The marina and its accompanying services
2. Tourism, Recreation and Sport (Excluding Marine Sport)
3. Pedestrian Traffic and Transportation
4. Landscape Planning
5. Infrastructures
6. Stages of Implementation

Chapter IV: Completions on Marine Pollution, Noise, Impacts on Appearance and Landscape.

Chapter V: Proposal for the Regulations of the Plan

Regulations based on the description of activities presented in Chapter III and the measures to prevent nuisances enumerated in Chapter IV, in addition to the following:

1. Regulations for development and operation of the marina
2. Regulations for the development of regional recreation and tourism
3. Regulations for conservation, designs and landscape rehabilitation
4. Regulations to ensure implementation of open public areas and pedestrian pathways
5. Regulations to ensure implementation of infrastructures for sewage and waste systems.

ANNEX II

**THE MEDITERRANEAN COAST IN ISRAEL:
SOCIAL AND ECONOMIC EVALUATION**



UNITED NATIONS ENVIRONMENT PROGRAMME
MEDITERRANEAN ACTION PLAN



PRIORITY
ACTIONS
PROGRAMME



Coastal Area Management Programme (CAMP) for Israel

The Mediterranean Coast in Israel: Social and Economic Evaluation

Report prepared by
Zvi Tropp and Shaul Zaban



Priority Actions Programme
Regional Activity Centre
Split, 2000

Foreword

Growing threats to coastal environments have precipitated a world-wide move toward the integrated management of coastal areas. MAP, in general, and CAMP, specifically, have played a vital role in introducing this concept to Israel. In 1996, a CAMP Israel Agreement was signed in response to the growing recognition by national authorities and institutions in Israel that an integrated coastal zone management (ICZM) programme should be implemented in Israel. The principles of the programme accord with the sustainable development approach defined in MAP Phase II and Agenda 21.

Israel's 188-kilometre long coastal strip has been subject to ever-growing pressures and conflicts. The need to formulate specific policies to protect this sensitive and dynamic environment has been recognised by the Ministry of the Environment for more than two decades. Therefore, the Ministry is especially pleased to see the shift toward wise management of the coastal zone which has emerged in recent years and wishes to express its appreciation to MAP for its continued guidance and support. Hopefully, the experience which has been accumulated in Israel in the area of ICZM will be of interest and use to all who are concerned with this important issue, both in this country and elsewhere.

This report was prepared within the framework of the United Nations Environment Programme – Mediterranean Action Plan (UNEP-MAP) Coastal Area Management Programme (CAMP) for Israel and was made possible by the generous support of the Priority Actions Programme Regional Activity Centre (PAP/RAC).

Acknowledgements are due to the many individuals in the Ministry of the Environment, scientific organisations and non-governmental organisations who made important contributions to every part of this document.

Executive Summary

Background

Israel has an 188-km long coastline or seashore extending from Rosh HaNiqra in the north to the Gaza Strip in the south. In addition to the general environmental and panoramic pleasures and benefits it affords, this seashore is utilized for the following purposes:

- Regulated, as unregulated, bathing beaches;
- Defense installations;
- Power stations;
- Ports;
- Hotels and leisure facilities;
- Boating marinas.

The coast has an adjacent strip of land, i.e. beaches, of varying width along its entire west-east front. The beaches are relatively wide in the southern coastal area, but their width diminishes considerably as one travels northwards towards Rosh HaNiqra. The beaches along the seashore and the overlying sand are highly valuable owing to their various special properties and uses, as follows:

- a. They constitute a protective barrier against the damage inflicted on the land by wave action;
- b. They serve as a resource base for tourism, leisure and recreation.

The seashore and the overlying sand are a public property, but unrestricted use of this property is often denied since many uses affect or deny benefits which could normally be derived by other users, i.e. the public. Hence, use of the seashore must be regulated in order to optimize the overall benefit derived by the public.

Objective of the Study

To determine the economic and social value of the seashore.

Methodology

In the first stage the specific added value derived by the Israel economy from the seashore was estimated for the following uses:

- a. Hotels and other accommodation facilities;
- b. Leisure and vacation;
- c. Property development.

In addition, the willingness of the public to pay for seashore conservation was assessed. For those uses for which there are substitutes which are not located directly on the seashore such as hotels and residential apartments, the added value to these services derived from their proximity to the seashore was estimated by analyzing and evaluating the additional contribution which various consumers are willing to pay for proximity to the seashore.

The values obtained were as follows:

Use	Annual revenue (\$, millions)	Net Present Value over a 20-year period (\$, millions)
Hotels	105	1,500
Vacationing and leisure	125	1,720
Property for housing	265	4,400
Willingness to pay	12	65

In the second stage, the impact of the marina constructed at Herzliyya in the 1990's on the adjacent seashore, and which has been affected by the marina, was analyzed.

Construction of this marina is one of the most conspicuous examples demonstrating the impact of development activities on Israel's seashore by one user on the benefits of other users of the seashore. This marina impedes the natural movement of the sand along the seashore and its establishment has resulted, on the one hand, in increasing the depth of sand of the adjacent southern beach, and, on the other hand, in reducing the depth of the sand on the beach lying to its north.

This strip of the seashore is occupied by bathing beaches operated by the Herzliyya Municipality, by private beaches belonging to the hotels located on the seashore, and by the marina, as well as by residential apartment buildings and other consumer facilities. Owing to the narrow strip of the northern, the kurkar cliffs are subject to excessive weathering, erosion and collapse with resultant losses to property.

On the basis of the values attached to the various uses, it was possible to estimate the damage caused to the various users of the seashore north of the marina, as shown in the following table.

Estimated Added Value and Loss of Value Resulting from Construction of the Herzliyya Marina

Subject	Added value (\$, millions)	Loss of value (\$, millions)
Added seashore value to property in the marina	150	-
Endangered property to the north of the marina	-	80
Denial of opportunity to vacationers and bathers	-	27
Expansion of the southern beach for vacationers and bathers	27	-
Possible damage to hotels north of the marina	-	25

Beach Restoration

Two alternatives have been proposed for restoration of the beaches affected by the marina:

Proposal of the Herzliyya Municipality - Construction of Additional Breakwaters

The Municipality proposes construction of two unconnected breakwaters opposite the damaged beach. It is contended that these breakwaters would delay the northward movement of the sand and increase the sand depth in the adjacent northern beach. On the other hand, this would transfer the problem of sand loss to the beaches further to the north. The cost of restoring the seashore along a length of 2 km according to this proposal is estimated at \$ 2.6-9.0 million.

It is considered that implementation of this plan would restore a 20-m width of beach, i.e. an area of 40 dunam (4 ha) whose value to the public is estimated at \$ 34 million.

Proposal of the Ministry of the Environment - Seashore Restoration by Marine Excavation of Sand for Beach Filling

According to this approach, the beach would be widened and restored by feeding the beach with sand. For this purpose a marine dredge would be employed which would excavate sand from the sea floor and deliver it to the beach by means of a pipeline. In order to reduce the loss of sand which would occur in this type of operation, measures would have to be taken to reduce movement of the sand during the filling operation. The total cost of the filling (inclusive of renting the dredging ship) is estimated at \$ 700,000; this work would have to be repeated every few years.

It should be noted that the main cost in this case is due to the need to rent the dredger.

Accordingly, it would be worthwhile in this case to carry our restoration works on a number of neighboring beaches and thus reduce the unit restoration costs per kilometer of beach.

Survey of Leisure Seekers in the Tel-Aviv Beach

Within the framework of the study a survey was made on seashore recreation habits in which 306 inhabitants of Tel-Aviv, Ramat Gan and Givatayim who visit the Tel-Aviv beaches were interviewed. It was found that these persons visit the bathing beaches and its municipal hinterland on average 26 times a year. In response to the question how much these interviewed persons would be prepared to pay each year for conservation of the beaches, it was concluded that on average they were prepared to contribute NIS 31/year. (about \$7.8). The most important factors determining which beach they visit were: beach cleanliness and the proximity of the beach to their homes.

Proposal for Imposition of Levies on Property Developers to Compensate for Environmental Damage and Denial of Leisure Opportunity to the Public

It goes without saying that the beach has a high social value, but even today we come up against cases in which entrepreneurs are granted rights to use of the seashore without having to compensate the public from immediate or future, perhaps as yet unforeseen environmental hazards. The award of these property development rights in most cases denies benefits which would otherwise be available to public; moreover, the entrepreneurs are not required to repair the damage caused (where this is possible) or to compensate the general public for this damage. The damage to the public may be categorized as follows:

(1) Occupation (expropriation) of a section of the beach; (2) Denying public access to the beach for leisure and recreation; (3) Damage to neighboring beaches, and (4) Obstruction and aesthetic detriment to the landscape.

The players active in the field of seashore property are motivated by business interests, while administrative limitations and the measures for enforcement of planning restrictions are insufficient to impede these activities. The business players do not internalize in their consideration criteria the impact of their development works on the general public. This study therefore proposes the imposition of measures which would result in these players internalizing the extraneous effects of their development works.

As stated, there is at present a deadministrative means to enforce property developers to compensate for immediate or expected damage to the environment as a result of property development, even though such compensation appears to be fully justified. A proposal is therefore put forward for imposition of a levy on property development in the vicinity of the

seashore. This would have the effect of internalizing the value of such damage and the revenues obtained - both from land betterment taxes and from on-going annual property taxes - would be diverted to environmental protection issues and to upgrading public welfare.

The mu

nicipality and the Israel Lands Administration would also have to allocate sums from the revenue obtained from the development promoter to protection works for prevention of damage to the environment and for upgrading environmental quality. The means of levying charges on the developer and payment procedures are discussed in Section 11 of the report.

1. Introduction and Background

Introduction

The report presented in the following was commissioned by the Mediterranean Action Plan in the context of CAMP Israel, through the aegis of the Israel Ministry of the Environment, with the object of seeking means of expressing concerns in economic terms and applying economic tools for environmental purposes. Specifically, the study reviews and analyzes the available data on the benefits of the Mediterranean seashore to the public of Israel, as well as data collected during the surveys carried out within the framework of the study, on the social and economic benefits of the Mediterranean seashore of Israel. Special attention is given to the hazards of marine development projects for the environment.

The Consultants consider that the study will contribute to the economic and social aspects of coastal zone management and assist in formulating a resource management policy for the Mediterranean coast of Israel. The study should also assist other Mediterranean countries in policy decisions related to the environmental aspects of seashore development works. It should be noted that marine and seashore development works have various other impacts on the environment such as groundwater and storm runoff, as well as many others issues, but these were not included in the Terms of Reference for the present study.

The study was carried out by Zenovar Consultants Ltd. of Tel-Aviv on behalf of the Israel Ministry of the Environment.

Background

The seashore of Israel serves as the base for several varied economic activities as a result of which the different users affect the state of the seashore, its economic value, and the ability of other users to benefit from the seashore.

Public awareness of the effect of various development works has increased in recent years. In particular, there has been increasing awareness in the present decade - following construction of the Herzliyya marina - of the effect of marine structures on the natural movement of the sea sand and consequently on the form of the beach and its width, as well as on the structure of the landscape to the rear of the beach. The changes resulting from these structures affect the ability to obtain economic benefits from the beach.

Economic awareness of the value of the seashore has also increased in recent years as a panorama with great attraction, as expressed in the increasing demand for land close to the seashore for residential purposes and for commercial activities such as hotels, cafes, etc. There is accordingly a trend towards construction of high-rise buildings close to the seashore which increases the property value of the land.

Land valuers whose estimates are considered to reflect the market value of different properties pay increasing attention to factors such as the panorama, the seashore, and the proximity of environmental nuisances as factors which increase or reduce land values.

Authorities responsible for the quality of the environment encounter difficulties in securing recognition of foreseen environmental problems stemming from property development when competing with the revenues - and the benefits to promoters and municipalities - which will accrue from development of property close to the seashore. Hence, the social and economic value of the seashore to the entire population and to persons living in the vicinity of the seashore should be evaluated.

Attaching an economic value to environmental factors is no simple matter and the present study is intended to serve as an additional cornerstone in the attempts to quantify the benefits of these factors. A number of studies have been carried out in Israel, which, among others, endeavored to attach an economic value to the Carmel Park (on Mount Carmel) and to general quietness. Various studies have been carried out in other countries which have attributed an economic value to the seashore panorama.

It should be borne in mind that there is a built-in difficulty in attributing an economic value to the seashore which will reflect the preferences of the entire public in present and future generations, apparently, in part, because of the increasing future scarcity of this resource and - what is more difficult - assessing the structure of preferences of future generations.

An attempt is made in this study to attach a price tag to the benefit that various users gain from the seashore. This price tag will enable assessment of the economic value of the changes caused and marine structures. It is, of course, also necessary to assess the economic value of the denial of public benefit resulting from property

development, but this aspect is not considered in this report owing to the difficulties and inherent complexity of expressing this in economic terms.

This estimate will serve as a basis for drawing up a management mechanism for the activities carried out on the seashore, as well as a mechanism which will bring the involved parties to internalize the extraneous influences of their development activities.

Estimating the value of economic activities on the beach involves four main factors: (1) accommodation facilities; (2) the beach as a site for public recreation and leisure; (3) the value to the Israeli public of the open seashore, and (4) the impact of the seashore on property values. The values estimated in this report are based on the data which can be quantified, bearing in mind that the value of certain properties of the seashore and their intrinsic benefits cannot be quantified.

2. Methodology and Report Sequence

The present study is aimed at delineating the "added seashore value" of the economic activities carried out on the seashore. In the case of hotels, for instance, an attempt is made to assess that part of their income derived from their location

close to the seashore. If we establish the value of the specific hotel property, then we should be able to establish that part of the value deriving from its location. This value is referred to as the "added seashore value".

Most of the activities examined have a cash flow stream extending over a period of years. In order to calculate their expected net present value, the expected cash flows were capitalized at an annual rate of 6%. Three periods were considered in these calculations, namely, a one-year period, a 20-year period up to Year 2020, and a 40-year period up to Year 2040. The assumption that the value of the environmental benefit will increase in the future is taken into consideration in the appropriate assumptions in the calculations. This assumption was not applied to the setting of a different discount rate for environmental benefit as against other benefits.

The following chapters of this report present the calculations for the economic value of the various uses of the seashore, as follows:

- The revenue derived by hotels and other accommodation facilities;
- The outlay incurred by visitors to the beaches and to sites in the municipal hinterland;
- Municipal expenditures on seashore maintenance;
- Consumer willingness to contribute to beach conservation, and
- The added value of property in the vicinity of the seashore.

The economic impact of the Herzliyya Marina is examined in this context as an example of the effect of such development works on property values and the environmental and social aspects of such development. Appendices 1 and 2 present detailed data of the economic aspects of the available accommodation facilities, while Appendix 3 presents the findings of a survey on the beach-going habits of 306 residents of Tel-Aviv, Ramat Gan and Givatayyim to the Tel-Aviv beaches. Appendix 4 examines the added value of property overlooking the sea.

3. The Mediterranean Coast of Israel

Israel has a Mediterranean coastal strip of 188 km from Rosh HaNiqra in the north to the Gaza Strip in the south. The coastal strip is generally defined as that lying within 100 m of the water front. The distribution of the coastal strip is given in Table 3.1.

Table 3.1: The Coast Line of Israel - Length of Each Strip and Length within

Municipal Boundaries

Strip	Length of Coastal Strip (km)	Length within Municipal Boundaries
Rosh-HaNiqra - Nahariyya	7.5	-
Nahariyya	3.5	3.5
Nahariyya-'Akko	7	-
'Akko	3.2	3.2
'Akko - Kiriot	6.7	-
Kiriot-Haifa Bay	9	9
Haifa	9	9
Haifa-Zikhron Ya'akov	23	-
Ziikhron Ya'akov-Hadera	15	-
Hadera	2	2
Hadera-Netanya	13	-
Netanya	3.6	3.6
Netanya-Herzliyya	14	-
Herzliyya	4.4	4.4
Herzliyya-Tel-Aviv	5.5	-
Tel-Aviv-Bat Yam	13.5	13.5
Bat Yam-Ashdod	20	-
Ashdod	5	5
Ashdod-Ashqelon	8.1	-
Ashqelon	7.5	7.5
Ashqelon-Gaza Strip	7.5	-
Total	188	60.7

* According to G.I.S measurements of the Ministry of the Environment

Sand Locations and Reservoirs for Beach Restoration

The beaches are that part of the seashore covered, in the main, by sea sand. Israel's sea sand is found both on the sea floor and on land and for the purposes of this study can be categorized as follows:

- On land:
 - Beach sands
 - Dune sands
 - Fossil sand (buried beneath the soil).
- On the sea floor:
 - Sand on the continental shelf;
 - Sand on the continental slope.

The existing sand reservoirs: These are important for a number of reasons, among them as a possible source of sand to be used to restore damaged beaches. Sand

used for beach restoration must have a suitable grain size since sand with excessively small grains will be flushed back to the sea and will not assist in beach restoration, whereas excessively large-grained sand will result in a less pleasant beach.

There are a number of possible sources of sand which can be used for beach restoration as follows:

- a. Sand reservoirs which have formed as a result of the construction of marine structures. Generally, sand accumulates on one side of these structures, whereas sand is depleted from the other side. The situation resulting from the construction of the Ashdod port may be cited as evidence of this sand accumulation. As a consequence of the marine works carried out for port construction, an estimated 4.5 million tons of sand have accumulated to the south of the port, part of which is below the water surface. Accumulation of sand at the seashore indicates that the sand is suitable from the aspect of grain size for beach restoration.
- b. Sand situated beneath the sea within the territorial waters of Israel. The quantity of sand on the sea floor and its suitability for beach restoration is presently being examined within the framework of a study on artificial islands (Sadan, 1999). At present, areas which have a depth of water less than 30 m are defined as areas prohibited for sand excavation owing to fear of damage to the beach.
- c. Sand could also be excavated for beach restoration from the coastal waters of Egypt, but here, too, excavation is subject to beach preservation regulations. It appears that the sand beneath the coastal waters of Egypt is suitable for restoration purposes but excavation for beach restoration in Israel is dependent on a trade agreement between the two countries.
- d. Israel's dune sands have served as a source for beach restoration works in recent times, but these dune sand reserves are being depleted and according to the Inter-Ministerial Committee for Supply of Sand, excavation of sand from the dunes will be reduced and will eventually cease entirely. Hence, these dune sands cannot be considered as a possible source.
- e. The possibility of importing sand from Sinai has been studied, but here too use of these sands is dependent on an agreement between Israel and Egypt.

Marine shipment of sand for beach restoration would, of course, be less costly than transportation from land sources since there would be no need for an unloading port and the sand can be delivered - with the aid of certain facilities - directly from the ship to the beach.

4. The Mediterranean Seashore as an Economic Resource

The main function of the beach and its immediate hinterland is for public recreation and leisure.

The various forms of use are described briefly in the following:

Tourism: Various types of hotels providing accommodation to incoming tourists and Municipal vacationers, as well as restaurants are located on the seashore. Even in the case of hotels located on the promenade to the rear of the sea front, the hotel location was originally largely determined by its proximity to the sea front. Land on or near the seashore is often used for building hotels and the hotels thus damage the resource which contributes part of their revenue.

Vacationing, bathing, sunbathing, sport and exercise: The general public uses the beach as a site for these various forms of recreation and leisure.

Landscape: The beach and seashore constitutes a landscape resource for the general public

National parks and nature reserves: These also exist on the sea front, as also in the water.

Motorized coasting: Excursions with light all-terrain vehicles (ATV's) and motor cycles in the sand dunes and beaches. The use has an adverse impact on the seashore since it accelerates cliff erosion and collapse. Movement of the ATV's also affects the texture of the sand and increases wind-blown sand. These activities require regulation so as to avoid damage to the beach and the seashore by restricting the area in which movement of these vehicles is permitted..

5. The Economic Value of Accommodation Facilities along the Mediterranean Seashore of Israel

There are at present about 11,300 hotel rooms along the coast of Israel, of which 9,980 rooms are in large hotels approved by the Ministry of Tourism as hotels for tourists, about 950 rooms in small hotels and in kibbutz and cooperative settlement guesthouses, about 140 B & B's in rural locations in kibbutzim and other settlements, and about 220 rooms in field schools and youth hostels. It is stressed that all these data relate to accommodation facilities located close to the seashore.

The number of night occupancies along the seashore was estimated for the year 1997 at 4.12 million, of which 2.64 million (64%) were tourists (see Table 5.1). Of the 4.12 million night occupancies, about 3.6 million were occupancies in large hotels, about 450,000 in small hotels and guesthouses, about 52,000 in village B & B's, and about 8,000 in field schools and youth hostels.

Table 5.1: Accommodation Facilities along the Mediterranean Coast of Israel, 1997 (*) ()**

Item	Hotels recognized by Ministry of Tourism	Small hand guho	B & B's in kibbutzim & cooperative settlements	B & B's Rural in private rural homes	Field schools and youth hostels	Total
No. of rooms	9,980	950	34	103	227	11,294
No. of night occupancies, (thousands)	3,608	448	13	39	8	4,116
Of which occupancy by tourists	67%	44%	20%	20%	33%	64%
Revenue from accommodation incl, VAT (NIS, thousands)	1,429,461	55,926	1,503	4,553	479	1,491,922
Of which revenue from tourists	55%	37%	20%	20%	33%	55%
No. of directly employed persons	6,253	367	11	32	?	6,680

(*) For detailed data see Appendix 2. Data are based on following sources: Yearbook of the Central Bureau of Statistics (1998) and CARTA (1997)

(**) Data relate only to accommodation facilities located close to the seashore, including hotels in the coastal cities (Tel-Aviv, Haifa, Herzliyya, Netanya and Ashqelon). Accommodation facilities in the proximity of the seashore are defined as those located west of Highway 2 (the Coastal Highway) or within a distance of 2 km from the seashore.

**General Note: The rate of exchange at the time of preparation of this report was
NIS 4 = US\$ 1.**

Table 5.1 shows that the total revenue from these accommodation facilities along the seashore amounted in 1997 to 1,492 billion New Israeli Sheqels (NIS) including VAT of which NIS 1,394 billion were exempt from VAT (foreign tourists).

In order to estimate the added value stemming from the location of accommodation close to the sea (within 2 km), prices for accommodation close to the sea were compared with prices for nearby accommodation but further from the seashore. The comparison showed that about 39% of the price for accommodation in a hotel by the sea is the added value for proximity to the sea (for details, see Appendix 2). According to this calculation, the added value of accommodation facilities stemming from its proximity to the seashore is estimated at 30% of the revenue, i.e. an added value of about NIS 420 million per year stemming from proximity of the location of the accommodation to the sea.

The national outline plan for tourist projects and recreational areas (National Outline Plan No. 12) is based on the assumption that the number of tourists visiting Israel will continue to grow and that the number of tourists visiting Israel will reach 5 million in the year 2010. This outline plan, which was drawn up in a peak year (1995) for incoming tourists, in which some 2.53 million tourists visited Israel, erred on the high side and forecast an annual growth of 4.6%. However, tourism is a branch much affected by extraneous factors which are difficult to foresee, and, in fact, the number of tourists declined steadily in the years 1996 to 1998 at a rate of 4.5% in each of these years.

The present study is based on the assumption of an intermediate scenario according to which the number of tourists will increase at an annual rate of 2% in the years 1999 to 2020. According to this assumption it is expected that 3.63 million tourists will visit Israel in the year 2020. It is also assumed that Israelis will increase their hotel and other vacation occupancies at a similar rate.

A calculation was made for the coming decades of the added seashore value from operation of hotels near the sea based on these assumptions. According to this calculation, the added seashore value, as defined above, will amount in 1999 to NIS 420 million. It is assumed that this added value will increase up to the year 2020 at a rate of 2% per year and will then remain stable. The added value was capitalized at a rate of 6%/year and accordingly the net present value from hotel and other resort occupancies up to the years 2020 and 2040 will amount, respectively, to NIS 6 billion

and NIS 8 billion.

For purposes of comparison, the findings from two other scenarios were studied. The first scenario is an optimistic one, according to which the number of incoming tourists will increase at a rate of 4.6% per year up to the year 2020 and from then on will remain steady at this figure. The number of tourists according to this scenario will reach 6.5 million in the year 2020. In this case the present net value of the added seashore value up to the year 2020 will amount to NIS 7.6 billion, and up to the year 2040 to NIS 11 billion.

Under the second, less optimistic scenario, the rate for incoming tourists will remain as at present and consequently only 2.3 million tourists will visit Israel in the year 2020, i.e. roughly the same number of tourists as recorded for the last year for which complete data are available (1998). In this case the present net value of the added seashore value up to the year 2020 will amount to NIS 5 billion and up to the year 2040 to NIS 6.4 billion.

6. The Economic Value of the Seashore as a Recreation and Leisure Site for the General Public

Surveys of vacationers and bathers (referred to hereinafter as "recreationers" or "beachgoers" at the seashore of Israel were conducted in the years 1982 and 1994. The surveys were conducted by means of aerial photography of the beaches on noon Saturday in the month of August (Kimhe, 1994). In the year 1994 there were 62,000 beachgoers at one time on the Israeli seashore and the number of private vehicles parked by the sea amounted to one vehicle per 2.8 recreationers¹. The 1982 survey reported about 98,000 persons at the seashore at noon on an August Saturday. It should be noted that the average of 2.8 persons per vehicle is similar to the survey of beachgoers in the Broward County of Florida where it was also found that the size of the beachgoing group averaged 2.8 (Broward County, 1997).

It appears that the decline in the number of beachgoers in the years 1982 to 1994 points to a number of trends in the habits of the Israeli recreationers, as follows:

- The transition to five working days a week (Sunday to Thursday) for most of the work force (instead of the previous six-day week) enables a distribution of beachgoing over a two-day period, and some of the beachgoers go to the beaches on Fridays and not on Saturdays.
- The growing awareness to the hazards of sunbathing has led to people going to the beach in the earlier or later hours of the day during which radiation is less hazardous and these persons were not therefore captured by the noontime survey. The change of the clock to summer time facilitates this trend. This fact may explain part of the decline in the number of noon time beachgoers indicated by the surveys for the two years, 1982 and 1994.
- There may be some decline in the public demand for the beaches owing to the development of country clubs and the variegation in the range of recreation ; moreover, it is not clear that if there is such a decline whether this trend has continued in 1995 to 1999. It is assumed in this study that this trend has been curbed and that the number of beachgoers as a percentage of the population has stabilized.

¹ This figure also includes persons arriving at the seashore by public transport or on foot.

Assessing the value that the public attributes to beachgoing is problematic owing to the fact that the seashore is not a marketed commodity. In order to obtain an index of the sum that the public is prepared to spend in order to relax by the sea, assuming the existence of market in which this form of recreation or leisure is traded, a number of items were examined, namely, the price for entry to beaches where an entrance fee is levied, the cost of travel to the beach, parking costs, and the municipal expenditure for maintaining the beaches within the jurisdiction of the municipalities.

These data were examined together with an estimate of the number of visits to the beach for bathing and recreation in the municipal hinterland of the seashore and the length of seashore within the municipality's jurisdiction (for details see Appendix 3).

The following conclusions were derived from this analysis.

- About 13 million beachgoers visit the Israel's beaches for bathing and sunbathing during the bathing season (see Appendix Table 3.3). These visitors spend about NIS 98 million in travel costs to the beaches, about NIS 25 million for entry fees, and about IS 8 millifor parking.
- Accorto sampling surveys carried out during the course of the year (not only the summer months), about 18 million persons spend time in the municipal hinterland of the beaches These visitors spend about NIS 79 million a year in travel to these sites. This calculation does not take into account parking costs and entrance fees to these sites.
- Another way in which the public allocates money (indirectly through municipal taxes) for the purpose of maintaining its ability to spend time at the sea is by means of the municipal budgets devoted to seashore maintenance. The Tel-Aviv municipality allocates about NIS 7.6 million/km/year of seashore for seashore maintenance, while the Herzliyya municipality allocates about NIS 6.8 million/km/year. For the purposes of this study a public spending index of NIS 6 million/km/year of seashore was assumed on the assumption that there are some municipalities and other authorities which spend less on seashore maintenance. The total length of the regulated bathing beaches is a little over 24 km and hence it is estimated that the public outlay on seashore maintenance amounts to about NIS 145 million per year.
- Up to this point, the calculation of the value of the benefit to the public has been presented, based on costs and prices for the various services in a steady state. However, this approach represents an under-estimate since the

public has a normal demand curve according to which demand increases as prices decline. The curve expresses the willingness of the public to pay in return for access to the beach. It is assumed that the price the public is willing to pay declines the greater the number of visits to the beach: the first visit to the beach brings greater pleasure than, say, the thirtieth visit in the same year.

The real benefit is that for which the public is willing to pay, and, in fact, the public, is willing to pay for beach recreation more than he is actually required to pay. The benefit which the consumer enjoys without incurring payment is referred to as "the consumer surplus"; this surplus is equal to the area above the price curve and below the demand curve. This consumer surplus is estimated in the present case at 70% of the public outlay for beach recreation and therefore amounts to about NIS 93 million/year, while the consumer surplus for visitors to the municipal hinterland is estimated at NIS 56 million per year.

The total outlay of the public for the possibility of spending time at Israel's beaches and in the municipal hinterland² (including the consumer surplus) is estimated at NIS 355 million/year, while the consumer surplus alone is estimated at NIS 149 million/year and the total public benefit at NIS 504 million/year (see Table 6.1). This study assumes that the value of the regulated beaches to the public at least equals this sum. The calculation per kilometer gives a benefit of about NIS 21 million/km of regulated seashore. On the assumption that the outlay of the public is proportional to the size of the population and that the population of Israel will grow in the coming decades at an annual average rate of 1.5%, then the present net value of the benefit to the public in these decades can be estimated. According to the calculation for the period up to the year 2020, the net present value of the public benefit is estimated at NIS 6.9 billion and up to the year 2040 at NIS 9.4 billion. This gives a net present value of NIS 285 million/km of regulated seashore up to the year 2020 and NIS 390 million/km up to the year 2040.

² The municipal hinterland is as the area to the rear of the beach in which there are restaurants and places of entertainment overlooking the sea

**Table 6.1: Public Benefit from the Beaches and Municipal Hinterland
(expressed in terms of net present value)**

Item	Year 1999 benefit	NPV up to Year 2020	NPV up to Year 2040
Value of recreation activity	131	1790	2,440
Consumer surplus - only for beachgoers	93	1,270	1,730
Total beachgoer benefit	224	3,060	4,170
Value of recreation activity in municipal hinterland	79	1,080	1,470
Consumer surplus of visitors - only to municipal hinterland	56	760	1,040
Total benefit of visitors to municipal hinterland	135	1,840	2,510
Municipal expenditure for seashore maintenance	145	1,980	2,700
Total public benefit from recreation on seashore and municipal hinterland incl. municipal expenditure	504	6,880	9,380

7. Willingness to Pay for Conservation of the Seashore

Apart from the active use of the beaches by the inhabitants of the country as a place for recreation, the public also attaches a value to the very existence of the seashore conserved as open, not built-up, areas. From data obtained in the survey carried out in the beginning of 1999 it is possible to estimate in part the value that the public attaches to the existence of the seashore.

In the framework of the survey, 306 persons residents of Tel-Aviv, Ramat Gan and Givatayyim - were interviewed and were asked the following questions: "Suppose that owing to financial considerations the Tel-Aviv Municipality were to grant contractors the right to build housing. If it was stated that this could be avoided if citizens contribute to a fund devoted solely to seashore conservation, then would you contribute to this fund?".

The average sum which the interviewed persons stated that they would contribute to this fund was NIS 31. It should be noted that there were a number of interviewed persons who stated that although they do not visit the beaches, they would be prepared to contribute up to NIS 250. From this it can be seen that there is a difference in the value that the active users of the beaches are willing to pay and that attributed by the passive users - those that benefit solely from the existence of the unrestricted seashore panorama.

Other surveys point to the existence of a lifetime value and similar values. A survey carried out among hikers in the Jezreel Valley shows that on average hikers were prepared to pay NIS 33 in order to preserve the agricultural landscape of the area (Fleischer, 1997). In 1989, following the forest fire on Mount Carmel, a fund was set-up to which many people contributed - further evidence of the willingness of the public to contribute to landscape and wild life conservation.

A survey carried out in 1996 examined the willingness of the public to contribute to a fund in order to prevent further damage to the Carmel Park. The survey encompassed a sample of the contributing population from the year 1989 and a sample of the general population. The average contribution of the contributing population in 1989 was NIS 53.7. Of those people surveyed, there were those who stated that they do not visit the Park but were prepared to contribute NIS 46.5 to the fund (average for those interviewed). The survey of the general population sample

showed an average contribution of NIS 37.4 and a contribution of those who do not visit the Park of NIS 29.7 (Nevo, et al.,1997)

A rough estimate based on these preliminary findings gives the following findings: Taking a figure of 1.59 million households in Israel and assuming that the average household places a value of NIS 31, as indicated above, on the preservation of the seashore, then the public as a whole attaches a value of NIS 51 million to the existence of an open seashore. However, this should be considered as only a preliminary figure which requires firming up and additional evaluation.

It may be assumed that owing to the increasing population density of Israel and the accelerated development of the country, the value that the public attaches to an open seashore will increase in the course of time. This study assumes that this value will increase at a rate of 0.5% per year. On the assumption that it is possible theoretically to request a payment from the public for this purpose once every four years, then the present value of the sums up accruing to the year 2020 would be about NIS 258 million and up to the year 2040 about NIS 432 million, taking a 6% capitalization rate.

8. The Economic Value of the Seashore for Property Development

Apartment prices increase the nearer the property is to the seashore price or it as compared similar but more distant apartments. The assumption presented here is that it is possible to apportion about 30% of the value of the property close to the sea to its actual location. Apparently, it should be possible to assess the high economic value found for properties on the seashore, but this does not constitute an advantage for the general public owing to the fact that construction on the seashore reduces the value of apartments situated behind the seashore apartments since these apartments previously had an unobstructed view of the sea.

>From this it appears that the seashore in itself contributes an added value of about 30% to the property in its vicinity and from this consideration it is worth preserving it. In the final analysis, building apartments or hotels on the seashore will not bring an added value to the public.

The breadth of the strip of land from which the property promoter benefits from the increase in value owing to its proximity to the seashore is estimated at 100 meters. In other words, about 30% of the value of the property in this strip is due to its location along the seashore. The value of property is not however uniform for the length of the entire coastline of Israel: the closer the property is to Tel-Aviv, the higher its value.

Table 8.1 gives an estimate of the value of land in the 100-meter broad strip of the entire coastline of Israel which benefits from an added seashore value. The estimate shows that the seashore gives an added value of about NIS 17.6 billion. The table also shows that the added seashore value of the property ranges from almost NIS 700,000 per dunam (south of Askqelon) to NIS 1.7 million per dunam (in the Tel-Aviv area).

Table 8.1: The Added Seashore Value of Property along the Seashore

Item	Gross value per dunam of land within 100 m of the seashore (NIS, thousands)	Of which added seashore value (NIS, thousands /dunam)	Length of the 100 m broad strip (km)	Area benefiting from added seashore value (dunam)	Total added seashore value (NIS, millions)
North of Haifa	2,286	686	28.5	2,850	1,954
Haifa & Kiryat	3,571	1,071	17.0	1,700	1,821
Haifa-Netanya	2,714	814	54.0	5,400	4,397
Netanya-Herzliyya	3,571	1,071	17.5	1,750	1,875
Herzliyya-Tel-Aviv	4,000	1,200	10.0	1,000	1,200
Tel-Aviv	5,714	1,714	6.0	600	1,029
Yaffo-Bat Yam		1,200	6.0	600	720
Bat Yam - Ashdod	3,571	1,071	25.5	2,550	2,732
Ashdod-Ashqelon	2,714	814	17.5	1,750	1,425
Ashqelon-Gaza Strip	2,286	686	6.0	600	411
Total			188.0	18,800	17,565

Loss of areas close to the seashore

Another aspect of the property value of the seashore relates to the loss of property value due to damage to the cliffs. The Geological Institute estimates that weathering of the cliffs along the Israeli seashore results in a loss at a rate of 20 cm/year, i.e. the cliffs are receding at a rate of 20 cm/year.

Apart from the damage to the landscape, this collapse represents a loss of land to the property owners along these cliffs. In locations where there has been intervention caused by marine structures, this rate of collapse is even greater. Hence, according to the estimates of the Geological Institute and also of the Department of Antiquities the rate of weathering of the cliff at Ashqelon since construction of the Ashqelon marina is 20 cm/year, or about 2 m since completion of construction in the late 80's.

In order to prevent collapse of the cliff, boulders have been laid in some areas at the foot of the cliffs. This protects the cliff, but does not prevent erosion of the beach. Hence, in the absence of other means of protection, one of two possibilities must be chosen: damage to the beach or damage to the cliff and the properties on it.

A cliff recession at a rate of 20 cm/year will result in a recession of an additional four meters by the year 2020. Accordingly, erosion which occurs along one kilometer will result in the loss of four dunam by the year 2020. On the basis of the attributed land values and the length of the built-up area in the area of the cliffs, an estimate is given in Table 8.2 of the damage which will be caused by loss of property to property

owners on the cliff as a result of cliff erosion only in the strips of seashore within municipal jurisdiction. It should be noted that if it becomes necessary to abandon houses owing to a recession of a few meters, then this will involve greater damage and will require construction of alternative housing.

Table 8.2: Estimate of Value of Property Lost to Owners along Municipal Seashores Resulting from Cliff Collapse and Erosion up to Year 2020

Strip of seashore	Length of municipal strip (km)	Estimated property value lost (NIS, millions)
Hadera-Givat Olga	2	21.7
Bet Yannay	1 (50% municipal)	14.3
Netanya - up to Poleg outfall	3.6	51.4
Herzliyya	4.4	70.4
Tel-Aviv - North	2	45.7
Ashqelon	7.5	68.6
Total	20.5	272.1

9. Sample Assessment of the Estimated Value of the Impact on the Seashore Resulting from Construction of the Herzliyya Marina

A change in the movement of sand in the area of Herzliyya has occurred since construction of the Herzliyya marina in the past decade and its adjacent three unconnected breakwaters. A pocket has been created between the marina in the south and Sidne "Ali to the north. The sand in this pocket has been captured around the breakwaters with resultant increase in the breadth of the facing strip of beach. On the other hand, the structures have resulted in a loss of sand to the north and the beach in this area has narrowed. Thus, sand accumulates to the south of the marina whose movement northward is at present impeded. The sand accumulates beneath the sea around the breakwaters which encompass the marina, but it is assumed that in time the northward movement of sand will resume.

Consequently, due to this capture of sand to the south of the marina, the breadth of beach near the two southern breakwaters has increased by 125 m, and near the northern breakwater by 70 m. In all, a 500-m long strip has been affected and has expanded bringing about an increase in the beach area of 40 dunam.

On the other hand, about a 2-km stretch of beach to the north of the marina has been adversely affected by these changes. In the first three years after construction of the marina there was an annual recession of 5 m, but this recession rate has since tailed off and amounts at present to about 1 m/year. The beach has receded about 20 m along a front of 2 km, i.e. a loss of about 40 dunam.

The marina planning engineers assumed that the seashore would stabilize around the years 2005-2007 at a steady state which would be characterized by a wide beach in the southerpart of the pocket and a narrow beach in the northern part. Two alternatives have been proposed for restoring the northern beach, one by the Herzliyya Municipality, the other by the Ministry of the Environment.

The plan put forward by the Municipality of Herzliyya proposes the transport of sand to the northern beach and construction of two to four separate breakwaters opposite the affected beach with the object of trapping the sand deposited in the northern area. The Municipality has some 300,000 cu.m of sand stored at the building site of the

marina and this sand could be transported and deposited to restore the affected northern beach. This quantity would apparently suffice for restoration of the beach and for on-going maintenance of the restoration works for several years.

The other alternative put forward by the Ministry of the Environment proposes to distribute sand, which would be excavated from the sea floor, for restoration of the northern beach, to carry out various on-going maintenance work, and to repeat the excavation and sand distribution operation once every few years. According to this plan, no additional breakwaters would be constructed since it is feared that though these would assist in solving the Municipal problem they would generate a new problem further to the north.

As for the breakwaters proposed by the Municipality, it is not at present clear whether one pair or pairs of breakwaters would be required at what depth the breakwaters would be constructed. It is estimated that deposition of sand on the beach and construction of one pair of breakwaters at a shallow depth, according to the Municipality's proposal, would cost about \$ 2.6 million.

If the breakwaters have to be constructed at greater depth, then the cost would amount to \$ 4.5 million, whereas if it is found necessary to construct two pairs of breakwaters, then the cost will increase, respectively, for shallow and deeper breakwaters to \$ 5.2 million and \$ 9 million.

The change in the structure of the seashore also has an economic impact on property values. An attempt is made in the following to assess the economic impact on the basis of the rather general data. More detailed data on the economic activities being carried out than are at present available are required in order to draw up a more reliable estimate. This preliminary assessment of the economic impact is presented in the following.

Influence of the Marina on Adjacent Property Values

Construction of the marina has resulted in the creation of areas for property development extending over some 130 dunam; this area has been granted 100% building rights. The gross value of the land is estimated at about NIS 8 million and the added seashore value at about 30% of this value, i.e. NIS 2.4 million per dunam. The value of all this land (130 dunam) is estimated at about NIS 1 billion, of which the added seashore value is about NIS 300 million. Buildings at present under

construction in the area facing the marina or in its vicinity are also valued at about an additional NIS 1 billion and the added seashore value of the property at NIS 300 million.

Data reported by sales personnel of the Migdalei Marina (Marina Towers) project, one of the apartment projects now under construction near the marina, are cited as an example of property values. The project consists of twin pairs of towers which will have a total of about 320 apartments priced as follows:

Apartment area* (sq.m)	Apartment price (\$, thousands)
70	282
80	357
123	530
144	680

* each category of apartment size constitutes about 25% of the total

In addition, areas encompassing some 40,000 sq.m are planned for commercial purposes. The entire project extends over about 25 dunam of the above-mentioned 130 dunam.

While the marina has resulted in generation of areas for property development, this is countered by the fear that the effects of marina construction endanger existing buildings located on the cliff above the affected northern beach. The damage incurred may result in the need to abandon the properties situated on the cliff. This may prove necessary if the seashore is not restored in which case property along a strip with a length of about one kilometer and a width of 100 m may be lost; these properties are valued at about NIS 332 million.

Influence of the Marina on Recreation and Leisure Opportunities

As stated, the area of the southern strip of beach has increased by 40 dunam, while that of the northern strip has decreased by 40 dunam. Thus, there has been a net nil overall change from the overall standpoint and this has had no effect on the ability of the public to benefit from the seashore as a recreation site; moreover, the breakwaters surrounding the marina have themselves become a recreation site for many visitors and constitute an additional attraction.

The economic significance of the change in the structure of the seashore lies in the transfer of the economic value of activities to the southern shore at the expense of the

northern seashore, both of which are managed by the same municipal authority. The activities of the municipal hinterland of the seashore have not been affected. The effect on the activities of the bathers for both sections of the beach is reported in the following.

It is estimated that about 721,000 persons visit the bathing beaches of Herzliyya each year. According to the calculation given in Appendix 4 to this report, the annual expenditure of these visitors for beach recreation totals about NIS 15 million/year and the total expenditure, inclusive of municipal outlays, about NIS 28.5 million/year as follows:

	NIS, millions/year
Travel to the beach:	4.1
Entry fee	4.5
Parking fees	0.2
Sub-total	8.8
Other items:	
Consumer surplus	6.2
Total public benefit	15.0
Municipal expenditure in seashore maintenance	13.5
Total expenditure	28.5

The area occupied by the Herzliyya bathing beaches was not measured in the framework of this study, but is estimated at about 200 dunam. The above calculation showing an overall annual benefit to the public of NIS 28.5 million/year gives a benefit per dunam of NIS 143,000/year. The movement of 40 dunam to the south can be interpreted as a southward movement of a resource estimated at NIS 5.7 million/year, representing a net present value up to the year 2020 for the 40-dunam area estimated at NIS 78 million, and up to the year 2040 estimated at NIS 106 million (assuming a visitor growth rate of 1.5% per year).

It should be noted that the area of the marina is planned to include numerous municipal leisure sites which will benefit from their proximity to the sea. This will naturally be of added value to the public related to the time spent in the municipal hinterland of the seashore.

Influence of the Marina on Accommodation Facilities

It might be supposed that hotels facing the expanded beach area would benefit from an additional added value, while those facing the contracted area would be adversely affected. However, from impressions gained from a visit to the area it appears that this supposition may not be valid. From the present condition of the northern beach it appears that its attraction to tourists has not been affected. Nor is it clear whether the expansion of the southern beach brings more tourists to the hotels on this stretch of the sea front.

There are at present five hotels recognized by the Ministry of Tourism as tourist class hotels in Herzliyya; these hotels have about 670 rooms. There is also one hotel - the Oceanos Apartment Hotel - for which no data are at present available. Of these six hotels, the Daniel Hotel (200 rooms) is situated on that section of the coast - cliff erosion begins to the north of this hotel. The Dan Accadia (206 rooms) south of the Daniel is situated opposite the expanded beach. The hotels facing the narrowed north beach consist of: the Sharon Hotel with about 200 rooms, the Eshel Hotel 50 rooms and the Marine Heights with 20 rooms. There are a number of additional hotels but these are located in the inner parts of Herzliyya town and are not close to the seashore.

The revenue from these hotels is estimated at NIS 127 million/year. About 400 hotel rooms are located opposite the expanded southern beaches, or those which have not been affected, and hence it can be stated that about 60% of the hotel revenue have not been affected (and have perhaps profited) by the changes to the beaches. whereas only 40% have been affected. Hence, activities amounting to about NIS 51 million per year have perhaps been affected. The added seashore value of these activities is estimated at NIS 15.3 million per year.

If nevertheless there has been some economic effect, it may be assumed that about a third of the added seashore value of the hotels which were affected has been lost and if so this means about NIS 5 million per year. The net present value for 20 years of this sum, assuming the growth rates assumed for the hotels at a capital rate of 6%, is estimated at NIS 71 million. For the 40-year period, the net present value would be NIS 100 million.

Restoration of the Beaches

Two alternatives for restoring the northern beach have been proposed.

Herzliyya Municipality Proposal: Construction of Breakwaters

This proposal is based on the construction of two breakwaters opposite the beach. These breakwaters would impede the movement of sand, increase the depth of the sand on the beach which they face, but would transpose the problem to beaches lying further north.

The cost of this beach restoration along a length of two kilometers is estimated at NIS 11 - 36 million.

The Ministry of the Environment proposal: Restoration of the Beach by Sand Fill

According to this approach sand cover of the northern strip of the beach will be thickened by sand filling of the beach. According to one of the methods applied for beach restoration, sand would be excavated from the sea floor by a marine dredger and delivered to the beach by pipeline. Free movement of the sand would be controlled in order to avoid loss of the delivered sand. This can be achieved by installing a 150 - 200-m long sleeve at right angles to the beach.

The cost of implementing this proposal depends on several factors: (1) the rate of annual loss of sand resulting from winter storms. (2) the cost of on-going maintenance of the sand cover on the beach from one year to another. (3) the cost of repeated dredging and refilling of the sand once every few years.

The cost of each dredging and sand filling operation is estimated at \$ 700,000 as detailed in the following, bearing in mind that this activity has to be repeated once every few years.

- The beach has a slope of 4-5°. Hence, the quantity of sand to be filled per kilometer of beach with a width of 20 m will total 16,000 cu.m. The strip of the beach in Herzliyya is 2 km long, thus requiring 32,000 cu.m. of sand.
- The cost of pumping and pipeline delivery of the sand from the marine dredger is estimated at \$ 3/cu.m., without taking into account the cost of the dredger.
- Accordingly, the total cost for increasing the depth of sand along 2 km of beach for a 20-m wide strip would amount to \$ 100,000, exclusive of the cost of the dredger.
- The cost of renting the marine dredger, laying the pipe and dismantling the system after completion of the work each time is estimated at \$ 600,000.

- In order to prevent movement of the sand northwards, 75-m long sand barriers would be required at right angles to the beach at intervals of 200 m. The cost of each barrier including the sand is estimated at \$ 130. In all, 11 sand barriers would be needed at a cost of about \$ 1,500.
- The total cost of the system and delivery of the sand for thickening the sand cover and placement of the sand barriers is therefore estimated at about \$ 700,000.
- It should be noted that the cost of renting the dredger constitutes the major part of this cost. Hence, it would be advisable to carry out restoration work on a number of adjacent beaches so as to reduce the restoration cost per kilometer of beach.

The economic impact of the change to the beach is summed up in Table 9.1.

Table 9.1: Gain and Loss of Benefits Stemming from Construction of the Herzliyya Marina

Item	Gain (NIS, millions)	Loss (NIS, millions)
Value of the marina land	1,000	-
Value of marina property	1,000	-
Total value - Land + property	2,000	-
Added value of marina property and land	600	-
Value of endangered property in the northern beach	-	322
Value to recreationers of the damage to the northern beach up to Year 2040	-	106
Value to recreationers of expansion of the southern beach up to Year 2040	106	-
Value of possible damage to hotels in the northern beach up to Year 2040	-	100
Cost of restoration of northern beach (exclusive of the balance of damage to the beach)	-	11-36 million or 2.8 million once every few years

10. Proposed Seashore Damage Compensation Policy

In this study the seashore is examined from the aspect of a resource belonging to the public and which constitutes a source of public benefit for two main uses:

- The benefit and pleasure gained from spending time at the seashore:
- The seashore as having an intrinsic landscape value.

Various activities carried out along the seashore adversely affect the benefit that the public reaps from this resource. Some of the effects are irreversible and some of the

activities embody latent irreversible hazards. The seashore is a limited resource with an extent of 188 km, and any irreversible use of it reduces the residual resource available to the public. These are the main economic concepts which form the basis for this document.

The public may be harmed by any of the following four main factors.

- Appropriation of an area of the seashore by private entrepreneurs;
- Limiting the access of the public to visit the seashore and to spend time there.
- Damage to nearby beaches as a result of movement of sand, generally from south to north (in the case of the Israeli coast). Some projects affect nearby beaches which bring about a change in the structure of the seashore; in general, these changes are detrimental.
- Landscape damage: Often, seashore projects change the characteristic landscape and also block the public's view of the horizon.

The government is duty bound to minimize harmful influences to the seashore resource and hence policy guidelines should be formulated.

Market Interests in Seashore Property

Before discussing the subject of policy, a brief description is given in the following of the main players.

Property Development Promoters: The seashore is a resource which gives pleasure to the public and this consequently increases the property value of land close to it. Hence, the main harm is caused by those interested in development of property which denies access, restricts the panorama, and causes other environmental damage to the seashore or its proximity. These players bring increasing pressure to bear in order to build near the seashore, principally because of the particular added value intrinsic in seashore development.

The Municipal Authorities: The interest of property developers coincides, at least partly, with the interests of the municipal authorities. These authorities are responsible for the welfare and benefits of their inhabitants, but, in parallel, they are also responsible for municipal expenditures and revenues. From the aspect of their public benefit responsibility they should have an interest in preserving the seashore

and in maintaining it. On the other hand, from the budgetary aspect, the national or Municipal authorities have an interest in supporting property development which yield both property betterment levies and on-going income from property taxes.

There is an additional problem in that the municipal authorities do not consider the benefits to the general population of the country, but only the benefits expected to accrue to inhabitants of the area within its jurisdiction, whereas the seashore is a resource belonging to the entire population. The municipal authorities thus wear two hats which conflict with one another and hence they do not represent the general national interest in preserving the seashore.

Landowners: Most land in Israel is the property of a government authority - the Israel Lands Administration which also wears two similar hats - on the one hand, that of maintaining the public welfare; on the other hand, promoting its budgetary interests.

The Greens: These are the only players who are interested solely in preserving the coastline and ensuring the public welfare. However, the Greens are not players in the property market. They have no means of affecting the cash flows of the other players and their influence is limited, on the one hand, to arousing public opinion and, on the other hand, by appeal to planning authorities and by evoking regulatory instruments defining what is permitted or forbidden from the planning aspect.

Application of obligatory planning regulations were highly effective in those cases when these received full institutional backing. But these regulations have been relaxed in recent years and the pressure of property developers has greatly increased. This relaxation has given rise to new expectations of the property developers regarding approval of problematic projects. These expectations have generated additional pressures and these expectations are often realized. A promoter may decide to initiate specific development, even though there may be objections from the regional and national planning authorities. The promoter embarks on a promotion campaign and eventually succeeds in convincing these authorities to approve the proposed project, in which case he recoups all his expenses. The promoter is not at present required to compensate the public for any damage to the seashore or the coastline. This is the main weakness in the enforcement of regulations defining what is permitted or prohibited; if the promoter succeeds in overcoming planning objections, the jackpot is all his and he is not held to account for any environmental

hazards, either present or future.

Justification for Imposing a Levy to Compensate for Damage to the Seashore

The situation described above provides a strong incentive to property developers to bend the planning regulations. Imposition of a financial levy for any immediate or expected hazards to the seashore is therefore proposed. This would operate in two ways:

- Internalization of the damage to the seashore to the developer's system of considerations since it would affect his expected cash flow, as well as that of the Municipal authorities and of the landowners.
- Compensation to the public for the damage caused.

The expected effects of the above are discussed in the following:

Internalization of the damage: Imposition of a levy on the property developer will adversely affect his cash flow and reduce the benefit he expects to gain from project implementation, whereas at present he gains from the development at the public expense whose benefits are adversely affected. The property developer does not operate in a vacuum and in the case of environmental quality and landscape conservation, there is a market deficiency since the harm incurred by the public does not affect the property developer. In the case of a market deficiency of this type, the municipal authority could intervene in order to remedy the harm caused. Imposition of a levy to compensate for the harm to the seashore would create a new and more fitting balance in the market for seashore property. Project development and construction costs would increase and demand for property would decline.

Compensation to the public: In the case of entrepreneurs who decide to go ahead with a specific project despite the levy, this will attest to the considerable importance of the project which, despite internalization of the damage, will still be worthwhile for the promoter to implement. The incoming revenue from the levy would be used to upgrade the public welfare in a manner to be decided and this would therefore provide some balance from the public benefit aspect.

The levy would be imposed on the promoter, but could also be imposed on other parties benefiting from the development such as the municipal authority and the Israel Lands Administration. Part of the property betterment tax and the annual property tax accruing to the municipal authority would be allocated for compensation of the harm to the public. Thus, these authorities would also internalize the extraneous effects of

projects which gain their backing. In this context it should be noted that the revenue accruing from the property betterment tax and municipal property tax is influenced by the value of the developed property. Without doubt, the value of the properties on the seashore are affected by their seashore location as argued in this study. It may therefore be stated that part of the revenue garnered by the municipal authority and the Israel Lands Administration stem from the added seashore value and there is therefore justification in their setting aside part of the incoming revenue for preserving the seashore and its surroundings.

The Manner of Public Compensation

The revenue obtained by means of the betterment and property taxes would be used for the public welfare. There are two main possibilities for utilizing this revenue:

- Transferring it to the government budget
- Transferring it to a defined environmental quality/seashore preservation budgetary allocation.

On the face of it, the more efficient course would be to transfer the incoming revenue to the general government budget since this budget is utilized to provide services to the public in a manner which gives the maximum benefit within the budget framework.

However, there are numerous shortcomings to this approach in view of the pressures for budgetary allocations exerted by interested parties.

It is therefore recommended to adopt the second course and allocate the revenue to a defined budgetary purpose intended for upgrading the public welfare by improving environmental quality, and ensuring that the revenue is earmarked for preservation of the seashore.

Levy Rate and Manner of Collection

The levy rate should be at least equal to the harm caused to the public. This study constitutes a basis for calculating the harm to the public from the following aspects: denying pleasure; reducing the existing area of the seashore, and landscape damage. The estimate to be prepared of the harm caused to the seashore will, in general, be an under-estimate since the open seashore is becoming scarcer and the open seashore panorama will in the future become a very scarce item. These trends were taken into account in preparing the estimates, but it appears that it is advisable

to add to the sum calculated in present terms an additional 20% as an estimate of the much higher future value. This seems logical since if the seashore becomes more costly in the future, then the value of the sponsored projects located on the seashore will likewise increase in value.

Apart from the harm caused to the public, regulations have been formulated by the Committee for Coastal Waters as to the location where construction can or cannot be approved. For example, regulations have been formulated relating to the maintenance of a continuous open seashore. The levy to be determined would be higher for those locations where the committee is opposed to construction in a manner which will internalize the planning considerations within the cash flows of the promoter.

The payments can be made in a number of ways. The two main alternatives are:

- **Alternative One:** Payment to be made as a one-time levy on approval of the project.
- **Alternative Two:** Payments to be made annually during the course of the project lifetime, with periodical updating of the sum to be paid according to the development of the magnitude of the damage which the project causes to the public.

These two alternatives could be combined by levying a partial payment at the beginning, while the rest of the sum due would be paid during the lifetime of the project. Alternatively, the promoter could be given the alternative of choosing the method of payment that he prefers.

Alternative One

Advantages

This alternative has the following advantages

- A one-time levy is simpler to collect from the administrative aspect and would not involve additional later calculations and debt collection efforts.
- It is a simpler method for the promoter since he is debited with a fixed levy known in advance and is subsequently free from any extraneous influences of the project.

Disadvantages

- It is difficult to estimate the likelihood of any future damage owing to the

need to base the levy on population estimates and forecasts with regard to the environmental situation.

- This alternative transfers responsibility to the government and municipal authority. A subsequent negative development which will increase the damage caused or the value attached to this damage will be to the Government's disadvantage since the promoter paid the entire sum at the outset.

Alternative Two

Advantages

- Assessments as to the value of the seashore to the public may change in the future in response to new environmental pressures and population growth. Data measured in real time are far superior to those assessed according to a forecast.
- Collecting the revenue each year will increase the responsibility of the promoter for any environmental damage that the project may cause. Acco, this will increase the consideration given by the promoter throughout the project life.

Disadvantages

- Implementation of this alternative is more complex from the administrative aspect and will give rise to disputes as to the damage caused.
- This alternative leaves both the promoter and the authorities with various uncertainties as to the payments which the promoter will have to pay periodically.

Appendix 1: Accommodation Facilities along the Coastline of Israel

The tables given in the following present data for accommodation facilities along the Mediterranean coastline of Israel. The data are for the year 1997 and are based on analysis of data given in the following sources: Central Bureau of Statistics Quarterly, Ministry of Tourism Plans and the Carta Guide to Village Tourism in Israel.

Appendix Table 1.1 : Accommodation Facilities along the Mediterranean Coastline of Israel - Number of Rooms, 1997

Place	Hotels recognized by Ministry of Tourism	Small hotels and kibbutz & other settlement guesthouses	B & B's in kibbutzim & other settlements	Private rural B & B's	Field schools & youth hostels	Total
Ahziv		48			25	73
Nahariyya	198	257				455
Shavei Ziyon		90				90
'Akko	119	75			12	206
Haiha	1,104					1,104
Nahsholim		80			24	104
Dor		83				83
Ma'agan Mikhael					25	25
Ceasaria	120					120
Sedot Yam			16		50	66
Newe Yam		40				40
Mikhmoret				80		80
Bet Yannai				15		15
Bitan Aharon						0
Avihayil				8		8
Netanya	1,881				8	1,881
Yaqum						8
Shefayyim		163				163
Herzliyya	667					667
Tel-Aviv-Yaffo	5,155					5,155
Bat Yam	402					402
Rishon LeZiyon	?					0
Ashdod	?					0
Nizzanim*					13	13
Nizzanim**						18
Ashqelon	224					334
Hof Qatif					70	70
Hof Deqalim		114			114	114
Total	9,980	950		1903	227	11,294

* Field school

** Kibbutz

**Appendix Table 1.2: Accommodation Facilities along the Mediterranean
Coastline of Israel - Occupancy By Israelis, 1997**

Place	Hotels recognized by Ministry of Tourism	Small hotels and kibbutz & other settlement guesthouses	B & B's in kibbutzim & other settlements	Private rural B & B's	Field schools & youth hostels	Total
Ahziv		12,600			593	13,193
Nahariyya	74,000	67,463				141,563
Shavei Ziyon		23,625				23,625
'Akko	19,940	19,688			285	39,012
Haifa	159,400					159,400
Nahsholim		21,000			569	21,569
Dor		21,788				21,788
Ma'agan Mikhael					593	593
Ceasaria	19,200					19,200
Sedot Yam			4,864		1,185	6,050
Newe Yam		10,500				10,500
Mikhmoret				24,322		24,322
Bet Yannai				4,560		4,560
Bitan Aharon						-
Avihayil				2,432		2,432
Netanya	272,700					272,700
Yaqum					190	190
Shefayyim		42,788				42,788
Herzliyya	91,000					91,000
Tel-Aviv-Yaffo	406,500					406,500
Bat Yam	61,900					61,900
Rishon LeZiyon	?					-
Nizzanim*					308	308
Nizzanim**			5,472			5,472
Ashqelon	76,600					76,600
Hof Qatif					1,660	1,660
Hof Deqalim		29,925				29,925
Total	1,180,000	249,375	10,337	31,314	5,382	1,476,948

* Field school

** Kibbutz

**Appendix Table 1.3: Accommodation facilities along the Mediterranean
Coastline of Israel - Occupancy by Tourists, 1997**

Location	Hotels recognized by Ministry of Tourism	Small hotels and kibbutz & other settlement guesthouses	B & B's in kibbutzim & other settlements	Private rural B & B's	Field schools & youth hostels	Total
Ahziv		10,029			286	10,315
Nahariyya	36,700	53,695				90,395
Shavei Ziyon		18,804				18,804
'Akko	25,704	15,670			137	41,511
Haiha	157,100					157,100
Nahsholim		16,714			275	16,989
Dor		17,341				17,341
Ma'agan Mikhael					286	286
Ceasaria	25,920					25,920
Sedot Yam			1,219		572	1,792
Newe Yam		8,357				8,357
Mikhmoret				6,097		6,097
Bet Yannai				1,143		1,143
Bitan Aharon						-
Avihayyil				610		610
Netanya	497,400					497,400
Yaqum					92	92
Shefayyim		34,055				34,055
Herzliyya	151,500					151,500
Tel-Aviv-Yaffo	1,407,900					1,407,900
Bat Yam	90,700					90,700
Rishon LeZiyon	?					-
Nizzanim*					149	149
Nizzanim**			1,372			1,372
Ashqelon	34,600					34,600
Hof Qatif					801	801
Hof Degalim		23,818				23,818
Total	2,427,524	198,482	2,591	7,850	2,598	2,639,046

* Field school

** Kibbutz

**Appendix Table 1.4: Accommodation Facilities along the Mediterranean
Coastline of Israel - Total Occupancy by Israelis and
Tourists, 1997**

Location	Hotels recognized by Ministry of Tourism	Small hotels and kibbutz & other settlement guesthouses	B & B's in kibbutzim & other settlements	Private rural B & B's	Field schools & youth hostels	Total
Ahziv		22,629			879	23,507
Nahariyya	110,800	121,157				231,957
Shavei Ziyyon		42,429				42,429
'Akko	44,744	35,357			422	80,523
Haiha	316,500					316,500
Nahsholim		37,714			844	38,558
Dor		39,129				39,129
Ma'agan Mikhael					879	879
Ceasaria	45,120					45,120
Sedot Yam			6,084		1,758	7,842
Newe Yam		18,857				18,857
Mikhmoret				30,419		31,419
Bet Yannai				5,704		5,704
Bitan Aharon						-
Avihayyil				3,042		3,042
Netanya	770,100					770,100
Yaqum					281	281
Shefayyim		76,843				76,843
Herzliyya	242,600					242,600
Tel-Aviv- Yaffo						1,814,400
Bat Yam	152,600					152,600
Rishon LeZiyyon	?					-
Nizzanim*			6,884		457	457
Nizzanim**						6,844
Ashqelon	111,200					111,200
Hof Qatif					2,461	2,461
Hof Deqalim		53,743				53,743
Total	3,608,064	447,857	12,928	39,165	7,980	4,115,994

* Field school

** Kibbutz

**Appendix Table 1.5: Accommodation Facilities along the Mediterranean Coastline of
Israel - Revenue from Occupancy by Israelis, 1997
(NIS, thousands, including VAT)**

Location	Hotels recognized by Ministry of Tourism	Small hotels and kibbutz & other settlement guesthouses	B & B's in kibbutzim & other settlements	Private rural B & B's	Field schools & youth hostels	Total
Ahziv		1,787			36	1,822
Nahariyya	23,018	9,566				32,584
Shavei Ziyon		3,350				3,350
'Akko	5,915	2,791			17	8,723
Haiha	89,889					89,889
Nahsholim		2,978			34	3,012
Dor		3,089				3,089
Ma'agan Mikhael					36	36
Ceasaria	5,964					5,964
Sedot Yam			565		71	637
Newe Yam		1,489				1,489
Mikhmoret				2,827		2,827
Bet Yannai				530		530
Bitan Aharon						-
Avihayyil				283		283
Netanya	72,336					72,336
Yaqum					11	11
Shefayyim		6,067				6,067
Herzliyya	68,242					68,242
Tel-Aviv-Yaffo	327,767					327,767
Bat Yam	19,229					19,229
Rishon LeZiyon	?					-
Nizzanim*					18	18
Nizzanim**			636			636
Ashqelon	23,795					23,795
Hof Qatif					100	100
Hof Degalim		4,243				4,243
Total	636,154	35,359	1,202	3,640	323	676,678

* Field school

** Kibbutz

**Table 1.6: Accommodation Facilities along the Mediterranean Coastline
of Israel - Revenue from Occupancy by Tourists, 1997***
(NIS, thousands)

Location	Hotels recognized by Ministry of Tourism	Small hotels and kibbutz & other settlement guesthouses	B & B's in kibbutzim & other settlements	Private rural B & B's	Field schools & youth hostels	Total
Ahziv		1,039			17	1,056
Nahariyya	10,282	5,564				15,846
Shavei Ziyon		1,948				1,948
'Akko	7,201	1,624			8	8,833
Haiha	48,652					48,652
Nahsholim		1,732			16	1,748
Dor		1,797				1,797
Ma'agan Mikhael					17	17
Ceasaria	7,262					7,262
Sedot Yam			142		34	176
Newe Yam		866				866
Mikhmoret				709		709
Bet Yannai				133		133
Bitan Aharon						-
Avihayil				71		71
Netanya	75,942					75,942
Yaqum					5	5
Shefayyim		3,529				3,529
Herzliyya	62,989					62,989
Tel-Aviv-Yaffo	545,873					545,873
Bat Yam	25,411					25,411
Rishon LeZiyon	?					-
Nizzanim*					9	9
Nizzanim**			159		9	159
Ashqelon	9,694					9,694
Hof Qatif					48	48
Hof Deqalim		2,468			2,468	2,468
Total	793,307	20,567	301	913	156	815,243

* Exempt from payment of VAT

** Field school

*** Kibbutz

**Appendix Table 1.7: Accommodation Facilities along the Mediterranean
Coastline of Israel - Revenue from Occupancy by Israelis
and Tourists, 1997***
(NIS, thousands)

Location	Hotels recognized by Ministry of	Small hotels and kibbutz & other settlement	B & B's in kibbutzim & other settlements	Private rural B & B's	Field schools & youth hostels	Total
Ahziv		2,826			53	2,878
Nahariyya	33,301	15,129				48,430
Shavei Ziyyon		5,298				5,298
'Akko	13,116	4,415			25	17,557
Haiha	138,541					138,541
Nahsholim		4,710			51	4,760
Dor		4,886				4,886
Ma'agan Mikhael					53	53
Ceasaria	13,226					13,226
Sedot Yam					105	813
Newe Yam		2,355	707			2,355
Mikhmoret						3,526
Bet Yannai				3,536		663
Bitan Aharon				663		-
Avihayil						354
Netanya	148,278			354		148,278
Yaqum					17	17
Shefayyim		9,596				9,596
Herzliyya	131,231					131,231
Tel-Aviv- Yaffo	873,640					873,640
Bat Yam	44,640					44,640
Rishon LeZiyyon	?					-
Nizzanim*					27	27
Nizzanim**			796			796
Ashqelon	33,489					33,489
Hof Qatif					148	148
Hof Degalim		6,711				6,771
Total	1,429,461	55,926	1,503	4,553	479	1,401,922

* Includes VAT for Israelis, Tourists exempt from payment of VAT

** Field school

*** Kibbutz

Appendix 2: Examination of B & B Prices in Kibbutzim and Other Settlements on the Coast and Inland

The prices for B & B's in kibbutzim and other settlements listed in Appendix Table 2.1 were those prevailing on 25.12.1998. The prices listed in the following are for a couple for one night at the weekend including breakfast. It should be noted that the examination was made in the winter and prices for summer accommodation may differ somewhat. The examination did not relate to the possible differences in the level of services and the prices listed should therefore be considered as giving a general index.

**Appendix Table 2.1: Prices for B & B's In Kibbutzim -
Near and Far from the Sea, December 1997**

Rooms near the sea	Price per week, B & B (NIS)
Shefayyim*	400
Dor	298
Nahsholim	334
Newe Yam*	300
Sedot Yam*	330
Rooms far from the sea	
Yad Hanna*	242
Bohan*	200
Nes Amim	250
Gesher Haziv*	260
Lohamei HaGettaot*	245
Nahshonim*	240
Kfar Glikson*	240

* Kibbutz

** Breakfast not included

An additional examination was made of the prices for hotels in the month of January 1999, as reported in Appendix Table 2.2.

**Appendix Table 2.2: Tel-Aviv And Ramat Gan Hotels - Accommodation Prices
Near the Sea and Far from the Sea**

Near the sea	Price - Weekend per couple - B & B (NIS)
Dan Panorama - 5 star	588
Dan Tel-Aviv - 5 star* - Not facing the sea	660
- Facing the sea	894
Holiday Inn - 5 star	800
Radison Moria	750
Far from the sea	
Kfar HaMaccabia - 4 star	500
Plaza Optima - 5 star* (Ramat Gan)	533

* Howard Johnson chain

Appendix 3: Assessment of the Number of Beachgoers to the Mediterranean Shore of Israel and Estimate of the Economic Value of the Seashore

According to the survey carried out on a Saturday noon on August 1994 of vacationers and bathers, there were about 61,000 people on the beaches (Kimche, 1994). On the basis of information obtained from beach managers of the Municipalities of Tel-Aviv and Herzliyya this number should be tripled in order to obtain an estimate of the total number of those present on the beaches throughout the whole day, i.e. on an August Saturday some 180,000 people come to the beach.

Appendix Tables 3.1, 3.2 and 3.3 give, respectively, the distribution of the number of bathing days, the number of beachgoers and the total number of beachgoers according to the number of days in the bathing season, the condition of the sea and number of visitors, on the basis of information obtained from the managers of the above-mentioned beaches, from annual statistical reports of the Rishon-le-Ziyyon Municipality and from the above-mentioned survey of beach comers.

Appendix Table 3.1: Distribution of the Number of Days in the Official Bathing Season according to the Condition of the Sea*

Condition of the sea	Total no. of bathing days**	Saturdays	Fridays***	Weekday during the long vacation	Normal weekdays	Sundays not during the long vacation
Black flag	35	5	5	9	13	3
Red flag	63	9	9	16	23	6
White flag	77	11	11	19	29	7
Total no. of bathing days	175	25	25	44	65	16

* The number of days in which a white, red or black flag is flown was taken from the statistical yearbook of the Rishon-le-Zion Municipality.

** According to the official no. of days on which lifeguards are present and a charge made for entry to the beach/parking

*** Not a working day

Appendix Table 3.2: Number of Beachcomers on an Average Day by Day of the Week and Condition of the Sea
(thousands)

Condition of the sea	Saturdays	Fridays*	Weekdays during the long vacation	Normal weekdays	Sundays not during the long vacation
Black flag	90	59.4	45	18	9
Red flag	180	118.8	90	36	18
White flag	180	118.8	90	36	18

* Not a working day

Appendix Table 3.3: Number of Beachgoers throughout the Bathing Season by Day of the Week and Condition of the Sea
(thousands)

Condition of the sea	Total	Saturdays	Fridays*	Weekdays during the long vacation	Normal weekdays	Sundays not during the long vacation
Black flag	1,413	450	297	405	234	27
Red flag	5,065	1,620	1,069	1,440	828	108
White flag	6,167	1,980	1,307	1,710	1,044	126
Total for the entire bathing season**	12,645	4,050	2,673	3,555	2,106	261

* Not a working day

** The number of days in which a white, red or black flag is flown was taken from the statistical yearbook of the Rishon-le-Ziyyon Municipality.

On the basis of the above data, a number of calculations were made to quantify the value of the sea in the view of the public. These calculations are mainly based on an estimate of the expenditure that the public is prepared to pay to go to the beaches.

According to Ministry of Tourism data, 61% of Israel's inhabitants are prepared to travel up to two hours to a recreation site when going on a one-day trip (Jerusalem Institute for Research in Israel, 1993). In the following, the calculations of the payments made by the public to go to the sea are presented based on the following assumptions.

- According to the survey of beachgoers there were 2.8 persons per vehicle at the seashore at Saturday noon in the month of August.
- According to the calculations made by a recognized economic organization in Israel, the cost of vehicle travel and maintenance amounts to NIS 1.59 per kilometer.
- The distribution of the number of persons at the beach is taken from the

survey of beachgoers.

- Many of the beaches in Israel do not charge for entry. At the Herzliyya beach the weighted entrance fee per person is NIS 8.8 (NIS 11 for an adult and NIS 7 for a pensioner and a child over the age of five). This price is similar to that charged for entry and parking of a vehicle, which averages NIS 25 and since each vehicle carries on average 2.8 persons, then the price per person amounts to NIS 8.9.

An additional index is the expenditure of the municipalities on maintaining, preserving and operating the beaches. It is assumed that the municipalities are aware of the price that the public is prepared to pay for spending time at the sea. The Tel-Aviv Municipality spends about NIS 30.3 million/year on operating and maintaining its beaches, while the Herzliyya Municipality spends about NIS 16 million/year and has an income of about NIS 2.5 million from entry fees. In other words, the net cost to the Herzliyya Municipality amounts to NIS 13.5 million. The length of the regulated bathing beach in Tel-Aviv is 4 km. and that of Herzliyya 2 km. Hence, the Tel-Aviv Municipality spends on average NIS 7.6 million/km/year, while the Herzliyya Municipality spends on average NIS 6.8 million/km/year. Assuming that some Municipalities spend less on beach maintenance, then an annual expenditure for beach mainis assumed to average NIS 6 million/km beach.

The nof persons who spend time at themunicipal hinterland of the seashore in some of the sea resorts must be added to the number of beachgoers. Analysis of the findings of a survey carried out recently indicates that there are at least three people on the Tel-Aviv promenade for each person on the beach. This study assumed that fewer people visit the municipal hinterland of the seashore in other municipalities and hence it is assumed that for these municipalities there are 1 - 1.5 visitors for each person on the beach.

Appendix 4: Added Value of Property Overlooking the Sea

Data were obtained indicating the differences in the value of property stemming from its proximity to the sea and a view of the sea from conversations with professionals and from valuers in the property field.

An assessment of the value of a project of cottages being built at present in Netanya shows that prices of cottages facing the sea are 12%% higher than for those which do not face the sea.

On the basis of an interview with persons from Reshef Properties and Neot Sharan relating to a building under construction near the Dan Hotel in Tel-Aviv, it appears that apartments facing the sea are 50% more expensive than apartments which do not face the sea. In the Arsoff Estate west of Shefayim the cost of a lot in the first row facing the sea is three times higher than that of a lot in the fourth row some 300 meters from the sea. A lot in Galei Techaylet Street in Herzliyya on the side facing the sea costs twice as much as that of a lot on the other side.

The property tariff published by Property Valuer Levy Yitzchak estimates that prices for apartments with a direct view of the sea are 10-20% higher than plots without a direct sea view. According to the "Homenet" property tariff, prices for apartments in Yarkon Street in Tel-Aviv facing the sea are 10-25% higher than for apartments in Ben Yehuda Street without a sea view.

Prices quoted by building companies in Jerusalem and Tel-Aviv in 1995 for an apartment with a private garden or a view from the window were some 10-15% higher than for apartments without a private garden or view (Tischler, 1995).

Examination of property values in the vicinity of Broward County in the USA shows that 19.9% of the cost of the property is due to its proximity to the seashore, though not necessarily adjacent to the seashore (Broward Country, 1997).

Restrictions on land development near Chesapeake Bay, Maryland, USA, have resulted in a 14 -27% rise in the price of apartments within 330 m of the sea front, whereas prices for apartments up to almost 5 km from the sea have increased at a rate of 4% to 11%. It is not clear in the case of Chesapeake Bay

whether the rise in prices is due to the lack of land owing to building restrictions, or to the knowledge that the landscape in this area is preserved. (Fausold and Lilieholm, 1996).

>From examination of data for five parks in Columbus, Ohio it was found that property facing an open landscape had a 7 - 23% on the value of the property. Examination of the values of the land around the park, which extends over an area of some 500 ha in Philadelphia, showed that 33% of the value of the land up to a distance of 12 m from the park was due to its location. Property prices in three estates in Boulder City, Colorado, close to a green belt around the city were on average 32% higher than properties in more distant areas (Fauslod and Lilidhom, 1996).

Bibliography In Hebrew

(For works in English, see Nos. 29-43)

1. Eidelman, E. 1997. "Alternative sediments for dune sand in coast area", **Sources of sand for constructing in Israel in the 2000**, The Israeli union for engineering and sediment sciences, Ashdod.
2. Ben-Basat, M. 1997. "Quarry sand as an alternative to natural sand in cement production", **Sources of sand for constructing in Israel in the 2000**, The Israeli union for engineering and sediment sciences, Ashdod.
3. Braun, M. 1997. "Fossil sands in the low land area - Alternative sediments for dune sand in coastal area", **Sources of sand for constructing in Israel in the 2000**, The Israeli union for engineering and sediment sciences, Ashdod.
4. Almagor, G., A, Prat, D., Gil. 1997. "Sand in the inland of Israel: Sediments and environmental aspects", **Sources of sand for constructing in Israel in the 2000**, The Israeli union for engineering and sediment sciences, Ashdod.
5. Goren, R. 1997. "The inter ministry committee for sand supply - targets and high - lights in the report", **Sources of sand for constructing in Israel in the 2000**, The Israeli union for engineering and sediment sciences, Ashdod.
6. The inter ministry committee for sand supply. 1997. **Interim report for April - December 1997**.
7. The inter ministry committee for sand supply. 1998. **Master plan for sand supply toward 2020**.
8. Central Bureau of Statistics (C. B. S.). 1998. **Quarterly report for tourism**. Volume 26 (3), Jerusalem.
9. Central Bureau of Statistics (C. B. S.). 1998. **Tourism 1997**, (Publication 1092), Jerusalem.
10. Tishler, Y. 1995. "Master plan for open areas in Jerusalem - economic aspects", **Master plan for open areas in Jerusalem Phase d (draft)**, Jerusalem.
11. Karta. 1997. **Karta guide to village tourism in Israel**.
12. Jerusalem Institute for Israel studies. 1993. **The demand for coast tourism**, Jerusalem.
13. Ministry of interior. 1994. **Master plan for coasts TM"A 13c**.
14. Ministry of tourism. 1997. A. M. N. sample, **Tourism survey in Israel: January - December 1996**.
15. Ministry of tourism, Ministry of Interior, Israel land authority. 1996. **Master plan for tourism areas and recreation activities - TM"A 12**.
16. Ministry of interior. 1998. **Coastal Zone Management Policy in Israel, drafts**.

17. Nevo, S., N., Zayzev, M., Schechter, B., Reiser. 1997. "Existing value of environmental resource", **Quarterly journal for economics**.
18. Sadan, E. 1999. "Economic feasibility study of man made islands in front of Tel - Aviv", **Man made islands pre feasibility study: interim findings of the Israeli - Netherlands team**.
19. Rishon Le Zion municipality, **Statistical report 1996. Volume 11**.
20. Tel - Aviv Jaffa municipality, **Statistical report 1995. Volume 35**.
21. Peitelson, A. 1985. **Two stage process for integrating environmental aspects in transportation planning: analogical analysis**, Jerusalem.
22. Peitelson, A. 1996. "Principles for real estate development policy", **Israel 2020: Master plan for two thousands years**, Jerusalem.
23. Fleisher, A., Y., Zur, A., Sidi. 1997. **Estimation of the economic value of agricultural areas as tourism resources**, Submitted to the Ministry of Agriculture, Rehovot.
24. Kimchy, Y. 1994. **Swimmers and beach goers in the Mediterranean - survey**, Jerusalem.
25. Kaplan, M., A., Dayan. 1996. **Israel 2020: Planning policy - Open area system**, Jerusalem.
26. Sadot, A. 1997. "Ecological aspects of sand cultivated area", **Sources of sand for constructing in Israel in the 2000**, The Israeli union for engineering and sediment sciences, Ashdod.
27. Shylony, Y. 1997. "The 'zifzif committee: the background of sand in Israel in the last 53 years", **Sources of sand for constructing in Israel in the 2000**, The Israeli union for engineering and sediment sciences, Ashdod.
28. **Master plan for tourism areas and recreation activities - TM"A 12**, Jerusalem, 1996.

In English

29. Almagor G., Gill D., and Perath I., **Marine Sand Resources Offshore Israel**, Geological Survey of Israel, Report GSI/25/98, Jerusalem, 1998.
30. Bouwes, W.N., and Schneider R., "Procedures in Estimating Benefits of Water Quality Change", **American Journal of Agriculture Economics**, August 1979.
31. Broward County Department of Natural Resource Protection, **Broward County Beaches: An Economic Study**, Technical Report 97-03, 1997.
32. Button, K.J., **Transport Economics**, England, 1993.
33. Clawson, M., **Methods of Measuring the Demand for and Value of Outdoor Recreation**, Reprint No. 10, Washington D.C.: Resources for the Future, 1059.
34. Cornes, R., and Sandler, T., **The Theory of Externalities Public Goods and Club Goods**, Cambridge, 1986.

35. Davis, R.K., "The Value of Outdoor Recreation: An Economic Study of the Maine Woods", **Unpublished Ph.D. Dissertation**, Harvard University, 1963.
36. Duffield, J., "Travel Cost and Contingent Valuation: A Comparative Analysis", **Advances in Applied Micro-Economics**, 3 (1984).
37. Fia, Raucher, R., "Intrinsic Benefits of Improved Water Quality: Conceptual and Empirical Perspectives", **Advances in Applied Micro-Economics**, 3(1984).
38. Freeman, A.M., **Benefits of Environmental Improvement**, Baltimore, 1979.
39. Hotelling, H., "The Economics of Public Recreation", **The Prewitt Report**, Mimeogra. Washington D.C., Dep. of the Interior, National Park Service, Land and Recreation Planning Division, 1947.
40. McConnell, K.E., "Congestion and Willingness to Pay: A Study of Beach Use", **Land Economics**, May 1977.
41. Silberman, J., Gerlowski, D.A., and Williams, N.A., "Estimating Existence Value for Users and Nonusers of New Jersey Beaches", **Land Economics**, May 1992.
42. Sutherland, R.J., and Walsh R.G., "Effect of Distance on the Preservation Value of Water Quality", **Land Economics**, August 1985.
43. Trice, A.H., and Wood S.E., "Measurement of Recreation Benefits", **Land Economy**, 34 (1958).

ANNEX III

**MANAGEMENT OF
ISRAELI COASTAL SAND RESOURCES**



UNITED NATIONS ENVIRONMENT PROGRAMME
MEDITERRANEAN ACTION PLAN



PRIORITY
ACTIONS
PROGRAMME



Coastal Area Management Programme (CAMP) for Israel

Management of the Israeli Coastal Sand Resources

Report prepared by
Abraham Golik and Dov S. Rosen



Priority Actions Programme
Regional Activity Centre
Split, 2000

Foreword

Growing threats to coastal environments have precipitated a world-wide move toward the integrated management of coastal areas. MAP, in general, and CAMP, specifically, have played a vital role in introducing this concept to Israel. In 1996, a CAMP Israel Agreement was signed in response to the growing recognition by national authorities and institutions in Israel that an integrated coastal zone management (ICZM) programme should be implemented in Israel. The principles of the programme accord with the sustainable development approach defined in MAP Phase II and Agenda 21.

Israel's 188-kilometre long coastal strip has been subject to ever-growing pressures and conflicts. The need to formulate specific policies to protect this sensitive and dynamic environment has been recognised by the Ministry of the Environment for more than two decades. Therefore, the Ministry is especially pleased to see the shift toward wise management of the coastal zone which has emerged in recent years and wishes to express its appreciation to MAP for its continued guidance and support. Hopefully, the experience which has been accumulated in Israel in the area of ICZM will be of interest and use to all who are concerned with this important issue, both in this country and elsewhere.

This report was prepared within the framework of the United Nations Environment Programme – Mediterranean Action Plan (UNEP-MAP) Coastal Area Management Programme (CAMP) for Israel and was made possible by the generous support of the Priority Actions Programme Regional Activity Centre (PAP/RAC).

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Management of the Israeli Coastal Sand Resources

Summary and Conclusions in Hebrew

ניהול משאבי החול בחוף הישראלי תמצית ומסקנות

אברהם גוליק ודב ס. רוזן

דו"ח זה מציג את התהליכים הטבעיים הפועלים בחוף הישראלי של הים התיכון ומעריך את השפעת האדם על החוף. מטרתו לתת למערכת התכנון הלאומי קוים מנחים, המבוססים על ממצאים מדעיים, לקביעת מדיניות ממשק החופים. מסקנות הדו"ח והמלצותיו הן:

- במאה העשרים הוצאו מהמערכת החופית כ-20 מ"מ חול. כמחצית הכמות נכרתה לצורכי בנייה וכמחצית נלכדה על ידי מבנים חופיים ושוב אינה משתתפת בתהליך תנועת החול לאורך החוף. כמות זו מהווה כשליש מכמות החול שהובאה לחוף באופן טבעי (הסעה מהדרום ובלייט המצוק החופי). לכן מאזן החול החופי נמצא כיום בגירעון. לנוכח התחזיות לצמצום אספקת חול טבעית בעתיד, בשל השפעתו של סכר אסואן והקמת מבנים חופיים בחופי סיני ורצועת עזה, צפויה החמרה במצב החופים אם לא ינקטו צעדי מנע.
- למרות מצב הגירעון במאזן החול החופי, לא נמצאו עדויות לנסיגה כללית של קו החוף בחלקו הדרומי מזיקים ועד לשפיים. לא ידוע אם קיימת נסיגה כזו בקטע החוף שבין שפיים ועתלית, ומומלץ לבצע מעקב דציף אחר מצבו של חוף זה משום שהוא הקטע הפגיע ביותר להרס.
- למרות מציאות כמויות עצומות של סדימנטים (כ-4 מיליארד מ"מ³) על קרקעית הים הרדוד עד לעומק מים של 30 מ', מומלץ לאסור את כרייתם של סדימנטים אלה שכן זו תגרום לדלדול החול בחוף. כ-500 מיליון מ"מ³ חול, המכוסה במעטה דק יחסית של בוץ, מצויים על מדף היבשת בעומק מים גדול מ-30 מ' מומלץ לבדוק היתכנות ניצול חול זה.
- כ-12 מיליון מ"מ³ חול נלכדו ע"י מבנים חופיים ומרביתה של כמות זו מצויה ליד מבנים גדולים כגון נמלים ותחנות כח. מומלץ לבדוק אפשרות כרייתו של חול זה והשבתו למערכת ההסעה החופית ממנה סולק.
- קצב הסעת החול לאורך החוף מושפע מאד על ידי סערות עזות. סערה כזו, המתחוללת אחת ל-10 שנים או יותר, מסוגלת להסיע במספר ימים כמות חול השווה לזו המוסעת בשנה ממוצעת או שתיים.
- לנוכח לכידת החול הרבה ליד מבנים חופיים מומלץ שהקמת מבנים חדשים תותנה בהעברת חול מצדו האחד של המבנה לצדו האחר, כדי למזער את הנזק להסעה הטבעית. קצב העברת החול צריך להיות זהה לקצב לכידתו, וכיון שזה האחרון הוא בעל שונות גבוהה, יש לבצע ניטור מתמיד של קרקעית הים בסביבת המבנה כדי לוודא העברת חול בכמות נאותה. כמו כן יש להקפיד שהחול המועבר יהיה מקרבת שורש המבנה אשר לידו מצטבר החול הגס שלשפת הים.
- הרעה במצב החופים עלולה להתרחש כתוצאה מהעלייה הצפויה של פני הים בשל אפקט החממה. מומלץ לבצע מחקר סדימנטולוגי כדי לקבוע את החופים הפגיעים, ולמצוא דרך להגן עליהם באמצעים הנדסיים.

- כדי לבסס ממשק חופים נכון יש להכין תכנית ניטור לאומית לחוף הישראלי, במימון ממשלתי, אשר תכלול בין השאר: א) טיסות צילום אוויר, עם תיקון אורתופוטו, לשם מיפוי וקביעת קו המים של כל החוף אחת לשנתיים ולאחר סעודת בהן גובה הגל המשמעותי בים עמוק גדול מ-6 מ', ב) מיפוי ימי של כל החוף הישראלי עד לעומק מים של 30 מ' אחת לכמה שנים, ו ג) ניטור מתמשך של רוחות, גלים, זרמים ומפלס פני הים במספר תחנות שיספיק לכסות את כל החוף של ישראל.
- יש לרכז את כל הנתונים על מצב החופים, כולל נתוני הניטור השוטף, במסגרת "מרכז מידע אוקיאנוגרפי לאומי" שיופעל בדומה למרכזים הקיימים ברחבי העולם. המרכז יארגן, יתעד, ויפיץ את המידע באופן שוטף.

Management of the Israeli Coastal Sand Resources

Abraham Golik and Dov S. Rosen

Executive Summary

This report presents the natural processes active along the Mediterranean coast of Israel, extending between Ziqim in the South to Haifa in the North, and assesses man impact on the coast. The purpose of this report is to provide the national planning authority scientifically based guidelines for formulating a coastal and sand management policy in Israel.

The evaluation of the present sedimentological conditions along the coast is based on the integration of three methods of analysis: (a) comparisons of aerial photographs depicting changes of waterline and beach bluff or lower cliff line during the past 4-5 decades, (b) seabed volumetric changes determined from depth differential charts of redundant surveys, and (c) longshore sediment transport assessment using wave data.

The analysis of waterline changes in three sites, remote from coastal structures or other anthropogenic influence, did not reveal any constant trend of coast erosion, but more a fluctuating pattern, closely linked with the occurrence of extreme storms. These sites are located between Ziqim and Shefaiim, implying that at least from Shefaiim southward no general coastal erosion has occurred. It is not known whether overall coastal erosion occurs north of Shefaiim. Local impacts due to coastal structures are usually represented by the trapping of sand to the south and erosion to the north of the structures. North of Hadera this trend is reversed. Entrapment occurs north of the structures and erosion is apparent on their southern side.

The analysis of bathymetric changes which occurred in the areas studied shows that sand accumulation occurred in the area south of the structures. It implies that the long-term net littoral sediment transport in the study region is directed northwards. This complies with most of the results of the shoreline analysis as well as the results of the sediment transport rate derived by computation of the wave energy flux. This analysis also shows that sand entrapment near coastal structures is a stochastic process. The volume of sand deposited during a severe storm, occurring once in 10 years or more, which lasts only a few days, may be equivalent to the volume deposited in one or more "normal" years.

The long-term mean rate of the net longshore sand transport, is assessed to be some 400,000 m³/year at Gaza going northward, decreasing to about 100,000 m³/year at Haifa, still northward. On the other hand, for the period 04/94-03/99 the approximate yearly averages were: at Gaza 400,000 m³/year northward, at Ashdod 188,000 m³/year northward at Hadera 26,000 m³/year northward and 100,000 m³/year southward at Haifa.

Due to the shift in the orientation of the coast as well as the shift in the direction of incident waves along the coast, there may be periods of reversal in net transport confined to shallow waters (0-3 m depths) in the region north of Shefaiim.

In very general terms, the net input of sand from the south by longshore sand transport is 400,000 m³/year and input from the coastal cliff erosion about 200,000 m³/year. The sand loss to Haifa Bay is 100,000 m³/year, leaving 500,000 m³/year unaccounted for. The reduction in longshore sand transport volumes between any two adjacent sites means that there should be a long-term coastal accretion growing northward along the coast. As this is not the case, it means that the volumetric difference is transported offshore, or onshore or to both offshore and onshore. Since sand on the sea bottom is confined to water depths less than 30 m, one must pursue the other options. Hence, even though we can not quantitatively prove it, by circumstantial evidence we conclude that a significant part of the cross-shore net transport is blown to the land by wind. The other part is transported outside the surf zone.

Records show that prior to 1964, some 10 million m³ of sand were mined from the beach for building purposes. In addition, 12 million m³ of sand were trapped behind coastal structures. The long-term (20th century) mean of anthropogenic sand removal from the Israeli coast stands therefore on 220,000 m³/year, which is more than a third of the annual input to that coastal system, resulting in a negative coastal sand balance. This, with the forecasted reduction of sand input from the south due to the effect of Aswan Dam, and coastal structures built on the coasts of Sinai and Gaza, put the Israeli coast and its sand resources in a precarious situation.

Despite the huge sediment quantities (~ 4 billion m³) estimated to be present on the inner continental shelf (in water depths less than 30 m) it is recommended that mining in that area should be prohibited as it will deplete the beach sand. Exploitation of some 500 million m³ of sand, found under a relatively thin cover of silt and clay at water depths greater than 30 m should be examined. The building of coastal constructions should be forbidden unless proper steps are taken to ensure: (a) bypassing the natural longshore sand transport for the entire lifetime of the structure, and (b) prevention of reflection-induced erosion to neighboring beaches.

The rate of sand bypassing should be determined by the rate of sand entrapment next to a structure. This rate is highly variable and therefore continuous monitoring of the seabed in the vicinity of the structure should be carried out. Also, bypassing should be carried out from the root of the structure to ensure bypassing of coarse sand.

In view of the large volume of sand already trapped in the vicinity of major structures, utilization of this sand should be taken into consideration. This sand should be used for artificial nourishment of deteriorating beaches, complemented by proper means to prevent or minimize quick removal of the nourished sand.

The forecasted sea level rise due to the greenhouse effect is expected to further deteriorate the condition of the beaches as well as increase cliff erosion. The locations of cliffs sited in coastal sectors critically sensitive to sea-level rise should be determined by an adequate sedimentological study, and prevention means for the future must be considered, such as low reflection sea-walls and cliff/dune buried sea-walls.

Finally, to enable reliable information and correct decision-making acts, the government must routinely conduct a permanent and extensive coastal monitoring program. This program should include mapping the waterline, by means of aerial photography and orthophoto rectification of the entire coast every two years, and next to major coastal structures every year. In addition, aerial photography should be conducted in years with storms exceeding 6 m deep water characteristic wave height. Bathymetric charting of the entire coast should be carried out every several years and next to major or new structures every year. Environmental factors (sea level, wind, waves, and currents) should be monitored continuously at sufficient sites for proper coverage of the whole coast.

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1. INTRODUCTION

Israel has both a high population density and a high rate of population growth, coupled with a relatively high rate of economic growth. This manifests itself in intense development pressures in the coastal zone, where the main centers of economic and commercial activity of the country are located. The coastal zone is under development pressures from urbanization, tourism, ports and activities associated with marine transport, oil refining and electricity production, recreation and beach use, marinas for small craft, wastewater outlets, fishing and mariculture, and, until prohibited some 30 years ago, sand mining.

The impact of anthropomorphic activity on the coastal zone is clearly noticeable, in particular, adjacent to coastal structures which caused changes in the waterline position: accretion on one side of the structure and erosion on its other side. But beyond these changes, which are local, recent archaeological findings indicate that the coastal sand balance of Israel suffers from a significant deficit. Hershkovitz and Galili (1990) and Galili *et al.*, (1993) report on remains of a Neolithic village found at a water depth of 8 m off Atlit in which human skeletons were found exposed on the sea bottom (Figure 1). These skeletons could not have remained intact, exposed to the wave energy, had they not been covered and protected for thousands of years by a thick layer of sand. This layer of sand has disappeared and no sand replaced it. This indicates a deficit in the coastal sand balance. Another example is a merchant boat that ran aground 2,000 years ago on the beach of Ma'agan Michael (for geographical locations see Figure 2) and was recently exposed with all its merchandise on it, in excellent shape (Linder, 1992). Again, this boat could not have survived for 2,000 years in the surf zone without a sand cover to protect it, and this sand has disappeared.

Golik (1997a) estimates that during the 20th century, some 20 million m³ of sand was removed from the coastal zone by mining and entrapment of sand behind coastal structures. It is estimated that this quantity is equivalent to the natural influx of sand to the Israeli coast during some 50 years.

The anthropogenic and natural impact on the Israeli coast will only increase in the future. The expansion of Ashdod Port is already underway and that of Haifa Port is in the stages of approval. A feasibility study for the construction of artificial islands in the offshore of Israel is underway. Several marine farming ventures have already gained success offshore Elat in the Gulf of Aqaba and a few have recently begun in the Mediterranean, offshore Israel. If these too turn out to be successful, there is no doubt that this activity will catch momentum. Field surveys for laying a gas pipeline and a communication cable on the Israeli continental shelf are already under way. There is no doubt that the construction of the Gaza fishing port, the planned construction of the Gaza Port, installations for desalination and other "small" structures, will have their effect on the coast, as will the predicted global sea level rise and climate change.

It is quite obvious that in order to accommodate all these activities in some harmony with nature, two things are required. First, a sound understanding of the natural processes which govern and shape the coastal zone, and a sustainable integrated coastal management program which would guide and control concerted human activity along the coastal zone acting with nature rather than against it.

The most urgent problems that the management of the Israeli coastal zone is facing, in regard to coastal resources and hazards are:

a) The deficit in sand balance - Although early warnings concerning the development of a deficit in sand balance along the Israeli coastline were already noted in the '60s (see the Zifzif Commission, 1964), it was only recently recognized as a problem of a national importance. This occurred when it was realized that: (i) reserves of sand on land for the building industry will suffice for only 2-3 more years; (ii) the expansion of the ports of Haifa and Ashdod requires some 12 million m³ of fill material; (iii) that if the plans for construction of artificial islands materialize, a 40-50 million m³ per 2 km² island will be required and that (iv) an unknown but significant quantity of sand will be required to nourish deteriorating bathing beaches;

b) The deterioration of the coastal cliff - The erosion of the coastal cliff of Israel is a natural phenomenon and there is evidence that this process has been going on at

least since sea level reached its present stand some 2,000 years ago. However, there are clear indications that the erosion of the coastal cliff has been intensified in the last century due to human intervention, mostly building, irrigation and heavy vehicle traffic on top of the cliff. As the top of the cliff has a high real estate value, the conflict between economic pressure to build on top of the cliff on one hand, and the desire to protect the cliff and reduce its erosion, on the other hand, is quite obvious;

c) The changes in the configuration of the Israeli coastline – Almost every coastal structure built on the beach causes changes in the configuration of the waterline. These changes could be accretion on one side of the structure and erosion on its other side, or the creation of spits or tombolos behind detached breakwaters. Some of these changes improve the coastline while others damage it. A sustainable integrated coastal zone management program must relate to this phenomenon.

Many studies on the coastal processes and relating issues in Israel have been carried out during the past 40 years. An excellent review of these was recently prepared by Almagor *et al.* (1998b) and will not be repeated here. The purposes of this study were to gather existing information on the coastal processes along the Israeli coastline, to generate new information on some issues, and on the basis of these to propose guidelines, for sand management in the coastal zone. This study is based on five tasks:

- a) Evaluation of changes in the waterline position which occurred during the last 50 years, by comparing old aerial photographs to recent ones;
- b) Estimation of the volume of sediment eroded, or accumulated, on the seabed in the vicinity of coastal structures;
- c) Estimation of the longshore sediment transport rate along the Israeli coastline as derived from wave energy flux, sand characteristics and beach profile.
- d) Estimation of the sand reserves on the Israeli continental shelf;

Two sedimentological provinces are recognized along the Israeli beaches: south of Akko, the beaches consist of fine to medium-sized quartz grains with small quantities of carbonates; north of Akko, the sand is biogenic, of local source, with some reworked kurkar or limestone fragments. The source of the quartz sand is the Nile River as shown by Pomerancblum (1966) using heavy mineral analyses. The sand grain size decreases from 0.3 mm on Ziqim beach to 0.2 mm north of Tel Aviv to 0.18 mm in the vicinity of Haifa.

The orientation of the Israeli continental shelf follows that of the coastline, gradually changing from south-west in the south to north-south in the north. Its width (defined by the 100 m depth contour) also changes gradually from some 20 km off Ziqim to 10 km off Haifa. From the beach to a water depth of approximately 30 m, the sea floor slope is 0.5-1° and from there to a water depth of about 80 m with a slope of only 10' to 20'.

The continental shelf is generally smooth. Two major morphological features found on it are the Akhziv Canyon found a few km south of the Israeli-Lebanese border and the protrusion of Mt. Carmel which is locally called the "Carmel Nose". In this area, the shelf is shallower and the shelf break begins at 60 m only. Other irregularities on the continental shelf are submerged kurkar hills which crop out of the surrounding sediment. Their relief is a few meters although some of them reach above sea level to form small islets.

3. CHARACTERIZATION OF THE MARINE ENVIRONMENT

3.1 General

A summary of environmental characteristics of the Mediterranean coast of Israel is presented below to give the reader the necessary background. These refer to the climatic characteristics of the parameters responsible directly and indirectly for the transport of sand, namely the sea-level, the waves, the wind and the currents.

2. GEOMORPHOLOGICAL SETTING

The Israeli coastline is located on the southeastern corner of the Mediterranean Sea. Extending along some 180 km from Ziqim in the south to Rosh HaNiqra in the north, it gently curves from N 35 E at Ziqim to N 20 E in its central part to N 10 E at Rosh HaNiqra (Figure 3). It is generally a smooth coastline, with the exception of Mt. Carmel, which protrudes into the sea thus forming Haifa Bay. Most of the coastline consists of a coastal cliff which ranges from low bluff mostly in the south to a pronounced cliff which is almost continuous between Herzliya and Givat Olga reaching up to 40 m in height. The cliff is built of alternating layers of kurkar (a local term for eolianite sandstone) and red-brown sandy loam called Hamra.

Large areas of the Israeli coastal plain are covered by sand dunes, mostly in the south. South of Tel Aviv, these dunes penetrate landward to a distance of 5 to 10 km from the shore. North of Tel Aviv, dunes are restricted to river outlets to the sea, where breaches in the coastal cliff allow sand penetration landward. Two exceptions are the Hadera and Haifa Bay areas where extensive dune fields are found.

The Israeli beaches are relatively narrow. Between Ziqim and Tel Aviv, as well as between Givat Olga and Rosh HaNiqra they range in width between 20 to 50 m with the exception of river outlets where they may reach up to 200-300 m in width. In the central part of the coast, between Tel Aviv and Givat Olga, the beaches are only a few meters wide and sometimes non-existent.

Beach rock is present in most of the beaches. It consists of consolidated sand, kurkar fragments and shells. The beach rock is located on the beach at the water level and forms abrasional platforms which provide some protection for the beach from waves. In some places, small tombolos are formed behind the beach rock. Partially submerged kurkar ridges also cause formation of tombolos, lagoons and small bays a few scores of meters in size.

3.2 Sea levels and tides

The tidal (astronomic) range on the Mediterranean coast of Israel is characteristic of the low-tide range of the Eastern-Mediterranean basin.

The tide usually varies between 0.40m during spring tides and 0.15m during neap tides. The tide contribution exhibits the usual semi-diurnal periodicity (twice a day highs and lows) and fortnight (14 days) periodicity.

Extreme sea levels may occur in combination with extreme meteorological conditions. However these may differ from site to site along the coast of Israel, particularly in the Haifa bay due to the shadowing effect of Mount Carmel Cape protrusion into the sea-body. During spring and particularly in November – December months, offshore directed easterly winds occur at Haifa inducing lower sea-levels in Haifa Port and Bay area, while that effect is not detected at other locations further south along the Israeli coast.

Low sea-levels occur in winter during February-March months, while high sea-levels occur in August-September, with a second maximum in December.

Extreme sea levels may occur in combination with extreme meteorological conditions. Based on 30 years of data, the following average return periods were assessed (Rosen, 1998a):

Average Return Period [years]	Low Sea Level [m]	High Sea Level [m]
1	-0.41	0.60
50	-0.79	1.00
100	-0.90	1.06

The above values however, do not include the expected sea-level rise due to the "greenhouse effect", for which the assessed global value for 2100 is 0.5 m for the "most probable" scenario.

3.3 Waves

Wave measurements in Israel started in 1957 at Ashdod using visual observations and developed through to instrumental measurements of wave height and period since the late 70's and to full instrumental directional measurements in the 80's using pressure

gage arrays in shallow water, to directional wave buoys at Ashdod and Haifa and directional pressure and current gage at Hadera at the beginning of the 90's.

Rosen (1998a,b) indicated that the old non-instrumental directional wave data gathered before the new equipment has been installed at Hadera in December 1991 (in 27m water depth), at Ashdod in April 1992 (in 24m water depth) and at Haifa in late November 1993 (also in 24m water depth) do not provide sufficient accuracy in regards to the directions, and hence are unsuitable for use in longshore sediment transport assessments.

Directional wave distribution in an average year:

The higher wave conditions approaching the Mediterranean coast of Israel are induced by cyclones passing in the Mediterranean from west to east, especially when these became stationary for a few days in the region of Cyprus. All moderate and higher sea states come from WSW to NNW through W. About 66% of all waves approach from W through WNW directions. The highest sea states approach from W direction, but storm development occurs by veering from WSW to NW through W directions. Along the coast from south to north, a counter clockwise shift in the simultaneous incident deep water wave direction is found, due to the relative position of the storm cells. A shift of up to 20 degrees was found between Ashdod and Haifa in low sea-states, while in high sea-states this angular shift reduces to only a few degrees. A graphic description of this phenomenon is explained in Figure 4. In very moderate years westerly storms may be absent.

Average Year Deep Water Characteristic Waves :

low sea states (less than 1 m) occur about 50% of the time, **moderate** sea states (between 1 m and 2 m) occur about 25% of the time, **strong** sea states (between 2 m and 4 m) occur some 20% of the time and **high** sea states (above 4 m) occur about 5% of the time. A characteristic seasonal wave height distribution is shown in Figure 5.

Peak wave periods range between 3 and 15 seconds. During high sea states they range usually between 10 and 13 seconds, and very high sea states have peak periods between 12 and 15 seconds.

Extreme Sea States and Average Return Periods:

Average Return Period	years	2	5	10	15	20	50	100
Deep Water Characteristic Wave Height	meter	5.15	6.15	6.80	7.15	7.40	8.20	8.70

3.4 Winds

Statistics of extreme wind distribution are presented in Figure 6. Rosen (1998a) indicated also that the offshore wind climate shows stronger winds than those measured at shore. The following data describe the general coastal wind climatic characteristics at the Mediterranean coast of Israel:

Average Year Intensity Distribution:

light winds (less than 10 knots)	~ 81.4 percent of time
fresh winds (11 to 21 knots)	18.3 percent of time
strong winds (22 to 33 knots)	1.2 percent of time
winds above 33 knots	< 0.1 percent of time

Average Year Directional Distribution:

77% of the **fresh** winds blow from directions W to N through NW.

77% of the **strong** winds blow from directions SW to W trough WSW.

Average Seasonal Distribution:

94% of the **strong** winds occur between November and March, and

60% of the **strong** winds occur in January and February.

3.5 Currents

Tidal Currents:

Tidal currents in this region are in general weak, in the order of about 5 cm/second.

General Circulation:

In this region, the general circulation, is due mainly to the geostrophic current and shelf waves and is oriented counter clockwise most of the time. The currents in most cases have low speeds of about 10 cm/sec flowing parallel to the coast northward more than 70% of the time. The vertical distribution is almost uniform in winter, but decays towards the bottom in summer. The speed decreases towards the shore. In certain instances, currents of about 2 knots were measured.

Wave Induced Currents:

These currents prevail and are predominant within the surf zone. Longshore currents are induced by waves approaching obliquely to the contour lines, and flow parallel to the shore line. Rip currents are generated by perpendicular waves or edge waves, and flow from the shore offshore, almost perpendicular to shore line to a distance of up to

about 3 times the surf zone width, within which they decay completely. The former may attain during storms speeds of 4 knots and even more. The latter may also attain 1 to 2 knots, but also in calmer sea states (Bowman et al., 1988a,b, 1992).

Analysis of the correlation between current speeds, against waves and land based winds shows that they were correlated, the correlation coefficient becoming higher during high sea-states, especially between relatively strong current speeds and high waves. Levine (1996) found a varying correlation with the wind during storms, explained by him as being due to the quick change of wind direction and speed during storms, leading to stronger current speeds at the beginning of the storms and weaker later. This was explained by Rosen (1998a) to be due to the changing track of the winds and waves, which at the beginning of the storms being SW-ly to W-ly directed, generate wave induced northward longshore currents in the same direction with the predominant northward current direction strengthening the shallow currents, while later, during the stage of storm decay the locally generated wind waves (sea) change to NW-ly, inducing an opposite longshore current which would reduce the total current speed. The characteristic current statistics on the coast of Israel are presented in Figure 6.

4. CHANGES IN WATERLINE POSITION

4.1 General

The sedimentological balance of a coastline affects the waterline position: a deficit in sand balance would cause beach erosion, shifting of the waterline landward and/or steepening of the beach cross-shore profile. A surplus in sand balance would result in accretion, shifting of the waterline seaward and/or moderation of the beach profile. Therefore, investigation into the history of the waterline position should provide an indication with regard to the condition of the sedimentological balance along the coast.

Contrasting rectified old aerial photographs of the coast to new ones may help in detecting changes in the waterline position. As the waterline shift is rather slow, one needs aerial photographs covering long periods of time in order to detect these

changes. Although aerial photographs of the Israeli coastline were taken as early as the beginning of this century, only those taken from 1945 onward could be used for our purposes due to difficulties in analyzing the photographs as discussed below.

Studies in the change of the waterline position along sections of the Mediterranean coast of Israel, by analyzing aerial photographs, have already been carried out in the past. Striem (1963) analyzed the waterline of Atlit. Vajda (1980) and Rosen (1990, 1992) the coast between Hadera and Sdot-Yam, Shoshany (1991) the waterline of Ashqelon near the Rutenberg Power Plant. Shoshany et al. (1996) the waterlines of Netanya and Gaza, Golik et al. (1996a,b) the waterline of Ashdod on both sides of Ashdod Port, Rosen (1998) the waterline between Palmakhim and Bet Yanai and Zviely (in press) the waterline of Herzliya. Most of these were carried out in the vicinity of coastal structures, where changes in waterline position was local, rather large and rapid. It is, however, of interest to find out whether the deficit in the coastal sand budget has caused erosion of the entire Israeli Mediterranean waterline. Therefore, beach sections which were remote from any coastal structure, were selected for analysis in this study. The beaches which were selected are Ziqim, Palmakhim and Atlit-Haifa. In the analysis of the waterline position, results of other studies were also incorporated.

4.2 Methodology

Coastline mapping by means of historical aerial photography is a difficult task due to two typical problems. The first concerns data quality that varies greatly with respect to acquisition equipment, methods of photography and storage. Some of the photographs may be reproduced only from contact prints as a result of the lack of negatives or diapositives. Inaccuracies due to object displacement, geometrical film/paper distortions, resolution limitations and low contrast are compounded where the quality of the photographs has deteriorated. The second problem relates to coastal zone complexity and dynamics, at the beginning, due to the wide range of components (dry sand, wet sand, waves, foam, beach rock, etc.) and their mixtures, and afterwards, due to the fast rate of change in their spatial distribution. The momentary, daily, seasonal and annual displacements of the waterline add to the difficulty of differentiating the component of long-term changes from the total changes detected.

In order to achieve the accuracy necessary for determining long-term coastal changes, the methodology utilized here is based on the following three key elements:

a) Selection of the time of year which is most suitable for monitoring the waterline:

During autumn (mid September to mid November) the level of wave energy along the Israeli coast is at its lowest, reaching a minimum in October (Rosen, 1982; Goldsmith and Sofer, 1983; Carmel *et al.*, 1985). As a result, during this season, the beach profile reaches its most pronounced summer profile characterized by maximum beach width, the berm is at its highest level and the beach face is at its steepest condition. Hence, the selection of this period for determination of waterline position has two advantages: the first concerns relative calm sea condition, which implies that the weekly/diurnal fluctuations of the waterline position will be of a low magnitude. The second advantage is that horizontal displacements of the waterline are of minimal magnitude when the beach face is at its steepest condition. This will decrease the inaccuracies due to momentary changes in its position. Accordingly, a search was conducted for all aerial photographs that were taken during autumn in the aerial photograph archives of the Survey of Israel. Photographs selected for this study were from the period of 1945-1995. Most of these were taken after 1955, during autumn (end of August to mid November) but one sortie, from January 1945 covering a section of the Haifa-Atlit coast, was included in order to expand the time range covered by the study.

b) Selection of the waterline type: Dolan *et al.* (1978), Smith and Zarillo (1990) and Shoshany and Degani (1992) argued that the line, which separates the wet part of the beach from the dry one, provides the most suitable element for monitoring waterline position using aerial photographs. They claim that this line (referred to here as the D/W line) is seen clearly and sharply in the photograph. In addition, this line does not fluctuate momentarily as the waterline does. Therefore, the D/W line was used in this study as the waterline.

c) Application of digital image processing methods: A detailed description of these methods, used to eliminate distortions in the photographs and relate one photograph to the one it is compared with, is detailed in Shoshany and Degani

(1992) and Shoshany *et al.* (1996). It will suffice to say here that the photographs are converted from analog/photographic form into a digital format by scanning. The D/W line, which is represented by brightness contrast between the dry and wet sand, is accentuated by enhancing the brightness contrast. This enables the operator to trace the D/W line on the photograph with greater ease. It is estimated that the error involved in determination of the waterline position on a certain photograph is about 10 m.

The method described above was used in the analysis of coastal sections used for this study - Ziqim, Palmakhim and Atlit-Haifa. The same method was also employed in the studies of Golik *et al.* (1996a), Golik *et al.* (1999b) and Shoshany *et al.* (1996) mentioned below. Correction of distortions of the aerial photographs was carried out also in the studies of Rosen (1998) and Zviely (in press), but the waterline was determined as a line running through the middle of the swash zone. Furthermore, these researchers made corrections for the wave-induced setup, tide and wind assuming a certain slope of the beach. Therefore, when results obtained by the two methods are compared to each other, the absolute waterline position may differ, but relative changes in the waterline position during the same period of time should be the same.

4.3 Changes in Waterline Position Along the Israeli Coast

2.3.1 Ziqim

Aerial photographs from 4 sorties, conducted in autumn 1958, 1971, 1980 and 1989, along a 1 km stretch of coastline in the vicinity of Ziqim were used for the analysis. Figure 7 shows the positions of the waterline of the northern section of this stretch at these dates. Figure 8 presents, at 10 meters intervals, the distance of the 1958 waterline from each of the succeeding dates. In this graph, the X axis represents the North-South coordinates of the old Israeli grid system and the Y axis is the distance, in meters, of each sampled point from that of 1958. Negative values indicate retreat of the waterline (an eastward shift) and positive values indicate accretion (a westward shift). It can be seen that most of the fluctuations are within ± 10 m with a few points of differences up to 20 m. Figure 9 presents the means and standard deviations of

these differences in meters. It shows that during the period of 1958-1989 the largest difference in the mean waterline position, detected for this beach, is 8 m between 1980 and 1989.

4.3.2 *Ashdod*

Changes in the waterline of Ashdod, both south and north of Ashdod Port for a distance of some 4 km from the port, were studied by Golik *et al.* (1996a, b). It was found that during the lifetime of the port since its construction in 1960, the beach south of the port has accreted by more than 100 m. This accretion gradually tapered off at a distance of 2.5 km from the port. North of the port, the waterline did not change its position. Golik *et al.* (1996a, b) explain that the intensive sand mining that took place on this beach prior to the port construction left this beach rocky, devoid of sand and therefore no erosion took place there after construction of the port. The waterline changes that occurred in the vicinity of Ashdod Port clearly indicate that net longshore sand transport there is from south northward.

4.3.3 *Palmakhim*

Analysis of the Palmakhim coastline is based on 5 aerial photography sorties which were carried out during autumn 1956, 1964, 1971, 1980, and 1990 along a 1 km stretch of coastline. The changes that took place during this period with respect to the position of this waterline are presented in Figure 10 as the distances of the means and standard deviations of the waterline position of 1956 from those of the succeeding dates. It is apparent that the largest difference of waterline position, 8.9 m, occurred between 1964 and 1990.

Rosen (1998) conducted a similar study on this coast, almost on the same beach stretch, covering a 1 km coast length. His study was directed more into determining the impact of the strongest storms known during the period of 1958-1998, namely November 1964, January 1968 and February 1992. His results showed very similar patterns to those obtained in the present study. The range of waterline fluctuations was between 5 and 10 m and did not seem to indicate any clear erosional trend over the years. They were related to stormy and calm years. The impact of Ashdod Port

was also not visible as one would have expected if the long-term bypassing is considered negligible as concluded by Dearnaley (1996) and estimated by Baird and Associates (1996).

4.3.4 *Bat-Yam*

A coast length of 1km was studied by Rosen (1998) at Bat Yam using 7 flights on 06.08.1966, 02.10.1971, 06.11.1976, 13.09.1986, 21.06.1991, 05.09.1992 and 09.11.1997. With regard to the waterline in the southern sector, only four flights were available. Changes in the waterline position of this coast were up to 40 m but with no specific trend. At some sections of that coast, a waterline retreat of 30 m occurred after the storm of 1992 but not all along the coast.

4.3.5 *Tel-Aviv: Yafo Harbour to Sheraton Hotel*

A series of detached breakwaters were built along this 3 km long coastal section. Rosen(1998) provides a detailed description of the waterline changes on the basis of the analysis of 9 aerial flights conducted between 1958 and 1997. It shows waterline changes which resulted from tombolos formation following the construction of the detached breakwater. Rosen (1998) concludes that the coastal enclosure has become stable since 1976 after accumulating sand which widened the waterline by about 70 m with some sediment exchange during high storms by trapping it and releasing it during milder wave climate years. The same is true with respect to the Sheraton and Hilton breakwaters.

4.3.6 *Tel-Baruch*

This coastal sector was investigated by Rosen (1998) using aerial photographs taken in 6 aerial flights between 1960 and 1997. Changes in waterline position which are related to the detached breakwater were found. For our study, the interesting findings were those in the coastal section further north to the Tel Baruch detached breakwater where no significant changes were found between 1960 and 1971. In 1973, the waterline advanced (westward) by 6 to 8 m and an additional 8 m in 1976. The situation in 1991 returned back to that of 1971, followed by very minor changes in 1992 through 1997. Hence this section of the coast may be considered stable.

4.3.7 *Herzliya*

The Herzliya marina complex which includes the marina as well as three detached breakwaters north of it, was constructed between 1990 and 1992. Zviely (in press) used a series of aerial photographs taken between 1965 and 1997 to analyze waterline changes there. The photographs cover a 4,250 m long section of the coast, to a distance of 2,500 m north of the marina's lee breakwater and 1,000 m south of its main breakwater. It was found that prior to construction of the marina, the waterline was not stable, fluctuating on the average between 12 to 16 m landward during 1965-1979 and between 15 to 25 m seaward during 1979-1990.

After construction of the marina, the waterline in the study area did not behave uniformly and Zviely divided the waterline into two groups. One group consisted of the beaches, which are in the range of 1,000-2,500 m north of the lee breakwater and 500-1000 m south of the main breakwater. In this group, a mean waterline retreat with a magnitude of 12-15 m was observed. The second group consists of the beaches, which are at the back of the three detached breakwaters and some 500 m south of the main breakwater. The breakwaters induced formation of tombolos behind them, and therefore beach accretion there was large - 53 m on the average. However, the accretion that took place south of the main breakwater was rather modest - 15 m.

4.3.8 *Shefaiim*

A 1 km long beach stretch in this sector was studied by Rosen (1998). The position of the waterline in 1964 was used as a reference. As may be seen in Figure 11, the waterline of 1968 was found to be relatively advanced to that of 1964 by some 4 to 8 m. Furthermore, in 1991 the waterline state retreated back to the 1964 position or even further back in the northern part of the coast, but in 1992 the waterline advanced the coast to the state of 1968 in the south or even further more by some 5m in the northern part. However, the waterline in 1997 retreated some 3 m in the southern part to some 10 m in the northern part, indicating a clear erosion process. The fluctuations in the waterline position of this sector of the coast are within the detection limits of the analysis and the waterline may be considered as a stable one.

4.3.9 Netanya

Two detached, shore-parallel breakwaters which were built off Netanya in 1969-1970, formed two tombolos behind them. Shoshany *et al.* (1996) analyzed aerial photographs that were taken of the waterline to a distance of 1,400 m south and north of the tombolos. Of 7 aerial photography sorties taken between 1955 and 1990, 3 were conducted before formation of the tombolos (1955, 1961, 1964) and 4 (1976, 1982, 1984, 1990) after their formation. Results show that after formation of the tombolos a 20 m accretion occurred north of the tombolos whereas south of them the waterline underwent erosion of some 10 m. The interpretation of Shoshany *et al.* (1996) of these findings is that the tombolos act as obstacles to the longshore littoral drift and changes in the waterline position indicate a southward sand flow at Netanya. However, Rosen (1998) reports that contrasting photographs taken in 1991, 1992 and 1997 from that area shows a reversal in the above mentioned trend. The waterline accreted by some 10 m between 1991 and 1992 south of the tombolos and then remained unchanged until 1997, whereas north of the tombolos, an erosion of 15 m, and at places even 30 m, occurred between 1991 and 1992 and stabilization from then until 1997.

4.3.10 Atlit (*Hof HaCarmel - Megadim*)

Waterline changes along the 10 km coastline between Hof HaCarmel and Megadim were analyzed using aerial photographs taken in 10 sorties between 1945 and 1995. For the purpose of analysis, this coast was divided into 6 sections. Figure 12 shows the geographical extension of these sections and the position of the waterline at each of the dates for which aerial photographs were available. Not all of the sections were covered by the same aerial photographs. The oldest sortie, from 1945, covered only sections 1-3 but not sections 4-6 for which the oldest sortie was 1956.

In section 1, a detached, shore-parallel breakwater was built during 1968-1969 at a distance of some 200 m off shore. Figure 13 shows that prior to breakwater construction between 1945 and 1963, this beach experienced a slight accretion. However, by 1970, approximately two years after construction of the breakwater, a tombolo had already been formed behind it. This tombolo continued to develop after

1970. but it can be seen that accretion took place on its northern side whereas the waterline on the southern side remained stable.

Figure 14 shows the change in the mean waterline position with time, relative to the mean of 1945 and 1956, in section 2, which is to the south of the Hof HaCarmel tombolo. One may easily distinguish the difference between the two periods of waterline development. In the first, between 1945 and 1963, the waterline is relatively stable, but in the second, after the construction of the breakwater between 1970 and 1976, the waterline retreated close to 30 m on the average and remained so until 1995.

Figure 15 shows the change in the mean position of the waterline with time for sections 3-6. It can be seen that in all of them a drastic retreat ranging in magnitude between 34 and 48 m occurred between 1956 and the early 60's (1961 for section 3, 1963 for sections 4-6). From then on, accretion of the beach took place. The magnitude of this accretion was 37 m between 1963 and 1984 in section 3, whereas for sections 4-6 it ranged between 16 and 24 m during the period of 1963-1966. After this period of fast recovery, the position of the waterline in the various sections fluctuated back and forth by a few meters but it never regained the position it had in 1956.

4.3.11 *Qishon Harbor - Qiryat Yam*

Aerial photographs, taken on 8 dates between 1945 and 1995 of the coastline between the main breakwater of the Qishon Harbor and Qiryat Yam were used by Golik *et al.* (1999b) for investigation of changes in the waterline position there. This 10 km coast was divided into 6 sections (see Figure 16). The mean and standard deviation of the difference in position of the waterline between 1956 and the succeeding years, in each of the six sections, are shown in Figure 17. It can be seen that between 1956 and 1970, a sharp retreat of up to 25 m of the waterline occurred in sections 1-4. A continuous advance followed this retreat between 1970 and 1990 with stabilization or a slight advance from that time until 1995. The advance of the waterline after 1970 was as much as 35 m. In the two southern sections (5&6), the retreat continued until 1990 and at that point, the waterline began to advance.

4.4 Analysis of Results

The analysis of waterline behavior during the last few decades by means of aerial photographs was carried out for three purposes. The first, to examine if during that period, in which human intervention in the coastal zone was very intensive, an overall, significant change in the position of the Israeli waterline has occurred; The second, to gather evidence on the direction of sediment flow along the Israeli coast; The third, to examine the rehabilitation rate of beaches that suffered damages from beach mining.

4.4.1 *Overall Position of the Israeli Waterline.*

In order to obtain a picture on the overall behavior of the Israeli waterline during the last few decades, the analysis of aerial photographs must be carried out on beaches which are remote from coastal structures in order to eliminate local effects of the structure. The only stretches of coastline, which are, to some extent, remote from anthropogenic activity, are those of Ziqim, Palmakhim and Shefaiim. Even these are not too far away from sites of coastal structures. Ziqim is only 11 km north of the breakwaters of Gaza and 7 km south of the cooling basin of the Rutenberg power plant. Palmakhim beach is 13 km north of Ashdod Port and Shefaiim is 5 km north of Herzliya marina and 12 km south of the breakwaters of Netanya. At least part of the Atlit Coast that was analyzed is also remote from a coastal structure, but there beach sand mining in the past has interfered with the natural processes on the beach. The rest of the beach sections for which the behavior of the waterline was studied by means of aerial photographs were affected by human activity.

The results obtained from Ziqim, Palmakhim and Shefaiim show that the changes in waterline position at these sites, during the last 4-5 decades, are smaller than the detection limit (10 m). Furthermore, the changes which were detected did not show a continuous trend with time, but fluctuated between beach accretion and erosion. These findings lead to the conclusion that at least in the southern part of the Israeli Coast, a general significant erosion or accretion of the waterline did not take place during the last 4-5 decades.

4.4.2 *Changes in Waterline Position as Indicator of Longshore Transport Direction*

The waterline shift in the vicinity of coastal structures, whether detected by analysis of a series of aerial photographs, or by systematic long-term observations in the field, may serve as an indicator to the direction and intensity of the prevailing and predominant longshore sand transport. It must, however, be stressed that in most cases the interference of a coastal structure in the sand transport is restricted to the inshore zone* and will therefore indicate in most cases the flow direction in that zone.

On the basis of the findings in the vicinity of coastal structures, the Israeli coastline can be divided into three: southern, central and northern parts. All the coastal structures in the southern part, the cooling basin of the Rutenberg power plant near Ashqelon, the Ashqelon marina, the Ashdod marina and Ashdod Port exhibit a significant and consistent beach accretion on the southern side of the structure and beach erosion on the northern side. Figure 18 is an aerial photograph of the boat anchorage of the Elat-Ashqelon Oil Pipeline Co. south of Ashqelon. This photograph was taken in 1978, some 6 years after the anchorage construction was completed and prior to the construction of the cooling basin of the Rutenberg power plant in that location. The picture clearly shows the massive accumulation of sand south of the anchorage and the erosion that took place north of it. This process has continued after the construction of the basin. Figure 19, taken from Golik *et al.* (1996a), shows the accretion that took place south of the main breakwater of the Port of Ashdod between 1958 and 1992. It shows not only the magnitude of the accretion, more than 100 m near the breakwater and tapering off at a distance of 2.5 km, but that it was consistent in time. Although quantitative information concerning erosion and accretion next to the marinas of Ashqelon and Ashdod is not available, there is no doubt that the pattern described above exists also there. One therefore may conclude that the net longshore sand flow in the surf zone in the southern part of the Israeli Coast is northward.

In the central part of the coastline, between Tel Aviv and Netanya, the waterline changes in the vicinity of coastal structures are not as dramatic. The series of the

* *Defined as the zone of the beach profile extending seaward from the foreshore to just beyond the breaker zone.*

symmetrical tombolos formed behind the offshore breakwaters in Tel Aviv cannot be indicative as to the longshore direction of the sand flow because this complex is a closed system. The waterline changes that occurred in the vicinity of the Herzliya marina complex after its construction indicate that the net longshore sand transport in the surf zone is from south northward. However, the magnitude of waterline changes which occurred after construction are in the same order of magnitude observed there, under natural conditions, prior to construction. The northward rate of net longshore sand transport at Herzliya must therefore be rather low. The findings at Netanya indicate that the direction of longshore transport there fluctuates between northward and southward. The longshore sand transport in the central part of the Israeli Coast must therefore be in both directions with probably low net flow northward.

The pattern of accretion/erosion next to coastal structures in the northern part of the Israeli Coast shows a net southward sand transport. Beach accretion occurred on the northern side of the cooling basin of the Hadera power plant as soon as its construction started and continued until the beach regained new steady-state conditions. Although the accretion there according to the second author is due mainly to the local near-closed cell conditions, the accretion of the beach along about 1.5km of coast is an indisputable fact and at least part of the accretion is attributed to southward sand transport. Figure 20 shows the beach accretion which occurred north of the basin. In a similar way, a small groin, located a few km south of Hof HaCarmel in Haifa shows accretion on its northern side and erosion to its south (Figure 21). The magnitude of these changes is rather small but they are consistent. The asymmetric development of the Hof HaCarmel tombolo in Haifa, expansion of its northern side vs. stability of its southern one (Figure 13) and the retreat of the waterline south of the tombolo following its formation (Figure 14), are further evidence to a net southward sand flow in the surf zone in this area.

The inference that can be made regarding waterline behavior next to coastal structures is that the littoral drift along the Israeli coast is directed northward, with a decreasing intensity, from Ziqim to Herzliya. In the vicinity of Netanya, the flow direction is reversed and between Hadera and Haifa it is southward. It must be understood that this pattern is general and changes from year to year fluctuates in accordance with the

wave climate. This is clearly demonstrated in Netanya, where shift in waterline position indicated southward sand flow until 1991 and northward transport later.

4.4.3 *Rehabilitation of Damaged Beaches*

Analysis of waterline position by means of aerial photographs may provide information regarding rehabilitation processes of damaged beaches. A case study is the southern section of the Hof HaCarmel-Megadim Coast. In that coast, two sites were used in the past for sand quarrying: Kfar Samir (also called Tira) which is found in section 3 of this study and Megadim beach which corresponds to sections 5 and 6 (see Figure 12). In 1963 only, 155,000 m³ were quarried from the beach of Kfar Samir and 140,000 m³ from Megadim (Zifzif Commission, 1964, p.11). Between 1958 and 1963, the quantity of sand which was mined from Kfar Samir was 324,500 m³ and between 1957 and 1963 760,000 m³ were mined from Megadim (Zifzif Commission, 1964, Annex 1). In actuality, the quantity of sand which was mined might have been larger as according to testimony of the mining company, mining took place near Megadim as early as 1951 (Zifzif Commission, 1964, Annex 3, p. 4).

Undoubtedly, this massive sand mining from the beach has caused the more than 40 m retreat of the waterline between 1956 and 1963 as evidenced by the analysis of the aerial photographs (Figure 15). In 1964, the government prohibited sand mining from the beach. It is not known when mining actually ceased in the area of our study but its effect is noticed in the waterline migration seaward after 1963. From the data we have at hand, it is impossible to determine whether the rehabilitation process of the beach is still going on or not, but until now, the waterline has not returned to its 1956 position.

The rehabilitation rate of the beaches in Haifa Bay between the Qishon Harbor and Qiryat Yam was faster than that of the Haifa-Atlit coast. Golik *et al.* (1999b) suggest that the waterline retreat, which occurred between 1956 and 1970 near Qiryat Yam, was a result of beach sand mining, which was carried out there for the construction of Qiryat Yam and its neighboring towns. However, once the mining stopped, rehabilitation of the beaches was fast, consistent and even surpassed the waterline of 1945-56.

5. SAND ACCUMULATION / EROSION ON THE SEABED

5.1 General

Redundant topographic and bathymetric surveys may provide quantitative information regarding erosional or depositional processes on the seabed and beach face. Subtraction of a chart from another, which was surveyed earlier, will result in a depth differential map that would indicate if such processes took place during the period between the two surveys. However, this method is susceptible to large errors as even a small depth difference between any two surveys, when multiplied by a large area, will result in a large volume. In this manner, an error in a depth reading of only 10 cm when multiplied by an area of 1 km² will result in an error of 100,000 m³. Therefore, this method is appropriate in areas where a depth change between surveys was large. This will occur where the natural processes, which hold the seabed in steady-state conditions, have been disturbed, e.g. near man-made structures.

Volumetric analysis of seabed changes in the vicinity of a coastal structure may yield information as to the direction of the natural flow of sediment on the sea bottom and a semi-quantitative estimate of its rate and the amount of sand trapped by the structure. Although many coastal structures were built during the last 50 years along the Israeli coastline, very little monitoring of their effect on the seabed was carried out. As a matter of fact, the only cases where repetitive sea bottom surveys in the vicinity of a coastal structure were used for volumetric analysis of seabed changes are the Rutenberg power plant south of Ashqelon performed in the framework of the present study, the Port of Ashdod (Golik *et al.*; 1996a,b), coastal structures between Bat Yam and Netanya (Rosen, 1998) and the Port of Haifa (Golik *et al.*; 1999b).

5.2 Methodology

The bathymetric charts which were used for the analysis of the Rutenberg power plant were obtained from the archives of the Israel Electrical Co., for the ports of Ashdod and Haifa from the Israel Port and Railway Authority and for the structures in the central coast from various sources (see Rosen, 1998, Table 4). The dates of these

surveys range from 1976 to 1995 for the Rutenberg power plant, 1957 to 1995 for Ashdod Port, 1962-1997 for the coastal structures in the central coast and 1928 to 1997 for Haifa Port. The accuracy of these charts was therefore, not the same. It is presumed that in the early surveys, probably until the late 1950's, navigation of the surveying vessel was carried out using sextant readings to benchmarks on land, and depth was determined using a line and weight. Since 1957, an echosounder was employed for depth determination and since the late 1970s, electronic positioning systems (Miniranger, and later DGPS) were used. In view of the high sensitivity of volumetric estimates derived from differential maps to errors in depth measurement, the reader must bear in mind that although the accuracy of bathymetric survey has improved with time, the subtraction of recent maps from older ones, presumably less accurate, still results in significant errors.

The maps that were used for analysis were digitized and an interpolated 50X50 m depth grid was prepared for each survey (in Ashdod Port 25X25 m). The origin and orientation of these grids were identical. This allowed the subtraction of one grid from the other in order to obtain differential grids, which were used for preparation of depth differential maps. It should be stressed that no correction of the original digitized data was performed and the results below refer to the original maps.

5.3 Results

5.3.1 Cooling Basin of the Rutenberg Power Plant

In 1972-1974, a complex of an anchorage with a groin on each side was built for the boats of the Elat-Ashqelon Oil Pipeline Co. south of Ashqelon. In 1986-7, an L-shaped cooling basin was built around the anchorage. A series of bathymetric surveys were conducted in the area between 1976 and 1995. Figure 22 shows their coverage.

Four canyons incise the sea bottom off the Rutenberg cooling basin (Figure 23). These run in a west-east direction, starting at a water depth of 30 m or less with their heads reaching a water depth of 6 m. The canyons are located next to the oil pipelines of the Elat-Ashqelon oil terminal, and there is little doubt that their formation is

related to these pipelines. The southern canyon heads to the main breakwater of the cooling basin and Figure 24 shows the position of its axis at various years. It can be seen that it drifted northward with time.

Figure 25 is a depth differential map between November 1976 and May 1982, showing that during that period, prior to the construction of the cooling basin, sand deposited south of the anchorage and erosion occurred on its northern side. The longshore erosional belt seen in Figure 25 is a result of the seasonal shift in position of the bar and trough system.

Figures 26-29 are depth differential maps prepared by subtracting the survey of 1982 from those of November 1986, December 1991, June 1992 and November 1995, surveyed after the construction of the cooling basin. Next to the waterline an alternating deposition/erosion belt may be noticed. This is a result of the seasonal shift of the bar and trough system. However, seaward of that, two belts of deposition are found in all the maps. One, south of the basin, runs parallel to the shore and the other, in front of the main breakwater of the basin, is oriented in an east-west direction. Juxtaposed to this second belt, and north of it, an erosional belt, located in the canyon site, is noticed. Examination of figures 26-29 in sequence shows that deposition and erosion increases with time in the corresponding belts. One can also notice, that in comparison with the other periods examined, a sharp increase both in deposition and erosion took place during the 7-month period between December 1991 and June 1992.

Figure 30 is a depth differential map between July 1986 and November 1995. It extends over a larger area than figures 26-29 and shows all the 4 canyons in this area. One can see that deposition occurred on the southern side of each canyon and the impression is as if the canyons block the northward sand transport. The processes, which led to the formation of the canyons and their behavior, are beyond the scope of this paper, but it should be kept in mind that like coastal structures, these canyons trap sand on their flanks.

Volume changes with time on the seabed were computed using the differential maps. Only a 1.2-km² area, shown in Figure 24, could be used for this computation because

it was covered by all the surveys used for these computations. The results are presented in Table 1.

Table 1. Volumetric changes in m^3 , on the seabed in front of the Rutenberg Power Plant.

Period	May 82 - December 91	December 91 – June 92	June 92 – November 95	May 82 – November 95
Deposition	790,173	516,587	159,460	1,466,220
Erosion	150,014	75,773	24,371	250,158
Net Change	640,159	440,814	135,089	1,216,062

Table 1 shows that in comparison with the net deposition of 640,000 m^3 that occurred during the 10.5 years prior to December 1991 and the 135,000 m^3 during the 3.5 years after June 1992, 440,000 m^3 were deposited during a period of only 7 months, between December 1991 and June 1992.

The entrapped 1.2 million m^3 of sand is, as mentioned above, only in an area of 1.2 km^2 for which coverage of redundant surveys was available. In actuality, the area of deposition is much larger and it is estimated that the volume of sand trapped is at least two or three times as much.

5.3.2 Ashdod Port

Ashdod Port was constructed between 1960 and 1964. Seven bathymetric surveys, which were conducted between 1957 and 1995 in the vicinity of the port, were used by Golik *et al.* (1996a,b) in order to evaluate the effect of the port on the sea bottom. It was found that shortly after the port's construction, sand deposition occurred on the sea bottom south of the port and erosion on its northern side. This pattern of sedimentological developments continued throughout the port's lifetime.

Depth differential maps and volumetric computation of the depth differences showed that the port trapped some 4.5 million m^3 of sand until 1995 (Figure 31). Of this, 2.3 million m^3 were trapped between the port construction in 1960 and 1985, and 2.2

million m³ between 1985 and 1995 (Golik *et al.*: 1996b). It was shown that most of the sand entrapment, which occurred after 1985, must have been caused by a combination of an extremely severe storm, which occurred in February 1992, with the flooding of the nearby Lakhish River that occurred at the same time. On the basis of differential maps and volumetric calculations, it is roughly estimated that about half of the natural longshore sand transport bypasses the port.

In a follow up study regarding sand by-passing implications at Ashdod port, Cheshier and Dearnley (1999) studied also the bathymetric changes which occurred since 1995 in the Ashdod port area, including also the new Ashdod "Blue Marina" built some 2 km south of the port. Contrasting bathymetric maps of 1995, 1997 and 1998 they assessed the volumes eroded or deposited in various areas of the Ashdod coast. Rosen (1999b) analyzed their results and summarized them in table 2. The immediate impact of the construction of the Ashdod marina can be clearly seen. It caused accretion south of the marina, redistribution of the sediments north to and further sand trapping by the existing Ashdod Port.

Table 2. Sedimentologic changes at Ashdod shore between 1995 and 1998

Coast sector	Change period	Above 0.0m	Between 0m and -5m	Between -5 and -10m	Between -10m and -15m	Cumulative to -15m
South to Blue Marina	1997 - 1995	284,000	137,000	-2,000	35,000	^a 454,000
	1998 - 1997	-56,000	-21,000	-20,000	-91,000	-188,000
	1998 - 1995	228,000	116,000	-22,000	-56,000	266,000
Between the marina and the port main breakwater head	1997 - 1995	50,000	21,000	342,000	-33,000	^b 380,000
	1998 - 1997	-16,000	-98,000	-127,000	-32,000	-273,000
	1998 - 1995	34,000	-77,000	215,000	-65,000	107,000
Between Ashdod port and Eshkol cooling basin	1997 - 1995	-57,000	-31,000	55,000	-171,000	^c -204,000
	1998 - 1997	42,000	88,000	12,000	50,000	192,000
	1998 - 1995	-15,000	57,000	67,000	-121,000	-12,000
From Eshkol cooling basin to 1km north to the cooling basin	1997 - 1995	-8,000	-60,000	-14,000	-44,000	-126,000
	1998 - 1997	11,000	46,000	4,000	-28,000	^d 33,000
	1998 - 1995	3,000	-14,000	-10,000	-72,000	-93,000
North beyond the 1km from Eshkol basin	1997 - 1995	28,000	-49,000	-133,000	-180,000	-334,000
	1998 - 1997	-21,000	60,000	-48,000	-97,000	-106,000
	1998 - 1995	7,000	11,000	-181,000	-277,000	-440,000
South to the port						373,000
North to the port						-545,000

a Including 70,000 m³ dredged in the marina between 10/96 and 02/97 and 42,000 m³ dredged between 06/97 and 09/97 in the entrance to Ashdod port.

b Including 30,000 m³ due to dredging in the marina between 10/96 and 02/97, excluding 126,411 m³ deposited in deep water

c Including 26,810 m³ dredged in the Ashdod port entrance

d Including 7,500 m³ dredged in the Eshkol cooling basin in spring 1998

5.3.4 Bat Yam to Netanya

In an assessment of the sedimentological state of the central part of the Israeli coast, Rosen (1998) prepared a series of depth differential maps for various sites between Bat Yam and Netanya. He also computed the volume change, deposition and erosion, for each differential map. The results are given in Table 3.

Table 3. Volumetric changes on the seabed assessed by differential mapping at various sites on the central part of the Israeli Coast. From Rosen (1998).

Map area coverage	Period	No. of years	Accretion m ³	Erosion m ³	Residual m ³
Bat-Yam to Yafo	10/1986 - 11/1962	24	343,000	-735,000	-392,000
	11/1997 - 10/1986	11	1,565,000	-335,000	1,230,000
	11/1997 - 11/1962	35	2,225,000	-3,600,000	-1,375,000
Yarkon River Mouth	08/1994 - 11.1962	32	320,000	-1,280,000	-960,000
	11/1997 - 08/1994	3	1,350,000	-50,000	1,300,000
Atarim to Herzliya	11.1997 - 11.1962	35	7,250,000	-2,815,000	4,435,000
Herzliya Marina	05.1991 - 11.1989	2	860,000	-10,000	850,000
	11.1997 - 05.1991	6	835,000	-2,600,000	-1,765,000
	11.1997 - 11.1989	8	1,480,000	-165,000	1,315,000
Netanya	11.1997 - 06.1996	1	1,840,000	-105,000	1,735,000

It can be seen that the residual volume (deposition - erosion) at each of the sites fluctuates from positive to negative. However, as mentioned by Rosen (1998), some of the maps suffered in their accuracy so the figures presented were given only as indicative trends rather than quantitative ones.

5.3.4 Haifa Port

In a study aimed at investigating the sediment dynamics in Haifa Bay, Golik *et al.* (1999b) computed sea bottom changes that took place in front of the main breakwater

of Haifa Port. The study was based on 12 bathymetric charts which were surveyed between 1928 (prior to the construction of the port) and 1997. Depth differential maps showed that sand entrapment in front of the main breakwater occurred as soon as the construction of the latter has started. The trapped sand spread along the breakwater from its root to its head (from west to east). Volumetric computations of depth changes show that 4 million m³ of sand accumulated in front of the main breakwater by 1997 (Figure 32). This is not the total volume of sand that was trapped by the breakwater during its lifetime as some 1.3 million m³ of sand was dredged from that area in 1961-62 and another 0.6 million m³ of sand was dredged from the port entrance. A rough estimate of the very long-term mean rate of sediment flow into Haifa Bay must therefore be greater than 85,000 m³/year because an unknown quantity of sand has probably bypassed the breakwater and dredged from its vicinity during that period.

5.4 Analysis of Results

Examination of the depth differential maps shows that next to the coastal structures in the south, the Rutenberg cooling basin and Ashdod Port, deposition was consistent and on the southern side of the structure. Sand deposition south of the Elat-Ashqelon boat anchorage started as early as it was constructed and continued, on the same side, after the cooling basin of the Rutenberg power plant was built in that area. Golik *et al.* (1996a) show on a series of depth differential maps, a continuous deposition south of Ashdod Port since its construction in 1964. There are not enough redundant depth surveys in the central part of the Israeli coast to state unequivocally that a similar consistent pattern of deposition occurs there. Nevertheless, the impression is that there too, coastal structures caused deposition on their southern side and erosion on their northern side. In Haifa, deposition in front of the main breakwater of the port was also consistent. It was already noticed at the early stages of construction of the breakwater and continued at least until 1994.

The results obtained at Rutenberg and Ashdod Port show the role that storms play in depositing sand next to coastal structures. In February 1992, a severe storm attacked the Israeli coast. Deep water characteristic wave height measured off Hadera (Rosen, 1993) reached up to 7 m during that storm. The effect of this storm on sand

entrapment by the cooling basin can be seen in Table 3. More than a third of the sand volume deposited next to the basin during its more than 12 years of existence, took place during the 7-months period in which the storm occurred. Had there been more frequent depth surveys to allow narrower bracketing of the storm period, the effect of the storm on sand trapping next to a coastal structure, would be more dramatic. Golik *et al.* (1996a,b) estimate that close to half of the sediment volume which was deposited south of Ashdod Port by 1995, were trapped there by the three storms which occurred in December 1991, February 1992 and December 1992. Therefore, most of the effect of a coastal structure on sand entrapment occurs during severe storms.

6. LONGSHORE TRANSPORT ASSESSMENT VIA WAVE DATA

6.1 General

Another method utilized to determine the longshore sand transport is that using wave energy flux considerations combined to sediment, beach profile properties and various sediment transport formulas and models.. This method was applied also in the present study, as complementary to the other methods used .

6.2 Review of previous studies

We review these not in the chronological way but in regards to the sites/ areas investigated and their relevance for the present study, starting from Gaza as the southward boundary along the Mediterranean coast of Israel up to Haifa. A summary of the estimates of longshore net sediment transports at various sites is presented in Table 4.

6.2.1 Gaza coast

A number of sediment transport assessments were performed for the Gaza coast. The first was the assessment conducted by Migniot and Manoujan (1975), in regards to the design of the Hadera cooling basin. Using the LCHF sediment transport formula, with a coefficient calibrated based on Tunisian beaches (Migniot, 1985 - personal

Table. 4 - Summary of net yearly longshore sediment transport assessments

Place	Author(s) and year	Formula or Model	Volume at site (m ³ /year* 10 ³)
Nile Delta	Hammad -1979		400 to 3,200
Bardawil	Inman and Harris-1980		300 to 800
Gaza	Migniot-1975	LCHF	400
	PortConsult-1987		400
	Delft Hydraulics-1994	UNIBEST	350
	Bosboom (D.H.)-1996	Delft2DMOR	360
Ashqelon	Vajda and Finkelstein-1984	CERC	675
	Verner-1986		675
	PortConsult-1987		270
	Jensen-1990		250
	Delft Hydraulics-1994		300
Ashdod	Kaiser Engineers-1965	CERC	1,060
	Dornhelm-1972		250
	Migniot-1973	LCHF	215
	Finkelstein-1980	CAMERI	560
	Migniot and Manoujan-1983	LCHF	255
	Rosen-1985	CERC+Komar	350
	Vajda et al.-1988	Bijker without currents	700
	Vajda et al.-1988	Bijker with currents	1,880
	Delft Hydraulics-1994	UNIBEST	180
	Golik et al.-1996	Bijker with currents	350
	Nairn and Baird-1996	COSMOS (Ashdod wave data 04/92-03/93)	300
	Nairn and Baird-1996	COSMOS (Ashdod wave data 04/93-03/95)	-570
	Dearnley-1996	BEACHPLAN	153
	Dearnley-1996	PISCES	120 to 290
Tel-Aviv	Migniot-1966, Migniot and Manoujan-1968	LCHF	85 to 130
	Vajda-1972		150
	Enosh-1996		120 to 156
Herzliya	Nairn and Baird-1996	COSMOS (Asdod wave data 1958-94)	600
	Nairn and Baird-1996	COSMOS (Haifa wave data 1994-95)	650
	Nairn and Baird-1996	COSMOS (Ashdod wave data 04/93-03/95)	-400
Hadera	Migniot-1974	LCHF	100 to 150
Haifa -Dado	Carmel et al. -1985	CERC	110±100
Haifa -Dado	HR Wallingford-1996	Baillard	100
Haifa -Dado	Kit and Perlin-1999	CERC based	80
Haifa -Dado	Jorgensen and Mangor-1999	Fredsoe	36
Haifa -Dado	Toms and van Holland-1999	Bijker	-55

communication), and wave data derived from the visually observed wave data at Ashdod, they assessed the following yearly average sediment transports:

At Gaza - 400,000 m³/year, at Ashdod - 215,000 m³/year and at Hadera - 100,000 to 150,000 m³/year.

Another assessment was performed by PortConsult for a fishing port at Gaza (1987), which estimated the following volumes:

Site	Northward	Southward	Net
	m ³ /year	m ³ /year	m ³ /year
Gaza	400,000	-40,000	360,000
Ashqelon	567,000 ±128,000	-301,000±55,000	270,000

According to verbal information the assessment was based on visually derived wave data from Ashdod and Ashqelon and wind data from Gaza.

Finally, in regards with a major port requested by the Palestinian Authority to be built at Gaza, Delft Hydraulics conducted two studies, first (Delft Hydraulics, 1994) using UNIBEST model (one-line model) and later (Bosboom, 1996) with the Delft 2D-MOR model. The wave data were hindcasted wave data from wind data as well as some Ashdod wave data. The following assessments were obtained using Bijker formula:

Site	Northward	Southward	Net
	m ³ /year	m ³ /year	m ³ /year
Gaza (UNIBEST)	510,000	-160,000	350,000
Gaza (Delft2DMOR)	455,000	-95,000	360,000
Ashqelon	-	-	300,000
Ashdod	-	-	180,000

They also have shown that for Gaza, using various formulas the following results were obtained and selected Bijker formula as the most reasonable one:

Formula	Baillard	Bijker	Van Rijn
	m ³ /year	m ³ /year	m ³ /year
Net yearly at Gaza	170,000	-350,000	540,000

It should also be mentioned that in using the Delft-2D-MOR model, the values above were obtained with the Fredsoe bottom stress model (Fredsoe, 1992) which was considered to provide more reliable results, while using the Bijker (1967) bottom stress model about 40% lower values were obtained.

6.2.2 Ashqelon coast

For the Rutenberg cooling basing sedimentological assessments were performed by Finkelstein and Vajda (1982) and by Vajda and Finkelstein (1984). The assessments were performed using a number of formulae and Ashdod wave data (1958-1981) and their statistics (all visually observed wave directions). The following values were assessed:

Formula	Northward	Southward (-)	Net
	m ³ /year	m ³ /year	m ³ /year
Engelund-Hansen	4,000,000	-300,000	3,700,000
CERC	2,000,000	-150,000	1,800,000
SWANBY	1,100,000	-90,000	1,010,000
Bijker (no currents)	950,000	-75,000	875,000
CAMERI	740,000	-65,000	675,000
LCHF	400,000	-35,000	365,000

They concluded that the situation in 1980-82 is a new sedimentological equilibrium state, which led to various changes on the beach and bottom within 1km on each side of the boat anchorage of Katza. The total volume trapped was estimated at 200,000 m³ with some 40,000 m³ croded north of Katza. Based on a physical sedimentological model, it was estimated that as a result of the construction of the cooling basin, a yearly maintenance dredging of 10,000 m³ will be needed, as well as an initial 60,000 m³ dredging. It was estimated that a new equilibrium state will be reached within 5 years from the construction of the cooling basin, leading to an additional deposit of 170,000 m³ to the south of the cooling basin and some 50,000 m³ erosion in the shallow water north to the cooling basin.

Verner (1986) presented an assessment of the longshore transport at the site of the Ashqelon marina coast as follows

Northward	Southward	Net
m ³ /year	m ³ /year	m ³ /year
740,000	-65,000	675,000

Another assessment of the sediment transport at Ashqelon was performed by Jensen (1990), in regards with the design of the Ashqelon marina. Based on Delft Hydraulics (1994) their assessment was of a net transport northward of about 250,000m³, with negligible southward transport. The assessment was based on the visual wave data from Ashdod (1958-75).

6.2.3 Ashdod coast

Marine Advisers (1965) presented the first assessment on sediment transport at Ashdod Port on the basis measured wave data. According to their assessment, using

CERC formula, the following values were estimated:

Formula	Northward	Southward	Net
	m ³ /year	m ³ /year	m ³ /year
CERC	1,490,000	-420,000	1,060,000

Finkelstein (1980) investigated the sedimentological process near Ashdod Port as part of a study related to the calibration of a sedimentological model for that port. Considering wave energy, he concluded that the natural longshore sediment transport along that coast is 700,000 m³/year from south northward and 140,000 m³/year southward leaving a net flow northward of 560,000 m³/year.

Migniot and Manoujan (1983), conducted a sedimentological model study for the expansion of Ashdod port. Using all wave data gathered at Ashdod until then they assessed, using the LCHF formula, the following yearly average transports:

Formula	Northward	Southward	Net
	m ³ /year	m ³ /year	m ³ /year
LCHF	300,000	- 45,000	255,000

However, they concluded that since the construction of the existing port, almost no sediment has bypassed it, except for a very minor fraction of very fine sand, bringing the by-passed volume to about 15% of the original (~40,000m³).

On the basis of wave energy flux calculations, Rosen (1985) assessed the sediment transport at Ashdod employing the wave data gathered at Ashdod between 1957 and 1984. Using the CERC formula combined with the profile distribution of the longshore current, according to Komar (1977), he found a mean yearly transport capacity of about 413,000 m³ northward versus some 58,000 m³ southward with a net yearly mean transport capacity of some 350,000 m³. The distribution perpendicular to the shoreline indicated almost zero net transport near the shoreline, with largest net quantities between -2 m and -5 m depth contour lines. The *yearly long-term average* longshore sediment transport south of the port estimated by Rosen (1985) in that study was of about 450,000 m³ to the north, about 100,000 m³ to the south leaving a net transport capacity of about 350,000 m³. A new volumetric transport assessment

(Golik et al., 1996) was based on Bijker formula and 3 years of reliable directional wave data (04/92-03/95) and including general currents contribution to the longshore sediment transport, as well as on another 35 years of wave data with less reliable directions (1958-1992).

A successive sedimentological study related to the expansion of Ashdod port was conducted by Dearnaley (1996), using two numerical sedimentological models, one of the one-line type (BEACHPLAN) and the other two-dimensional (PISCES). For the present port conditions, the sediment transport volumes determined by Dearnaley (1996) were as follows:

MODEL TYPE FOR LONGSHORE TRANSPORT	SITE	BEACHPLAN	PISCES
Yearly Average Net Northward (1992-1995)	open beach	153,000 m ³	
Sensitivity Range of Yearly Average Net Northward	5km South of the port	120,900 m ³ to 290,500 m ³	
Yearly Average Net Northward (1992-1995)	South to port	105,000 m ³	132,000 m ³
Yearly Average Net Northward (1992-1995)	North of port	35,500 m ³	61,000 m ³
Sensitivity Range of Yearly Average Net Northward	North of Eshkol basin	33,800 m ³	26,600 m ³ to 42,900 m ³

These numbers indicate the assessment of the modelers that Ashdod port by-passes lower rates of only about 30% of the net transport on the open beach south to the port. However, it did not include assessment for major sand by-passing events during high storms such as those of 1992-1993, as was did Golik et al. (1996). It should be also mentioned that the assessment of sediment transport was based on the longshore transport derived using Baillard formula, which, as indicated by Delft Hydraulics (1994) leads to lower values than using the Bijker formula. It is obvious that if lower sediment rates bypass the port, a larger deficit would appear to the northern coast.

6.2.4 Tel-Aviv coast

Migniot (1966) and Migniot and Manoujan (1968) conducted a study in regards to the Reading power station cooling water basin. Using LCHF formula and visually observed wave data from Ashdod and from Tel-Aviv, they assessed the following transport rates at Tel-Aviv:

Transport Formula	Northward m ³ /year	Southward m ³ /year	Net m ³ /year
LCHF	110,000 to 150,000	20,000 to 25,000	85,000 to 130,000

Another sedimentological study was conducted by Vajda (1972). in regards to the detached breakwaters system at Atarim coast in Tel-Aviv. He based his initial assessment on the study of Reading mentioned above. but upon re-analysis of the data he assessed a net northward yearly transport at Tel-Aviv shore of about 150,000 m³ (p.19). He also mentions that the estimated detached breakwater system will trap more than 500,000m³ of sand.

In a later study for a marina city at the site of the Tel-Aviv harbour, Vajda (1973) presented the following sediment transport estimates using various formulas as well as another result from a report by LCHF as follows:

Transport	Northward	Southward	Net
Formula	m ³ /year	m ³ /year	m ³ /year
Bijker (b=5)	590,000	111,000	130,000
Bijker (b=1)	118,000	22,000	96,000
Eagleson	440,000	106,000	334,000
Caldwell (K=1.3-1.9)	575,000	97,000	478,000
Caldwell (K=1.0-1.9)	442,000	97,000	345,000
CERC	805,000	155,000	650,000
LCHF report	166,500	21,000	145,000

Another longshore sediment transport assessment based on LCHF formula is presented by ENOSH Environmental Systems (1995) for the Tel-Aviv coast at the Yarkon sector at Tel-Aviv, in regards with an environmental impact assessment for a marina project in the Yarkon river estuary. The assessment is given without specifying on what wave data the assessment was based. The following values are presented by ENOSH for a moderate year:

Transport	Northward	Southward	Net
Formula	m ³ /year	m ³ /year	m ³ /year
LCHF	180,000	60,000	120,000

They mention that for extremely stormy years the assessment will be affected by about 20%, which means that in very stormy years the northward transport would increase by 20% or be about 206,000 m³, leading to a net transport in that case of 156,000m³. However, this sentence is not based on any further data.

6.2.5 Herzliya coast

A number of sedimentological studies were performed in regards with the construction of marina Herzliya and its impact on the adjacent coast. The report of the original physical sedimentological model study with movable bed (using ebonite as

artificial sand) was not available to us. Since after the construction of the marina significant erosion occurred north to the sector protected by the three detached breakwaters in spite of the forecasted stabilization of the coast, its absence don't seem very important, except as a warning regarding model forecasts.

Baird and Associates (1996), conducted an analysis of the beach erosion on the Herzliya coast north to the marina and its 3 detached breakwaters. They analyzed aerial photographs, bathymetric charts and performed sediment transport assessments at the Herzliya coast based on a two dimensional sedimentological model.

Using wave data from Ashdod for a number of time periods and from Haifa for a two year period, they reached to the following longshore transport assessments at Herzliya coast, using a perpendicular to coast orientation of 284 degrees (as indeed is the case):

Transport	Northward	Southward	Net
Via COSMOS model	m ³ /year	m ³ /year	m ³ /year
via Ashdod 1958-94 daily wave maxima	1,750,000	-1,150,000	600,000
Via Ashdod wave data 04/1992-03/1993	1,200,000	-1,200,000	0
Via Ashdod wave data 04/1993-03/1995	550,000	-950,000	- 400,000
Haifa 1994 and 1995 3 hourly wave data	1,000,000	-350,000	650,000

Using the Haifa wave data for 1994 and 1995 and assuming a general constant current of 0.2 m/s, they estimated the contribution of the general circulation to be an additional rate of 6,000 m³/year in the range of depths between 12 and 24m. They concluded that the annual northward and southward longshore transport components are now in the range of 300,000 to 900,000 m³/year, or less, and that longshore sand transport in a single major storm event could be as high as 100,000 m³. Furthermore, they concluded that the bypassing of sand at Ashdod port is up to 10% of the south to north transport south of the Ashdod port, but at Herzliya marina it reached (in 1996) 30% of the pre-marina transport rate. These authors seem that did not attribute importance or were not aware of the low reliability of the old visually observed wave directions at Ashdod prior to April 1992, and the corresponding impact on their conclusions. They were apparently also not aware of the extremely stormy winter of 1991-1992.

A new study conducted again by the same authors (Baird W.F. & Associates Coastal Engineers Ltd., 1998). They re-analyzed the old data together with new data and presented an updated assessment of the longshore sediment transport at Herzliya coast. Their new assessment is summarized in Table 5 taken from Rosen (1999c) who reviewed their report.

Table 5. New sand transport assessment at Herzliya by Baird Associates (1998)

Position	Period	Northward yearly transport (m ³ /m)	Southward yearly transport (m ³ /m)	Net yearly transport (m ³ /m)
Section 2	04/92-12/97	460,000	-600,000	-140,000 (southward)
	12/95-12/97	500,000	-600,000	-100,000 (southward)
Section 3	04/92-12/97	300,000	-340,000	-40,000 (southward)
	12/95-12/97	270,000	-380,000	-110,000 (southward)
Section 4	04/92-12/97	160,000	Not provided	Not provided
	12/95-12/97	120,000	Not provided	Not provided

Rosen(1999b) in reviewing the above report evaluated for the same coast a long term yearly average longshore net transport of 175,000 m³ northward. Another study using the directional wave data from Haifa, Ashdod and Hadera was performed by Toms and van Holland (1999) in relation to islands development off the coast of Tel Aviv and Herzliya. The study, conducted using the Delft 3D/2Dh numerical sedimentological model assessed an average yearly transport northward of about 30,000m³ at Appolonia, some 3km north of Herzliya marina for the period 04/1994-03/1998 (average of 4 sedimentological years). At Bat-Yam for the same period a net northward transport of some 60,000 m³/year was assessed.

6.2.6 Hadera coast

A number of sedimentological studies were carried out for the coast of Hadera in relation to the construction of the cooling water basin of the Orot Rabin power station, its offshore coal unloading terminal there and coastal changes south and north of the cooling basin (see location on inner head page).

Migniot (1974) conducted a physical sedimentological model with movable bed with artificial sand (Bakelite specific density 1.4 gr/cm^3). His forecast were of accretion south to the cooling basin and erosion north to it. He estimated a yearly average net northward directed longshore transport of between 100,000 to 150,000 m^3 .

Finkelstein and Vajda (1979) conducted also a physical sedimentological model with movable bed with artificial sand (ebonite-specific density 1.8 gr/cm^3) in regards to an alternative of an offshore terminal based of a shore parallel breakwater in 22m water depth, 1km long. During the calibration phase, they obtained accretion north of the cooling basin lee breakwater and no erosion south of the cooling basin. The construction of the detached breakwater 1km long induced the creation of a large sand spit which could endanger the entrance to the basin by heavy silting. Their estimated yearly average net northward directed longshore transport was based on a new wave climate assessed by Rosen & Vajda (1977), which led to a value of 100,000 m^3/year .

A sediment transport using radioactive tracers was conducted by Sauzay et al. (1974), which indicated that the sediment transport was mainly to the north. Another field study was conducted by Golik et al. (1986), who monitored the spreading of coal particles falling at the coal unloading terminal (in water depth of about 22 to 24m). The results showed a clear northward transport, with some spreading towards to shore, but not closer than about -10m contour line.

A sand trap test was carried off Hadera at a water depth of about 28m by the IEC. A large pit (a few meters) was dredged there, and after a few months, it was found filled completely, indicating that sediment transport occurs also at such water depths.

6.2.7 Haifa coast

Carmel et al., 1985, used wave data gathered using a directional wave pressures array off Dado beach at the southern coast of Haifa and presented an assessment of about $110,000 \pm 100,000 \text{ m}^3/\text{year}$. This was due to the fact that the position of Haifa coast relative to the incoming major storms is almost perpendicular ($Az 5^\circ$ versus $Az 270^\circ$ of the westerly storms) leading to variations in transports from year to year according to the wave climate fluctuations. In recent years two sedimentological model studies were carried out at Haifa coast. The first dealt with the plans for a large marina at Shikmona and Bat-Galim coast, the latter with the expansion of Haifa port. Chesher

(1996) and Chesher and Dearnaley (1997) presented the results of numerical modeling assessments using a small sample of measured wave data from Haifa and 10 years of hindcasted wave data using the UK Meteorological Office Wave model. The later data were found later to be unreliable, but the Wavec data at Haifa were used with a one line model (BEACHPLAN) as well as with a numerical 2D model (PISCES) to assess the sediment transports on the Haifa coast. Their result obtained with the one line model and the Baillard formula for the Dado beach at Haifa south gave a net northward yearly transport of close to 100,000 m³.

In a research conducted by Perlin and Kit (1999) used the wave data between 1994 and 1998 and a new formulation derived from the CERC formula and provided assessments of longshore transports at Ashdod and Haifa. At Haifa, a net northward yearly transport for the above period of about 85,000 m³ was presented.

In a more recent study, Jorgensen and Mangor (1999) provided an additional assessment for the same coast using the same data from the Haifa Wavec buoy. Their averaged assessment, obtained with their one line LITPACK model and Fredsoe formula for the period of sedimentological years 04/94-03/96 and 04/97-03/98 gave a net northward transport of 36,000 m³/year.

Finally, Toms and van Holland using the Haifa wave data for the whole period of 04/94-03/98 assessed a southward average transport of -55,000m³/year for that period, using their UNIBEST model and Bijker formula. Hence, for Haifa contrasting results were obtained by different studies. The reasons for these differences will be discussed later, after presentation of the new longshore transport assessment obtained in the present study.

6.2.8 *General studies*

Goldsmith and Golik (1980), applying wave refraction to the whole coast, studied the sediment transport pattern along the coast assuming a constant wave approach angle in deep water for all the coast. By analyses of the contributions of various theoretical wave directions and periods, and the refracted wave directions relative the coast orientation along the cell, they concluded that the Nile Littoral Cell can be divided in three sectors: a sector south to Rafah where a continuous net northward longshore transport exists, a sector between Rafah and Haifa with longshore transport depending on incoming wave direction leading to shifting net transport to north or to south, and

the third sector consisting of Haifa Bay, extending from Haifa to Acre, which acts as a sediment sink. Beyond Acre the transport was considered not to be related to the Nile Littoral Cell. The authors indicated that in the southern part of the second cell predominated a net northward longshore transport, while in the northern part nodal point of net transport exist between Netanya and Haifa. The nodal points shifted according to the wave direction and wave period. However, as mentioned above, it was assumed that the deep water wave direction is constant for the whole coast, assumption found later to be not applicable for the Israeli coast (Rosen, 1998a).

Another general study was conducted by Rosen(1998b) covering the coast between Palmakhim in the south to BetYanai in the north, but actually extending between Haifa and Ashdod in respect to the longshore sediment transport via wave data. The longshore transports were assessed by a number of theoretical formulas and contrasted against ground true complimentary data from aerial photographs and bathymetric charts. The range of values assessed at Ashdod for period 04/92-03/98 was between 208,000m³/year to 285,000 m³/year. At Haifa this range was between 84,000 m³/year to 109,000 m³/year.

Toms and van Holland (1999) used the same data provided by Rosen(1998a) with a one-line numerical budgeting model (UNIBEST) and Bijker formula to assess transport rates on the coast of Israel. The following transport rates were assessed using this model:

Table 6. Longshore sand transport capacity rates assessed by Toms and van Holland (1999)with UNIBEST model

Location	Net annual northgoing longshore transport capacity (no current) m ³ /year	Net annual northgoing longshore transport capacity (with correlated current speed and direction) m ³ /year
Ashdod	190,000	
Palmakhim	130,000	
Tel Baruch	75,000	87,000
Ga'ash	55,000	
Bet Yanai	20,000	
North Hadera	0	
Atlit	-20,000	
Haifa	-55,000	

They also provided a detailed yearly assessment for the same period at Tel Baruch which is reproduced below:

Period	Net annual northgoing longshore transport capacity (no current) m ³ /year at Tel Baruch
04/94-03/95	26.000
04/95-03/96	135.000
04/96-03/97	58.000
04/97-03/98	80.000
Average	75,000

At Ashdod they assessed for the period 04/1994 - 03/1998 a net yearly northward average transport of 190,000 m³, while at Haifa their assessment was directed southward with an yearly average value for the same period of in relation to islands development off the coast of Tel Aviv and Herzliya. The study, conducted using the Delft 3D/2Dh numerical sedimentological model assessed an average yearly transport northward of about 30,000m³ at Appolonia, some 3km north of Herzliya marina for the period 04/1994-03/1998 (average of 4 sedimentological years). At Bat-Yam for the same period a net northward transport of some 60,000 m³/year was assessed.

6.3. New assessment of longshore transport using wave data

6.3.1 *General approach*

The assessment of longshore sediment transport may be obtained by a number of methods, such as budgeting of wave induced energy flux, sand accretion or erosion at a sand trap (coastal structure or bottom trench), repetitive mappings and tracers.

The present assessment of the sediment transport at the Mediterranean coast of Israel is based on budgeting of the wave induced sand transports produced by longshore wave energy fluxes. Among the relatively large number of formulations for assessing the potential longshore sediment transport rates (Rosen-1981b), the formulations known as the "CERC formula", the "Komar-Longuett Higgins formula", the "Bijker formula", and the French "LCHF formula" were used in two previous studies (Golik

et al., 1996 ; Rosen, 1998a). These formulas allow to assess the range of longshore sand transport quantities, to verify against other available means (maps) whether it is possible to tell which one is more reliable in forecasting sand transport rates, and to investigate the range of accuracy of the sediment transport estimates. Among the above mentioned formulas, those of CERC and LCHF provide estimates of the total longshore transport on a coast. The Komar-Longuett Higgins provides the cross-shore distribution of the longshore transport, using as a basis the total transport determined via the CERC formula. The Bijker formula provides both the cross-shore profile of the longshore transport and the total longshore sediment transport. Furthermore, it differentiates between the bed-load transport and the suspended load transport, taking into consideration not only the wave energy flux, but also local sediment properties such as grain size, local bottom slopes, ripple height, presence of currents, etc. The conclusion of the studies mentioned above was that the Bijker formula provides the most reliable results, and only this formula was used in the present study.

To account for the longshore sediment transport taking place beyond the surf zone, the joint contribution of wave stirring and geostrophic current transport was assessed using current data statistics gathered by IOLR off Ashqelon and off Hadera , in 27 m water depth. The studies mentioned before indicated that including the joint effect of wave stirring and current flow beyond the surf zone may significantly increase the sediment transport in the range beyond surf zone. Recent studies by Toms and van Holland (1999) have shown that the addition of general circulation current increase the transports by about 20%. On the other hand, they have shown that the presence of kurkar ridges in water depths between -3 m to -5m and between -12m to -15m along most of the coast from Gaza up to Haifa, decrease the longshore transports via energy dissipation and blocking of onshore sand transports. Consequently, the present assessment was conducted with the Bijker formula excluding general current circulation and disregarding presence of kurkar ridges, with the expectation that the results obtained will give approximately the integral longshore transports.

6.3.2 *Input data*

Sediment characteristics were determined in a number of studies mentioned elsewhere. An example of the characteristics of the sand on the Israeli coast is

presented in Figure 35. Cross shore beach profiles for the present study were determined from bathymetric charts of the selected study sectors.

The basic input selected for the present study were the relatively high accuracy directional wave data covering up to 7 full sedimentological years (April 1992 through March 1999) at Ashdod and Hadera and 5 full sedimentological years at Haifa (April 1994 through March 1999). However, to obtain a long term assessment of the sediment transport climate it is important to have a good knowledge of the history of stormy years and the average return period of various wave heights. Consequently, in Figure 33 we present an assessment of the yearly maxima deep water characteristic wave height during the last 40 years. In this study we use sedimentological years, namely years starting in April of a calendar year and ending at the end of March of the following calendar year. Doing so we ensure that each has a full winter season and a full summer season, as the storms in a certain winter are assumed to be dependent to a certain extent on each other. The results show the time history of the wave heights as well as those of the squares of the wave heights, which are proportional to the wave energy, thus indicating the true relative strength in regards to longshore sediment transport. The average return period of extreme sea-states is presented in figure 34.

As indicated in section 3, a shift in wave directions along the Israeli coast was found. Three directional wave data bases were derived: at Ashdod and Haifa using Wavec buoy and at Hadera using a directional pressure & currents instrument. Rosen (1998a) indicated that the Hadera instrument lacks the ability to correctly assess short waves below 6 seconds, which however contribute little to the normal longshore sediment transport. Consequently, it was decided to use the wave data gathered at Ashdod and Haifa by identical instruments and in identical water depths to assess the waves at other sites along the coast of Israel. The Hadera data were used for verification or gap filling.

The waves assessment at a total of 7 sites along the Israeli coast was derived in the following way:

a) The data from Ashdod, Haifa and Hadera were back refracted using linear wave theory assuming straight, coast parallel contour lines between the measuring stations

(-24m at Haifa and Ashdod, -27m at Hadera) using the peak wave period, in situ measured characteristic wave height and peak wave directions. The resulting deep water data included the values of the same parameters as time histories for the periods mentioned.

b) The deep water wave data derived for Ashdod and Haifa, which were gathered usually at 3 hours interval during sea-states below 2 m characteristic height and 1 or 2 hours in higher sea-states, were interpolated at each site to derive values at 1 hour intervals. This was done assuming that such interpolation is allowed between values up to 6 hours interval. Linear interpolation was applied between height and period values, while linear vectorial interpolation was applied for wave directions.

c) The data off Ashdod and Haifa were filtered to derive simultaneous values at both sites using Microsoft Access software.

d) Using the simultaneous data at both sites for the period 04/1994 through 03/1999, the corresponding simultaneous data time series at Hadera, Herzliya north and Bat-Yam were assessed using again linear interpolation as function of the distance along the coast in deep water between Haifa and Ashdod. For wave directions vectorial linear interpolation was used. Furthermore, to obtain an assessment in the sector south of Ashdod, the hourly deep water time histories of the waves were used to assess those in deep water off Ashqelon and off Gaza. In this respect linear vectorial extrapolation was applied for the wave directions, while the wave heights and periods measured at Ashdod were kept identical also for these sites. Another reason for this decision was due to the sheltering effect of the Egyptian coast on these sites to SW to WSW-ly waves, which otherwise the extrapolation could produce larger (unrealistic) heights. Furthermore, for the 2 sedimentological years of April 1992 through March 1994, when such data were not available at Haifa, while Hadera suffered in regards to the short period waves, the same data obtained in deep water at Ashdod were used to assess the deep water wave histories at Ashqelon and Gaza during these years.

e) The yearly data at each site were used to derive contingency tables of joint probabilities of occurrence of deep water characteristic wave heights, peak periods

and peak wave directions. The wave height bins were at 0.2 m intervals, those of the periods at 0.5 sec intervals and those of the directions at 10° intervals.

f) The assessment of the yearly longshore sand transport was carried out via BIJKER formula with the aid of a computer program written by the second author. Wave data at each of the sites mentioned above, the sand size characteristic dimensions at various depths and characteristic beach profiles at these sites were incorporated in the computations.

The results obtained with the Bijker formula provided the estimates of the longshore transport in the cross shore profiles at the sites studied both within and beyond the surf zone and its differentiation in bed load and suspended load modes.

6.3.3 Results

Examples of the cross-shore distribution of the longshore sediment transport for the sedimentological year 04/1994 - 03/1995, at Ashdod and Haifa are presented in Figures 36 and 37 respectively. The yearly distributions of the northward, southward, net and gross transports are presented in each figure. A significant difference can be observed in figure 37 relative figure 36. In the latter, the net transport cross shore distribution at Ashdod is (almost) always northward. In contrast, that at Haifa shows a transition from southward net transport in the surf zone up to 1.5 m depth and a net northward transport in deeper water depths. However, the total net transport in Haifa is almost null.

The northward and southward values are presented for the analysis period in Figure 38, while the net yearly transports are presented in Figure 39.

The results of the long term yearly average longshore sediment transport at the 7 sites covering the coast from Gaza to Haifa are presented in Table 7. This assessment is based on the average value assessed at Gaza for 04/92-03/99 and the long term average value of about 100,000 m³/year, derived from the at least 5.9 million and probably more deposited in the Haifa bay during 1931 through 1997.

Table 7. Assessment of long term average net longshore transports
(m³/year) on the Mediterranean coast of Israel (1931 - 1997).

Place	Gaza	Ashqelon	Ashdod	BatYam	Herzliya	Hadera	Haifa
Distance	0	20	40	63	83	115	150
long term yearly average	400,000	360000	300000	275000	230000	170000	100,000

6.4 Discussion of the longshore sediment transport results

An integrated sediment assessment was derived using the wave data to characterize the average longshore transport on the Mediterranean coast of Israel.

As we can see, the results for Ashdod and Gaza are similar to previous assessments. The new assessment obtained at Haifa is more in agreement with the results of Toms and van Holland but in disagreement with those obtained by Chesher and Dearnaley (1996), Rosen (1998b), Perlín and Kit (1999) and Jorgensen and Mangor (1999). Search for the disagreement reason did not lead to any clear reason, except that perhaps the interpolation to hourly data might have affected the results.

Other reasons could be different assumptions. As pointed out also by Kamphuis (1998), who investigated in more detail the reasons for uncertainties in sediment transport predictions, any such assessment may easily vary between 50% to 100% due to the following reasons:

a) Different definition of the coast angle, which may lead for 1 degree error in transport values of some 15,000 m³/year in the central part of the coast and even more in the northern part of the coast,

b) Uncertainty in wave direction may lead again to errors. Also in some cases the linear vectorial interpolation may not be correct. Furthermore, it must be pointed out that most of the present directional wave measuring still suffer of inaccuracies in determination of the wave directions because the assessment is based on point measurements and not wave arrays. However, a recent development may allow in the near future to obtain more accurate directional information.

c) Uncertainty in storm behavior may be such that simple interpolation between rare data will lead to wrong values.

d) Low prediction capability by simple computational methods which can not take into account the effect of various sand grain sizes, sand availability, presence of rocky bottoms, etc.

All these lead to the conclusion that additional physically sound information such as erosion and deposition volumes from bathymetric maps and waterline displacements in time are necessary to obtain a reliable assessment of the longshore sediment transport regime.

The actual yearly sediment transports may significantly fluctuate from the above average values, depending on the occurrence of strong storms on the one hand and the availability of sand on the sea-bottom. The estimated volumes of yearly averaged longshore sand transports were based on the reduced sand availability in the region, due to the presence of two major bands of rocky kurkar ridges along most of the coastal sector, in water depths of about -3 to -4m and -10m to -14m, covered with only a thin sand layer or exposed, and probably completely exposed to the hard and rough rocky bottom during storms.

Consequently, the net longshore transport along the coast is seen as a stochastic process which is considered grossly to behave in a saltation manner, mild accumulation to the south of coastal structures and mild erosion to the north of these structures during relatively calm periods. This is followed by transfer of large volumes from the southern side deposits to the northern side coasts during very stormy years occurring once every 10 or more years. These storms however, are also

associated with sediment reserves depletion to the offshore. During the intermediate "calm" years the beaches are recovering from the stormy years by widening the dry beach-face from on-shore sand transport, losing a significant part of these sands to the shore dunes by wind. In certain mild years, the occurrence of west-north-westerly storms may lead to reversal in sediment transport in the northern part of the coastal sector.

The net northward directed transports occurring in very stormy years may however reach two times more or even larger values, depending on the direction and heights of the waves. On the other hand, in calm or moderate years, the net longshore transports can be significantly smaller. Furthermore, due to the shift in the orientation of the coast as well as due to the shift in the direction of the incident waves along the coast, there may be periods of reversal in the net transport confined to the shallow water (0-3m depths) in the region north to Shefaiim.

Hence, the results assessed in Table 7 are considered those representing the long term average characteristics of the longshore sediment transport on the Israeli coast for the past 70 years. Nevertheless, from the assessment obtained for the 5 and 7 years of data, it is obvious that we can not consider the longshore transport as a constant transport in time. On the contrary, it is clear that during rare and strong storm events, occurring once in 15 or more years, the northward longshore sediment transport rate would have to be much larger in order to transport sand beyond the Carmel headland and deposit it in Haifa Bay. On the other hand, in mild wave weather years, which may extend from a few to some 10 to 20 years, a weaker but southward directed net transport may be encountered in the region between Shefaiim and Haifa..

Given the fact that the sea-bottom of the coast south to Haifa is presently covered with a relatively thin layer of sand and partly even completely exposed kurkar rocky bottom, the future may even look worse in respect to the situation of the beaches in the northern part of the Israeli coast, probably at least from Atlit northward.

If during mild years sand is transported southward, perhaps when a big storm comes there will not be enough sand available to reach Haifa before the storm decays to continue bypassing the Carmel headland at the same old rate. With time this may lead

to further depletion of sand in this region which has already taken place as definitely proven by the information presented in Figure 1. Consequently, the figures assessed as net long term longshore transports for the past 70 years, might be reduced in the future in the Haifa region by an unknown amount, becoming longshore sediment transport capacities only. The conclusion is that remedial measures of the present situation are necessary. Such measures could include artificial beach nourishment from external sand sources, including the sand which is deposited in the Haifa bay.

Most of the longshore sand transport (70%) occurs within the shallow surf zone. A smaller part is transported longshore beyond the predominant surf zone as a combined effect of sediment resuspension by wave orbital velocity stirring the bottom and longshore transport by the northward oriented current circulation.

6.5 Onshore-offshore sand transport.

The assessment of the onshore-offshore transport of sediments is rather difficult and less accurate than even the longshore transport. As mentioned in the Shore Protection Manual (US Corps of Engineers, 1984) the "quantitative engineering guidance has been more firmly established for rates of longshore transport than for rates of onshore-offshore transport. Predicted transport rates procedures can disagree by more than an order of magnitude, and no procedure can be recommended presently."

In reality, for the Mediterranean coast of Israel, very little is known about the onshore-offshore transport, especially in regards to quantitative estimates. Qualitative descriptions were obtained in the past by a number of field studies (Eitam (1974), Bowman et al. (1988a,b; 1992). One of the first assessment regarding the rate of cross-shore transport was derived by Per Bruun (1978, unpublished assessment) who analyzed successive bathymetric maps at Hadera coast and assessed a yearly rate of about 100,000 m³. New insight in the onshore-offshore transport became recently available with the application of numerical two dimensional models such as MIKE21, PISCES, DELFT3D/2Dh. However, as these models are area models, the onshore-offshore transport is automatically integrated with the longshore transport, making difficult to produce a "representative" onshore-offshore transport value. According to mathematical formulations and small scale physical models (Rosen,

1981), it is estimated that during wave conditions of mild deep water steepness (below 0.025) a net onshore transport is obtained while for steeper waves a offshore transport is obtained. Given the normal wave conditions at the Mediterranean coast of Israel, and using literature formulations, it is estimated that onshore transport is obtained for waves with deep water significant heights of roughly 1m, and offshore for higher deep water characteristic wave heights. Kit and Pelinovsky (1998) recently presented a new approach regarding modeling of onshore-offshore transport, but again the outcome can not be taken as representative of the Israeli coast onshore-offshore transport.

Finally, the cross-shore distribution of the longshore current between two sites, as obtained also in the present study may in theory provide a quantitative assessment of the onshore-offshore transport if a budgeting equation with only one variable can be obtained. As described further in this report, this is not the case, so in fact a quantitative reliable assessment of the onshore-offshore transport can not be presented.

7.COASTAL SAND BALANCE

7.1 General

The concept of coastal sand balance (also termed sand budget, or sediment budget) is, in essence, an application of the principle of conservation of mass to the littoral sediments (Bowen and Inman, 1966). The balance comprises all sand gains and losses of a defined coastal compartment. The gains are inputs of sand from rivers, longshore sand transport, onshore transport, cliff erosion, wind-blown sand, biological production and artificial deposition of sand on the beach or the sea bottom. The losses include longshore sand transport out of the area, offshore transport, wind blown sand from the beach and mining. If the volume of the gains does not equal that of the losses there should be a change in the sand volume of the coastal compartment studied. This should be manifested as beach erosion and/or beach profile steepening, if the losses are greater than the gains, and as beach accretion and/or profile moderation if it is *vice versa*.

The difficulty with the concept of coastal sand balance is that it is virtually impossible to prepare it in quantitative terms. It is practically impossible to measure some of the above mentioned balance components. Even those which are measured, are not measured directly and various assumptions are involved in the measurements. Therefore, the sand balance provides only a gross estimate of the magnitude of its components. It should be treated as a conceptual balance and as such, its importance is that it provides the coastal manager with a basic conception of the processes which control the coast that is under consideration and an idea of their relative importance.

7.2 Natural Sand Balance

The Israeli coastal compartment, which is used for the preparation of the coastal sand balance, is part of the Nile littoral cell. Its southern boundary, in Ziqim, is not a natural but a political boundary whereas its northern boundary, in Akko, is a natural one. Sand does not migrate northward of Akko and Nilotic quartz sand is not found beyond Akko to the north. The eastern boundary is the back of the beach which is either the foot of the cliff or the dune or the vegetated area found beyond the back of the beach. To the west, the boundary of the compartment is the edge of the inshore zone. This is the most dynamic part of the coast and most sand movement occurs there. Still, sand is found seaward of that zone as far as the 30 m depth contour line.

The most important contributor of sand to the Israeli coast is the longshore sand transport from the south. According to findings of this study, the long-term mean input by this agent is 400,000 m³/year. Coastal cliff erosion is another contributor of sand to the coastal system. Various studies, using different methods, resulted in remarkably close values of rate of cliff retreat. Ron (1982) reports on an average rate of coastal retreat at Netanya of 1.55m/year. Perath (1982) estimates the retreat of the Sharon Escarpment by 20 cm/year, and according to Schwartz (1997) the cliff of the Michmoret - Givat Olga coast has eroded during 1991-1996 at an average rate of 24 cm/year. Almagor *et al.* (1998) used these figures to estimate the annual sand input from cliff erosion as 200,000 m³.

On the basis of the volume of sand trapped in front of the main breakwater of Haifa Port and the longshore sand transport rate derived from computation of wave energy flux, the loss of sand to Haifa Bay is 100,000 m³/year. Two other losses must be taken into account: sand blown landward by wind and sand carried offshore from the inshore zone. Goldsmith *et al.* (1990) measured the rate of sand blown from beaches on the southern and northern parts of the Israeli coast using sand traps. They found that the mean rate of sand loss is 42,000 m³/year. In view of the magnitude of rates of longshore transport and the vast areas covered with sand dunes in the coastal plain, this value is a gross underestimation in our opinion.

Therefore, the present state of knowledge regarding the Israeli coastal sand balance is that the annual gains are 600,000 m³ and losses 100,000 m³, leaving an unaccounted volume of 500,000 m³. This volume is lost either landward, offshore or both, but we cannot say at what rate. Similar values were obtained by Almagor *et al.* (1998) except that they accept the value of sand lost to land as suggested by Goldsmith *et al.* (1990), thereby claiming that 450,000 m³/year escape seaward.

7.3 Anthropogenic Interference in the Sand Balance

7.3.1 Removal of Sand by Mining

Sand has always been used for building purposes but after the First World War, when massive immigration to Israel started, beach sand mining gained momentum. This mining lasted until 1964 when it was prohibited by the government. According to Neev *et al.* (1963) a total volume of 6.75 million m³ was mined from the Israeli beaches between 1948 and 1963 (in Tel Aviv region since 1936). As intensive building in Israel has started before these dates, it would be safe to generalize that 10 million m³ were mined from the beach during the 25 years period following the end of the First World War. Accordingly, the mean annual volume of sand mined is 400,000 m³. Indeed, written records state that in 1963 alone a volume 900,000 m³ was mined (Zifzif Commission, 1964). The significance of these figures is that there were years during that period that the mining rate surpassed that of the natural input of sand into the Israeli coast.

7.3.2 Entrapment of Sand by Coastal Structures

Sand which was trapped by coastal structures cannot be considered a loss in the coastal sand balance because it remains in the coastal compartment which is under study. However, within the compartment it is not allowed to move in its natural course, thus causing a loss to the beaches upstream of the trapping site. An attempt was made to estimate the volume of sand which was trapped by structures along the Israeli coast.

Two sorts of data were used for this estimate. The first are volumes of sand trapped as computed from depth differential maps. The other is by measurements made from aerial photographs. The latter one was applied to tombolos formed behind detached breakwaters. This is only a rough estimate as the aerial photographs were not orthophoto rectified and the water depth at the apex of the tombolo was not measured but estimated. According to Table 8 a total of more than 12 million m^3 was captured by the structures. With the exception of Haifa Port, coastal construction along the Israeli coast started in 1960 with Ashdod Port. If the volume trapped by Haifa Port is disregarded, because it is located in the sediment sink and therefore does not affect the coastal sand balance, we are left with some 9 million m^3 of sand trapped by structures during the last 40 years. On a long time average this is more than 200,000 m^3 /year of sand which is removed from the coastal system, or about a third of the annual input.

8. SAND RESERVES ON THE CONTINENTAL SHELF

The need for aggregates as building material in Israel has been on the increase since the beginning of the century. Beach sand was the major source material for building until it was realized that sand mining damages the beaches and the government stopped its mining in 1964. Other sites for aggregates had to be sought and one of these was the seabed. Exploration for aggregates on the Israeli continental shelf have been carried out and these provide us with quantitative estimates of sand which is present there.

Table 8. Volume of sand trapped behind coastal structures (in 1,000 m³)

Site	Volume	Sources
Rutenberg cooling basin	2,400	This study
3 tombolos south of Ashqelon Marina	128	This study
Ashqelon Marina	unknown	
3 tombolos north of Ashqelon Marina	26	This study
Ashdod Marina	266	Chesher and Dearnaley (1999)
Ashdod Port	4,500	Golik <i>et al.</i> (1996b)
Tel Aviv, Gordon Marina to Klor Park	186	This study
Tel Aviv, Hilton tombolo	50	This study
Tel Aviv, Sheraton tombolo	95	This study
Tel Baruch tombolo	30	This study
Herzliya Marina complex	800	Baird & Assoc., 1996
Netanya southern tombolo	85	This study
Netanya northern tombolo	63	This study
Hadera cooling basin	unknown	
Hof HaCarmel tombolo	67	This study
Haifa Port	4,000	Golik <i>et al.</i> (1996b)
Total	12,633	

The earliest study aimed at prospecting for aggregates on the seabed off Israel was carried out in the late '60s by Neev *et al.* (1970). This study consisted of shallow seismic profiling and vibracore sampling. It showed that sand is found beneath the silt at water depths of 30-40 m.

Another aggregate-prospecting survey was conducted in the early 70's by the Geological Survey of Israel. This was a feasibility study which covered many aspects related to aggregate exploitation (Bruins, 1976). It included seismic surveys and drillings aimed at locating kurkar and sand resources and determining their quality and volume (Hall and Bakler, 1975). The survey concentrated on Haifa Bay but covered also offshore kurkar outcrops opposite Caesarea, Giv'at Olga, Netanya, Tel Baruch and Yafo. The conclusion of that study was that exploitation of aggregates could be recommended only in Haifa Bay where a ridge protects the waterline, whereas in the other areas such protection of the waterline is absent. The reserves of aggregates (down to 25 m below sea level) that were found in Haifa Bay were 34 million m³ of unconsolidated aggregates and 151 million m³ of kurkar rock.

Nir (1984) estimated the volume of sand on the continental shelf using shallow seismic records, findings in offshore borings and theoretical considerations of sedimentation rates since the Holocene transgression. According to his computations, a volume of sand of some 6.5 billion m³ is found at 0-30 m water depths, and 3.5 billion m³ at 30-120 m water depths, between Rafah and Haifa Bay.

Golik *et al.* (1993) used boomer, sparkarray and ORE seismic records which have been surveyed since 1968 by the Geological Survey of Israel and Israel Oceanographic and Limnological Research (IOLR), in order to estimate the volume of unconsolidated sediment (sand and mud) on the inner part of the continental shelf. They estimated that 3.8-4.9 billion m³ of unconsolidated sediment are found between water depths of 15 and 30 m, and that the volume of sediment decreases from south northward.

Golik *et al.* (1999a) carried out a shallow seismic survey aimed at exploring aggregate reserves as fill material for possible construction of artificial islands offshore Israel. This survey covered the continental shelf off the Hadera-Ziqim coastline between water depths of 25 to 70 m. The survey was accompanied by sub-bottom sampling using vibrocores, CPT tests and drillings (Fugro Engineers, 1998), and geotechnical analyses of the samples (Almagor *et al.*, 1998a). The results of these analyses were correlated with the seismic results which enabled determination of the volume and nature of the sediment on the continental shelf.

The results of this survey show that a volume of 1.3 billion m³ of sand is found at water depths greater than 30 m. This sand is covered by a layer of silt which gradually increases in thickness from zero at a water depth of 15 m to 25 m at a water depth of about 40 m where a seismic reflector obscures other reflectors beneath it. In order to locate sites in which large concentrations of sand with a relatively thin cover of silt are found, the ratio of sand to overlying silt thickness was computed and plotted as a ratio map. At water depths greater than 30 m, in four areas that ratio was greater than 1: opposite Hadera-Netanya, Ga'ash, Yafó and Ashdod-Ziqim (Figure 40). The volumes of sand and overlying silt were computed for each of them. The results are given in Table 9.

Table 9. Areas and volumes of sand and overlying silt, where sand/silt thickness > 1.

From Golik *et al.* (1999a).

Location	Area (km ²)	Sand Volume (10 ⁶ m ³)	Silt Volume (10 ⁶ m ³)
Hadera-Netanya	9	48	13
Ga'ash	4	17	7
Yafo	2	11	5
Ashdod-Ziqim	37	327	96
Total	52	403	121

Figure 40 and Table 9 show that there is a general trend of reduction in the sand volume on the continental shelf from south to north. This was also the finding of Golik *et al.* (1993). Therefore, an educated guess is that the volume of sand with a relatively thin cover of silt on the Israeli continental shelf, at water depths greater than 30 m, is approximately 500 million m³.

The results of the geotechnical analyses showed that the sand contains 35-50% silt and clay (grain size smaller than 75µm). As such, it does not fit as direct fill material for the construction of artificial islands from fear that this sand may liquefy in case of an earthquake. It might, however, be used for this purpose after cleaning the fine material from it or for the building industry or beach nourishment, but this must be further investigated.

9. SAND AND COASTAL MANAGEMENT

9.1 Sand Exploitation from the Continental Shelf

As mentioned above, significant quantities of sand are found on the continental shelf and their exploitation must be considered. Sand is found on the seabed between the beach and a water depth of approximately 30 m. At depths greater than 30 m the surface sediment is silt and clay. The sand in the inshore zone is highly dynamic. It moves in a longshore as well as an on-offshore direction causing seasonal formation

and destruction of bars and troughs. Any exploitation of sand from this zone is comparable to mining sand directly from the beach and it should therefore be forbidden.

The sand between the inshore zone and the 30 m depth contour is less dynamic. There is evidence that this sand moves in the longshore direction but very little is known about its on-offshore movement. The problem with mining sand from that area is that such activity will increase the bottom slope, enhance sand movement down slope, and disturb beach equilibrium. In the past it has been suggested to dredge sand from this area in very thin (50 cm) slices and thereby keep the bottom slope unchanged. This argument is misleading as after the first slice, a second and a third one will be dredged and then the bottom slope will be disturbed.

Therefore, from the point of view of sand management, it should be permitted to mine only "dead" sand from the continental shelf. Such sand is either that which is buried beneath the mud, at water depths greater than 30 m, or outcropping kurkar rock which does not participate in the coastal processes. However, outcropping kurkar hills located in water depths less than 15 m are actively affecting sediment transport processes on our coast, as recently shown by Toms and van Holland (1999). Their effect is mainly one of dissipating wave energy and reducing longshore and on-offshore transport. They use also as an important marine life habitat. If dredging of such kurkar outcrops would be considered, very detailed impact studies would be needed before decision making.

9.2 Sand Bypassing

It has been shown here that coastal structures are one of the two major causes to negative sand balance due to the sand trapped by them. Therefore, future construction of coastal structures should not be permitted, unless they are accompanied for their whole life by sand bypassing of the natural longshore transport rates. This is now becoming widely accepted but the question is at what rate to bypass sand? A simplistic answer to that would be at a rate which is equivalent to the mean rate of the natural longshore sand transport. This may be a reasonable approach for normal-weather years. However, the findings of sediment entrapment by Ashdod Port

and the Rutenberg cooling basin show that the longshore sand transport is a stochastic process. One severe storm that lasts only a few days may drive a quantity of sand equivalent to that driven in one or more "normal" years. Therefore the bypassing rate should be determined according to the volume of sand which was actually trapped. The implication is that seabed near coastal structures should be monitored in a routine manner and that the quantity of sand to be bypassed should be determined on the basis of this monitoring.

Another issue related to sand bypassing of coastal structures is the sand grain size. Generally, sand grain size decreases gradually from the beach seaward. The sand trapped by a coastal structure will therefore be coarser than that which manages to bypass the structure. In this sense, a structure acts like a filter allowing only the finer fraction to move in the downstream direction. Golik (1997b) showed that this is indeed the case at the Ashdod Port where sand trapped by the main breakwater is coarser than sand found away from the breakwater at the same depths. The implication of this process is that sand size on the downstream beaches will gradually decrease. As fine sand is much less stable on the beach, this change in sand size will enhance erosion on the downstream beaches. Therefore, it is the coarser sand, which is trapped at the root of the structure, that must be bypassed, or artificially provided downstream and not just some plain sand found anywhere upstream of the structure.

9.3 Coastal Development in Haifa

At the Haifa coastline, south of Tel Shiqmona, the direction of the longshore sand flow has not been clearly determined. If the flow is northward, as indicated by some evidence, construction of coastal structures may be permitted provided that they are built in succession from north to south. Beach accretion will occur on the southern side of the structure, and time should be allowed for the beach to regain equilibrium before the next, southern structure, is built. In this manner, no erosion will occur on the beach and the only consequence of developing this coast will be the cessation of sand flow into Haifa Bay.

However, if sand migrates along this coast from north southward, any construction of structures which penetrate from land seaward should be prohibited unless also here

sand bypassing is carried out. Without it such construction would cause beach starvation downstream of the structure. In view of the low rate of sand transport along that coast and the slow rehabilitation process that it is now undergoing, beach erosion would occur. The issue of natural sand flow direction in this area must therefore be thoroughly investigated.

10. CONCLUSIONS AND RECOMMENDATIONS

1. Sand removal from Israeli beaches during the 20th century due to entrapment next to coastal structures and by mining for building purposes, was more than a third of the natural sand input to the coast during that period. This resulted in a negative coastal sand balance, for which field evidence already exists. In view of the forecasted reduction of sand input due to the effect of the Aswan Dam and coastal structures on the coasts of Sinai and Gaza, the Israeli coast and its sand resources are under a serious threat.
2. Despite evidence indicating a negative sand balance on the Israeli coast, no signs of overall, significant beach erosion was found between Ziqim and Shefaiim. There is no information regarding general coastal erosion in the northern part of the coast between Shefaiim and Atlit yet this section is susceptible to coastal erosion as it is at the end part of the Nile littoral cell. As human activity that may interfere in the coastal processes of this coast has been rather negligible, it is recommended to carry out there analysis of the waterline position by means of aerial photographs. The results of such an analysis should show if general, not local, erosion has started to affect the Israeli coast.
3. Huge quantities (~4 billion m³) of loose sediment in which sand must be the dominant component are found on the seabed at water depths shallower than 30 m. Nevertheless, mining of this sand would cause sand depletion from the beach and it should therefore be forbidden. An estimated quantity of 500 million m³ of sand is found beneath a relatively thin cover of mud at water depths greater than 30 m. The exploitation of this sand should be examined.

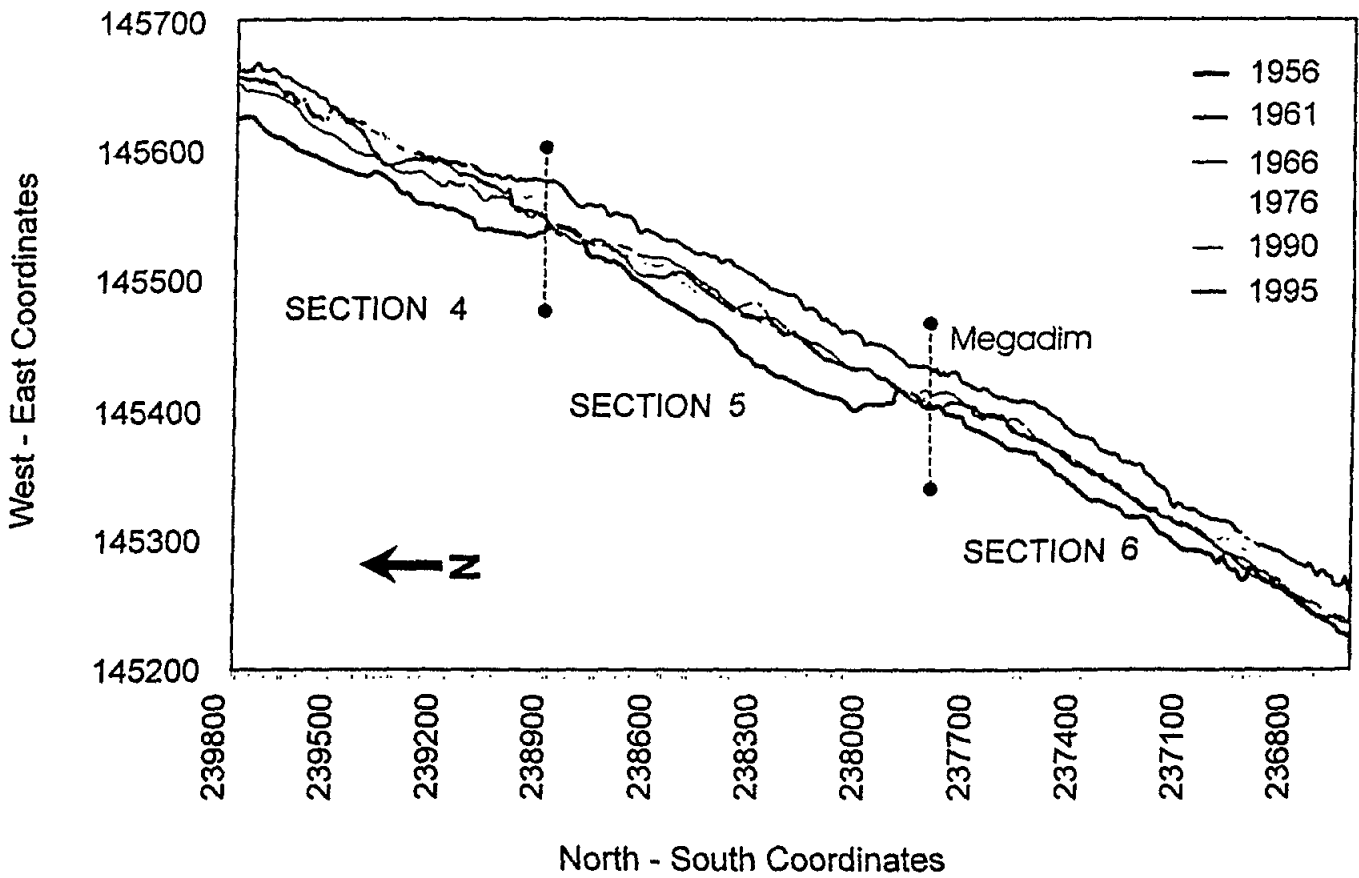
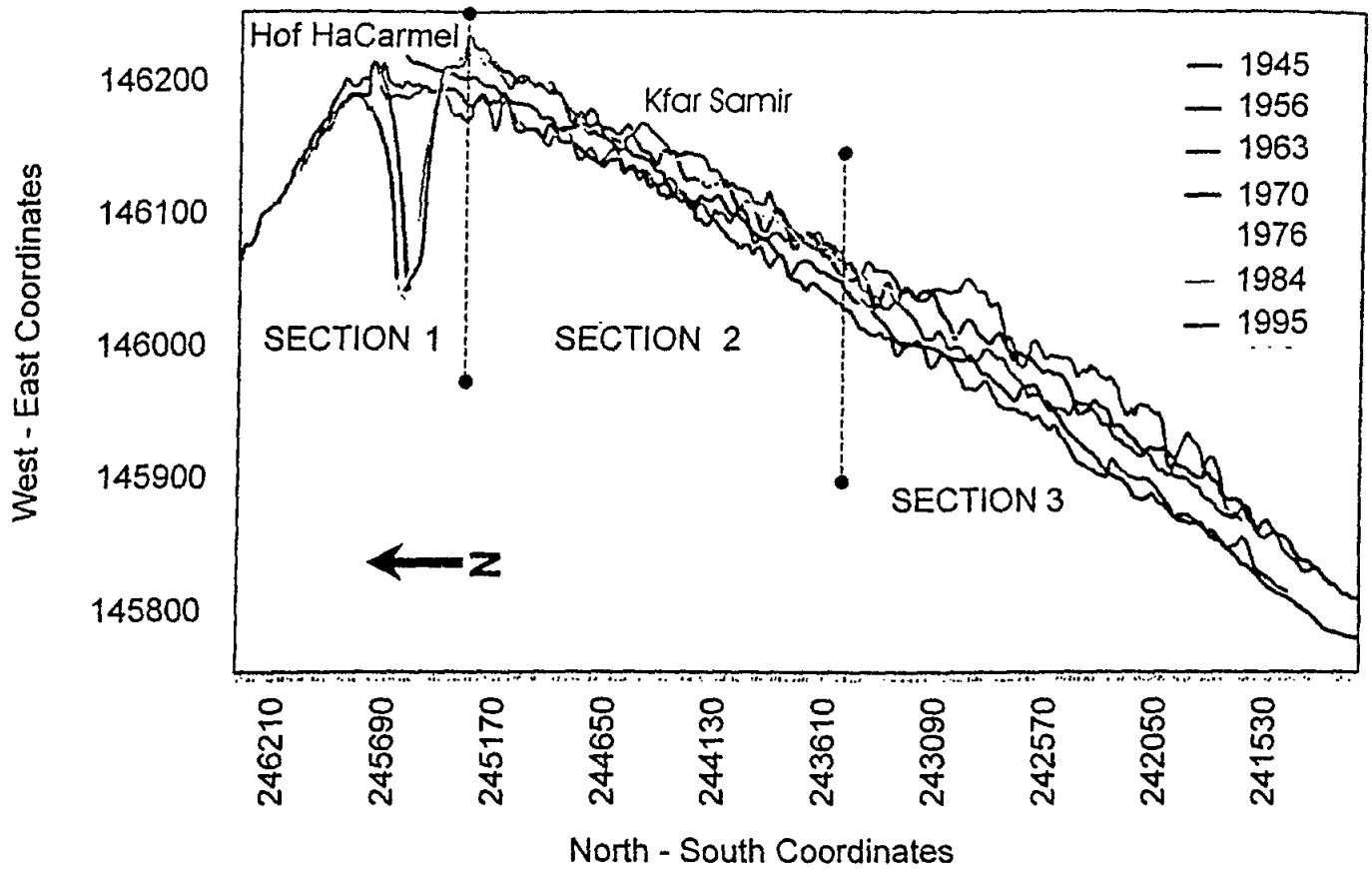


Figure 12. Hof Hacarmel - Megadim Coast with the 6 sections used for analysis of aerial photographs. From Golik *et al.* (1999b).

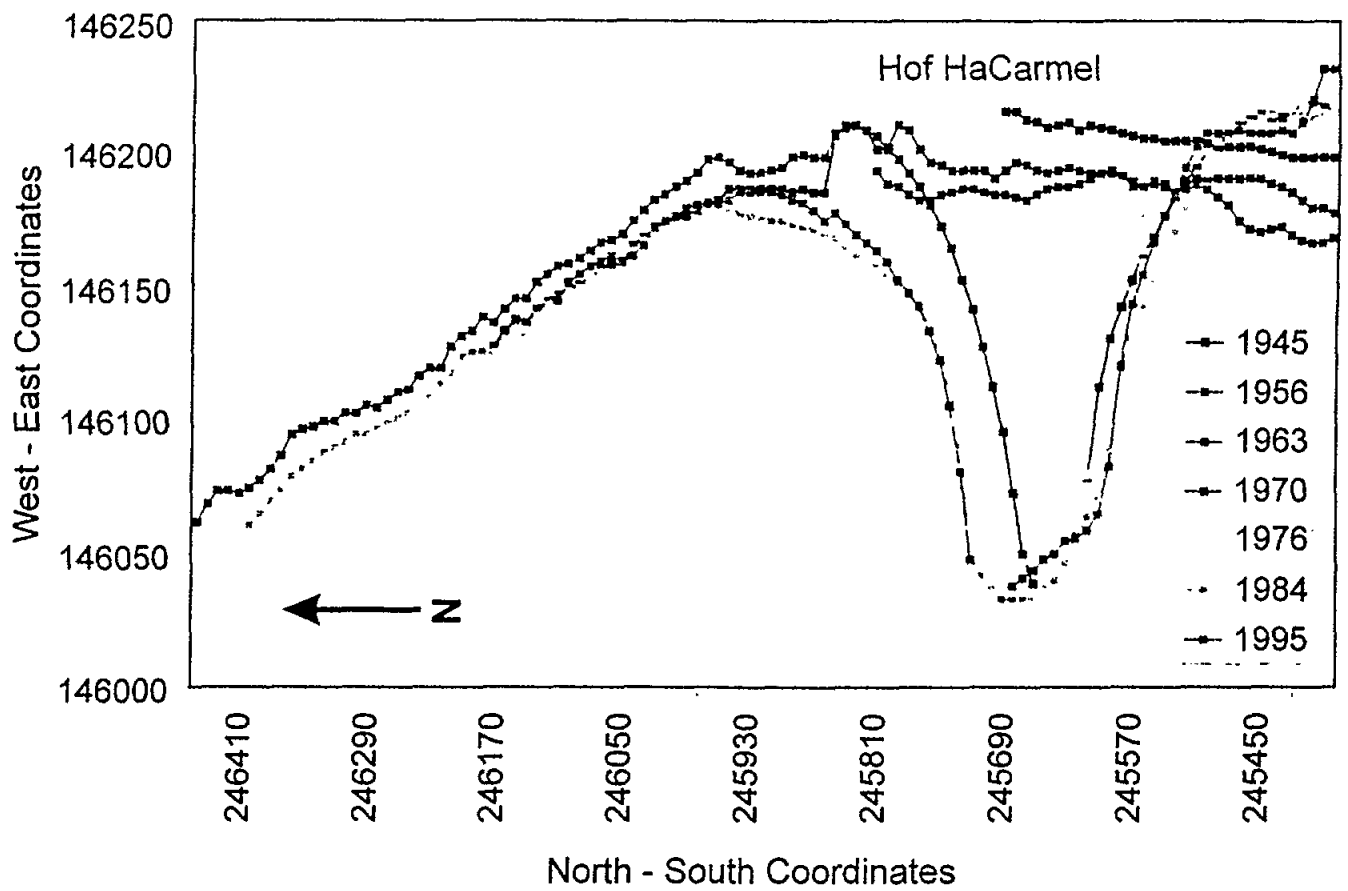


Figure 13. Waterline positions of Hof HaCarmel - Megadim Coast (section 1) between 1945 and 1995. From Golik et al. (1999b).

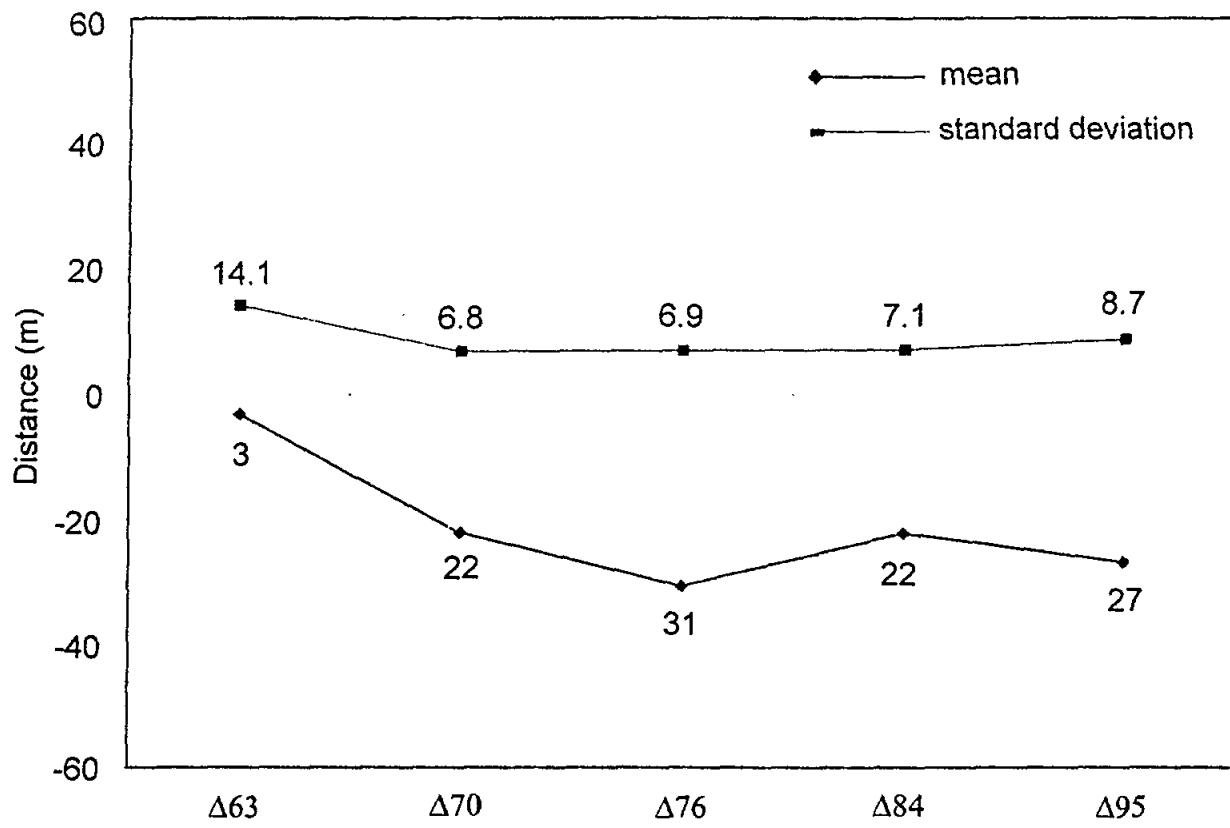


Figure 14. Change in the mean waterline position with time, relative to 1945 - 1956, for Hof HaCarmel - Megadim Coast (section 2). From Golik *et al.* (1999b).

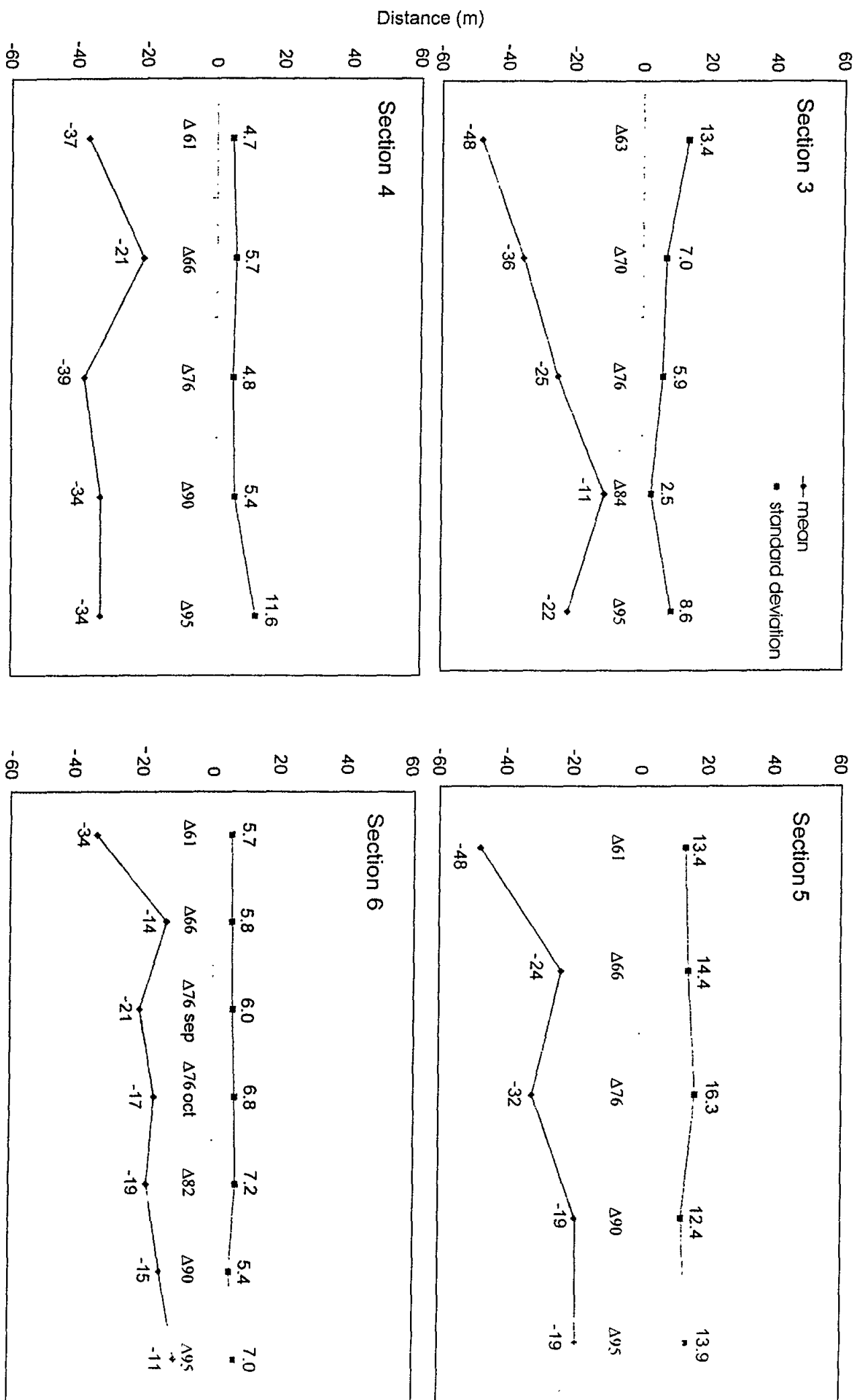


Figure 15. Change in the mean waterline position with time relative to 1956, for Hof HaCarmel - Megadim Coast (sections 3-6). From Golik *et al.* (1999b).

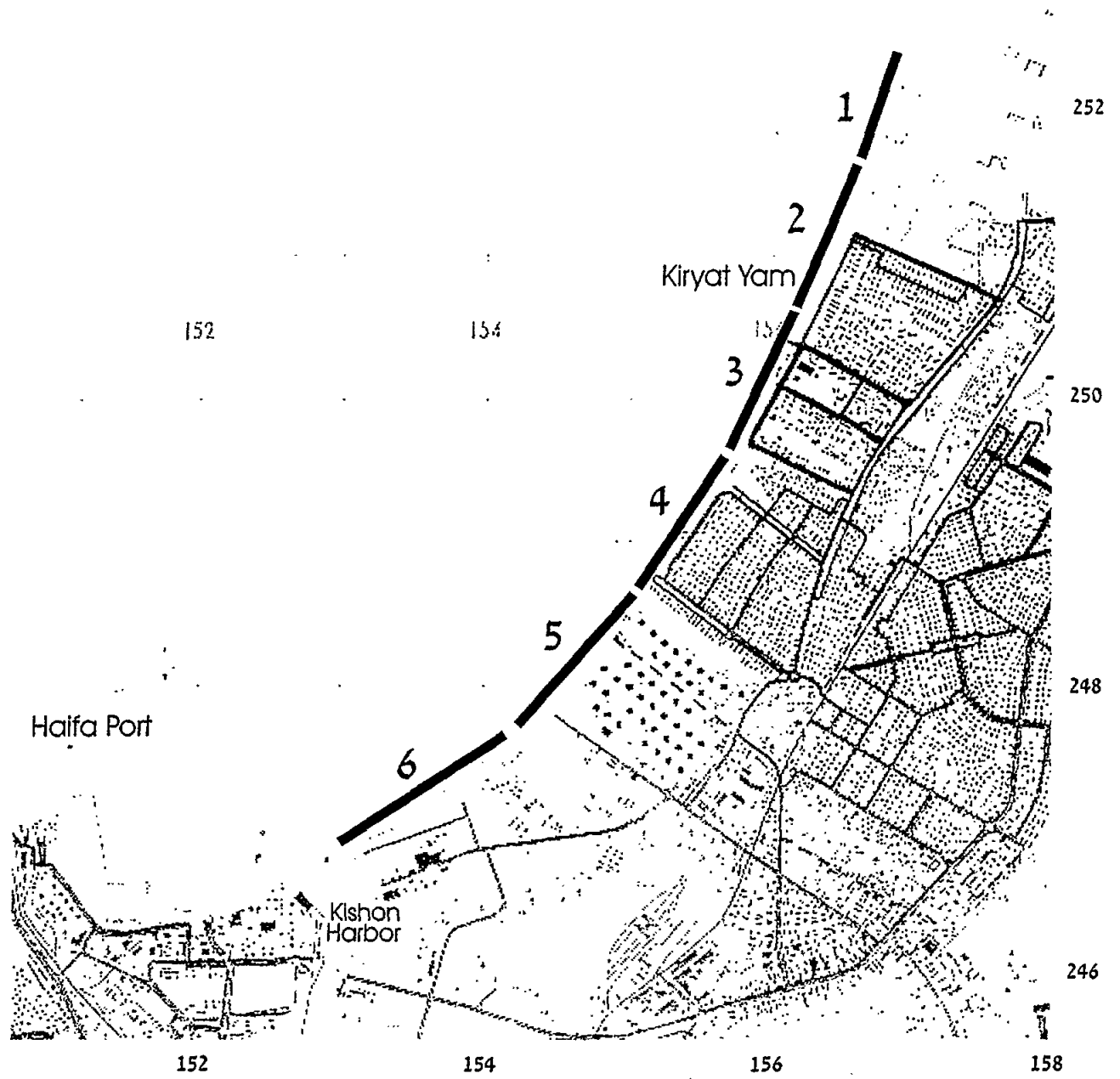


Figure 16. Kishon Harbor - Kiryat Yam Coast with 6 sections used for analysis of aerial photographs. From Golik *et al.* (1999b).

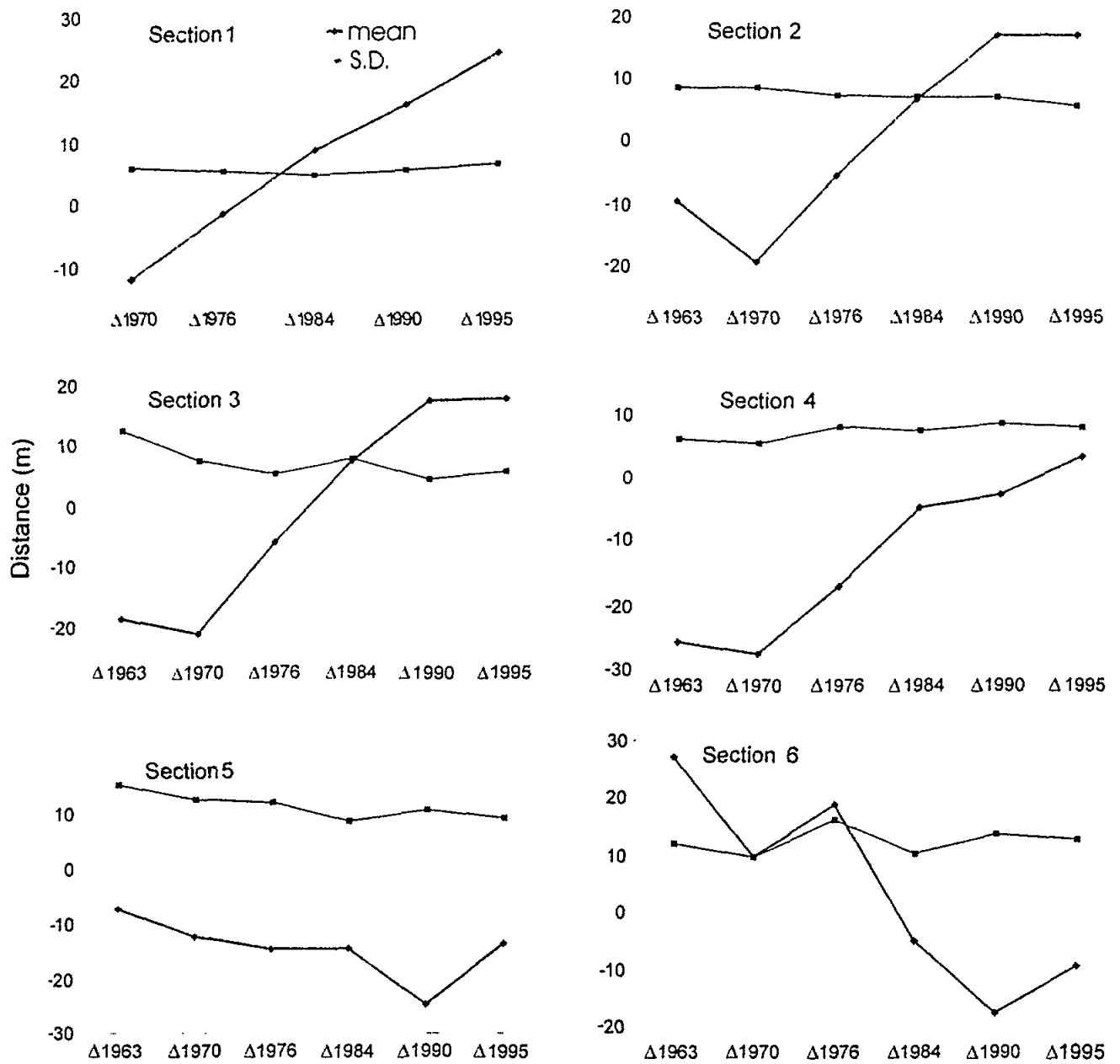


Figure 17. Change in the mean waterline position with time relative to 1945-56, for Kishon Harbor - Kiryat Yam Coast (sections 1-6). From Golik *et al.* (1999b).

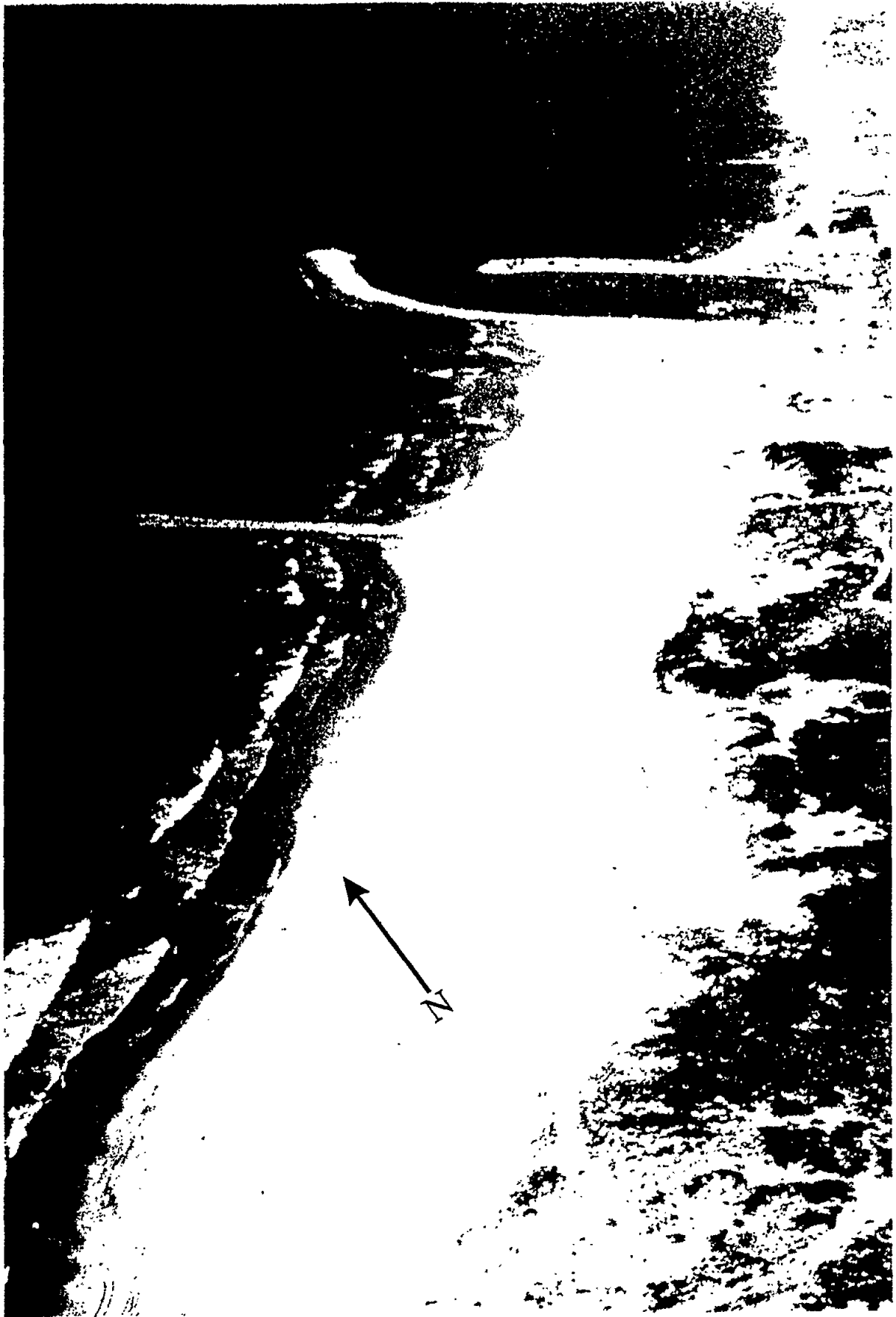


Figure 18. Oblique aerial photograph of the boat anchorage of Elat-Ahqelon Oil Pipeline Co. taken in 1978.

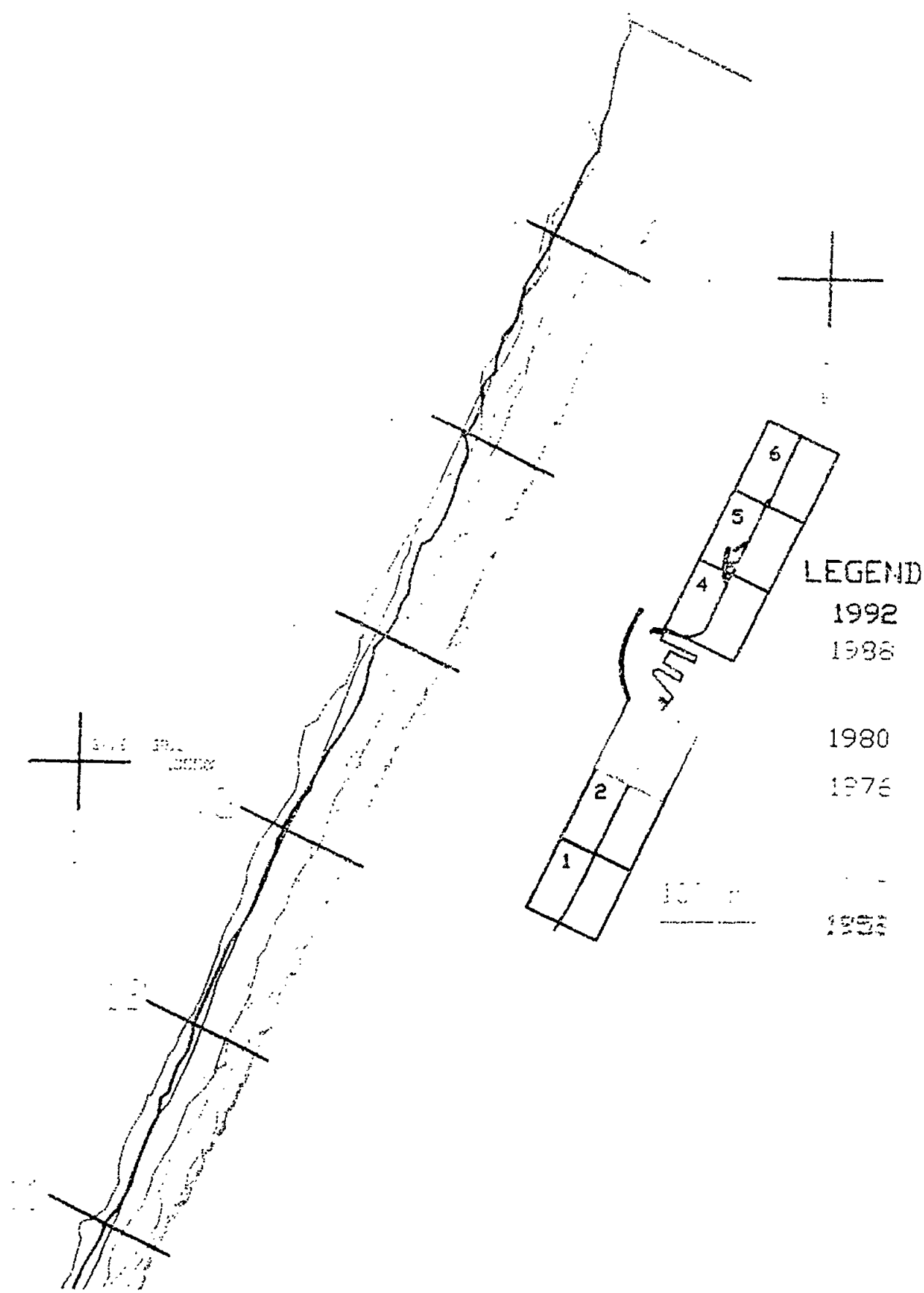


Figure 19. Positions of waterline south of Ashdod Port between 1958 and 1992. From Golik *et al.* (1996).

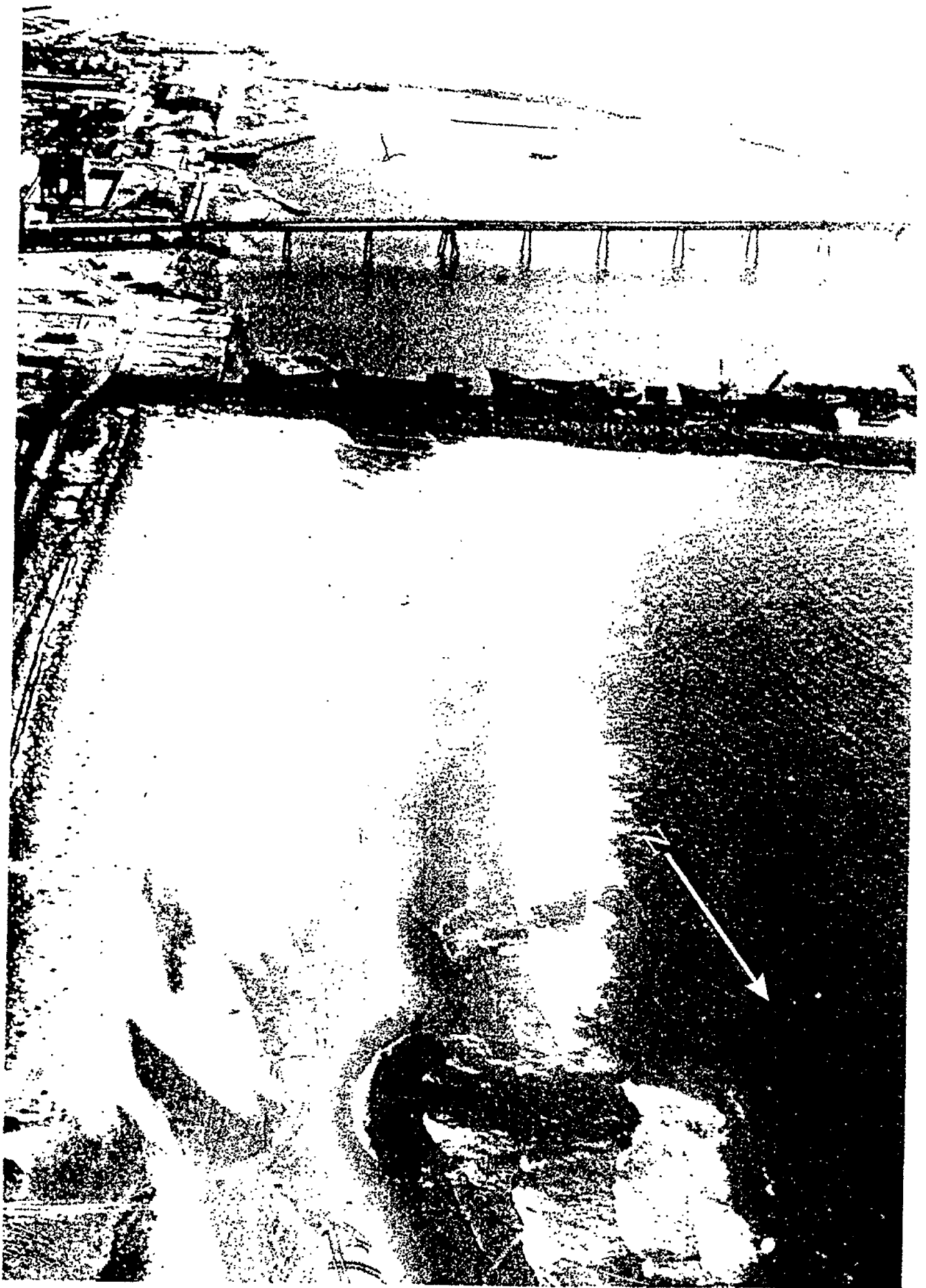


Figure 20. Oblique aerial photograph of Hadera cooling basin and the waterline adjacent to its lee breakwater.

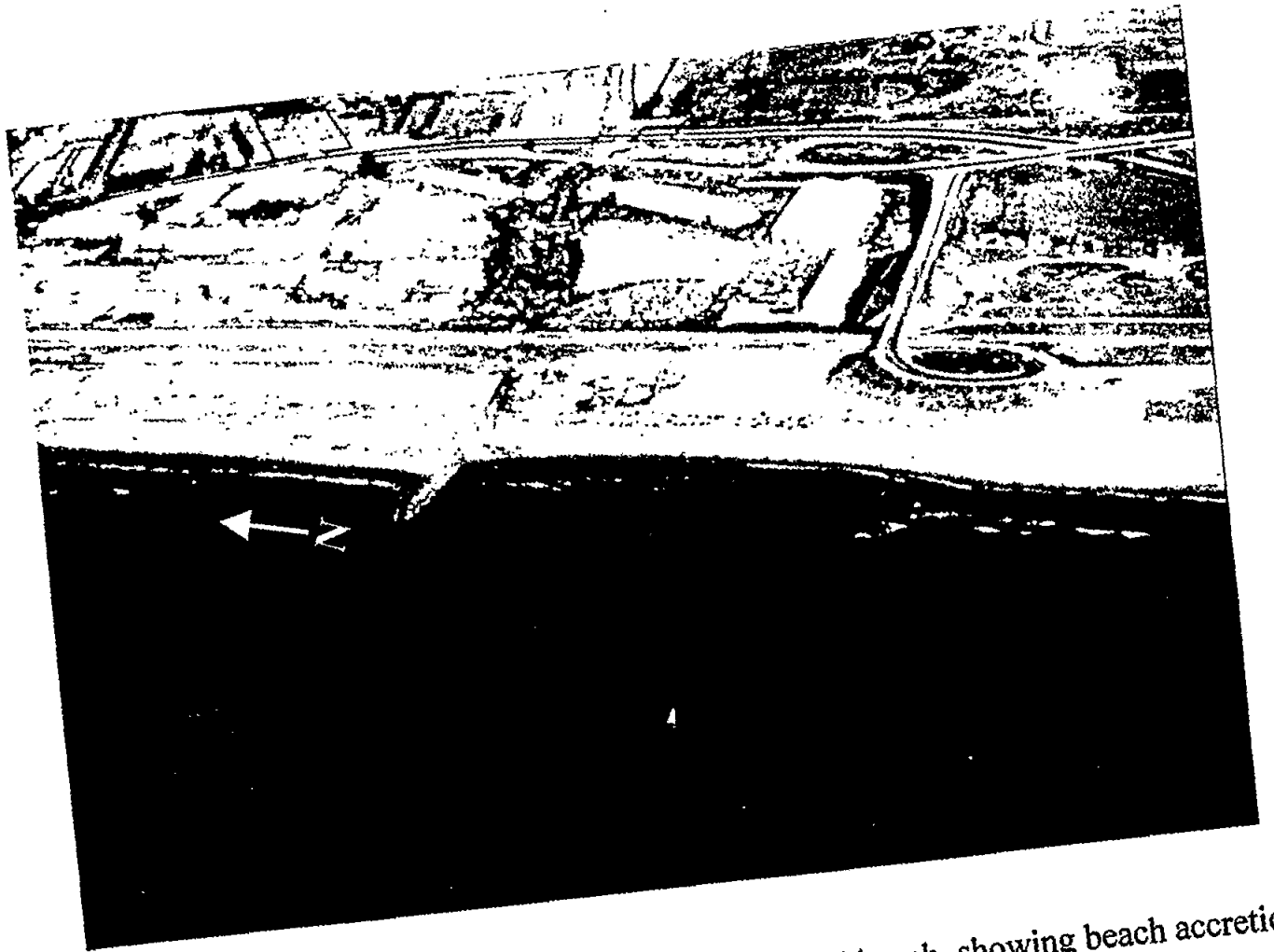


Figure 21. A small groin, 2 km south of Hof HaCarmel beach, showing beach accretion on its northern side. From Golik *et al.* (1999b).

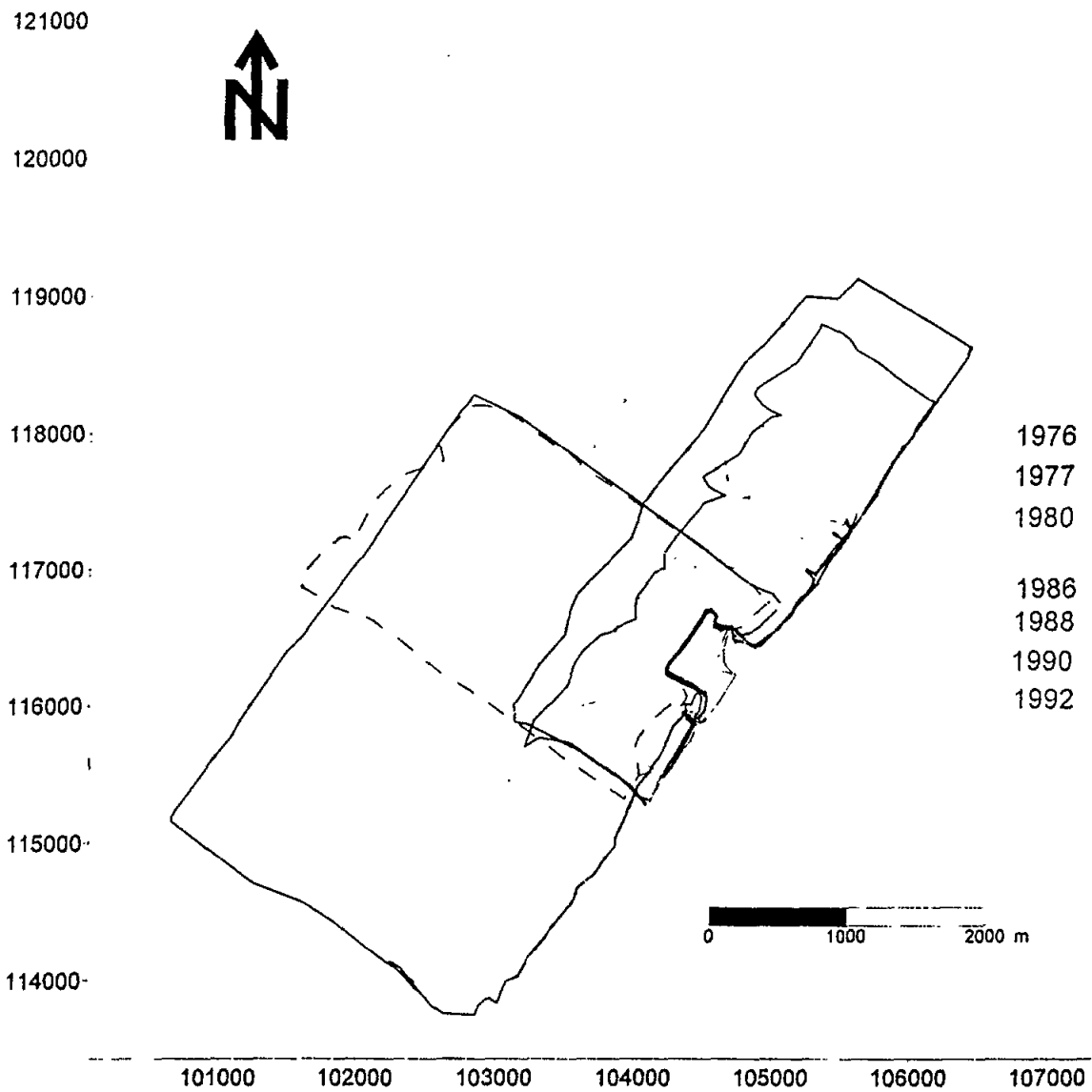


Figure 22. Area covered by each of the bottom surveys off the Rutenberg cooling basin.

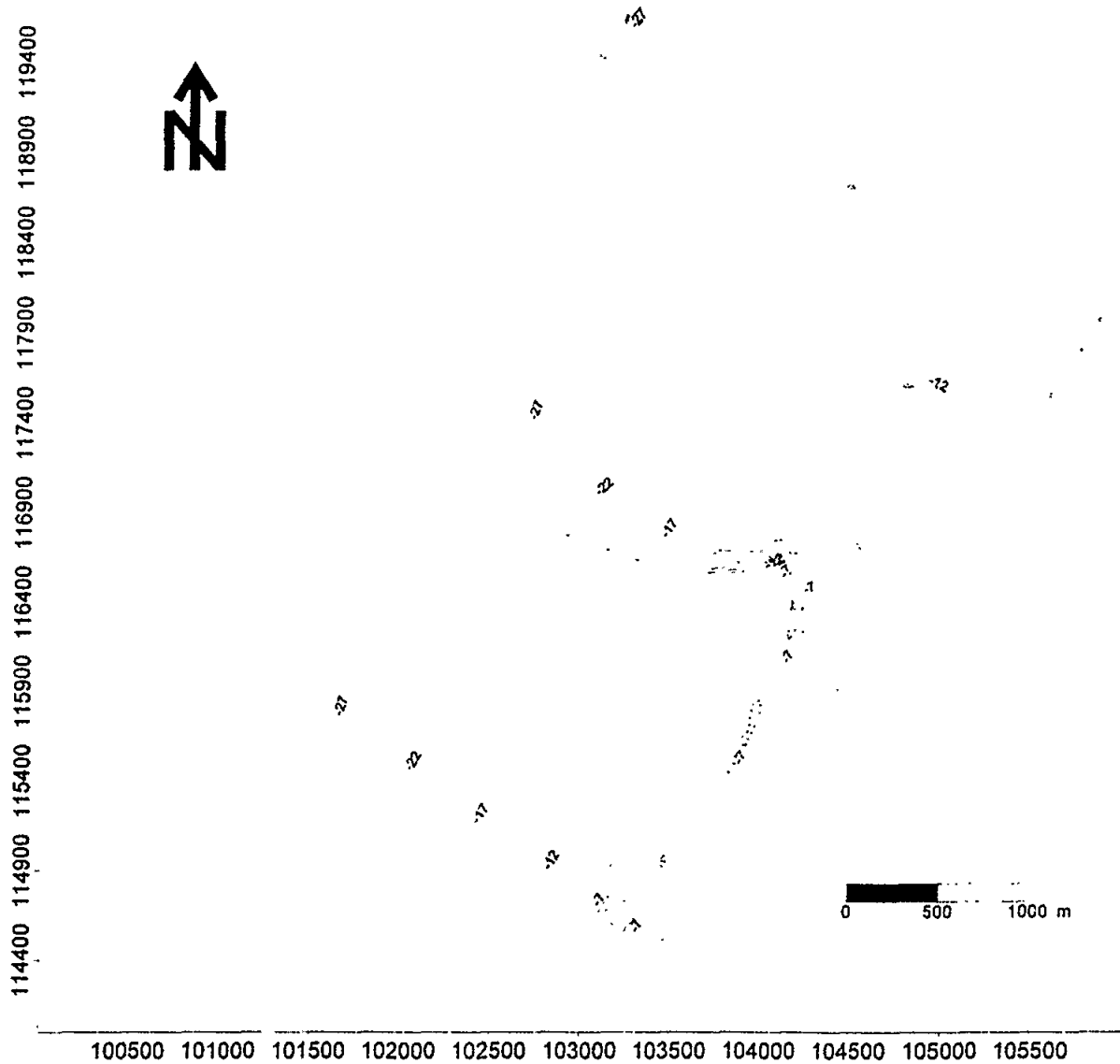


Figure 23. Bathymetric chart showing 4 canyons that incise the sea bottom off Rutenberg cooling basin.



Figure 24. Positions of canyon axes, offshore Rutenberg cooling basin, between 1976 and 1995, and area used for volume computations.

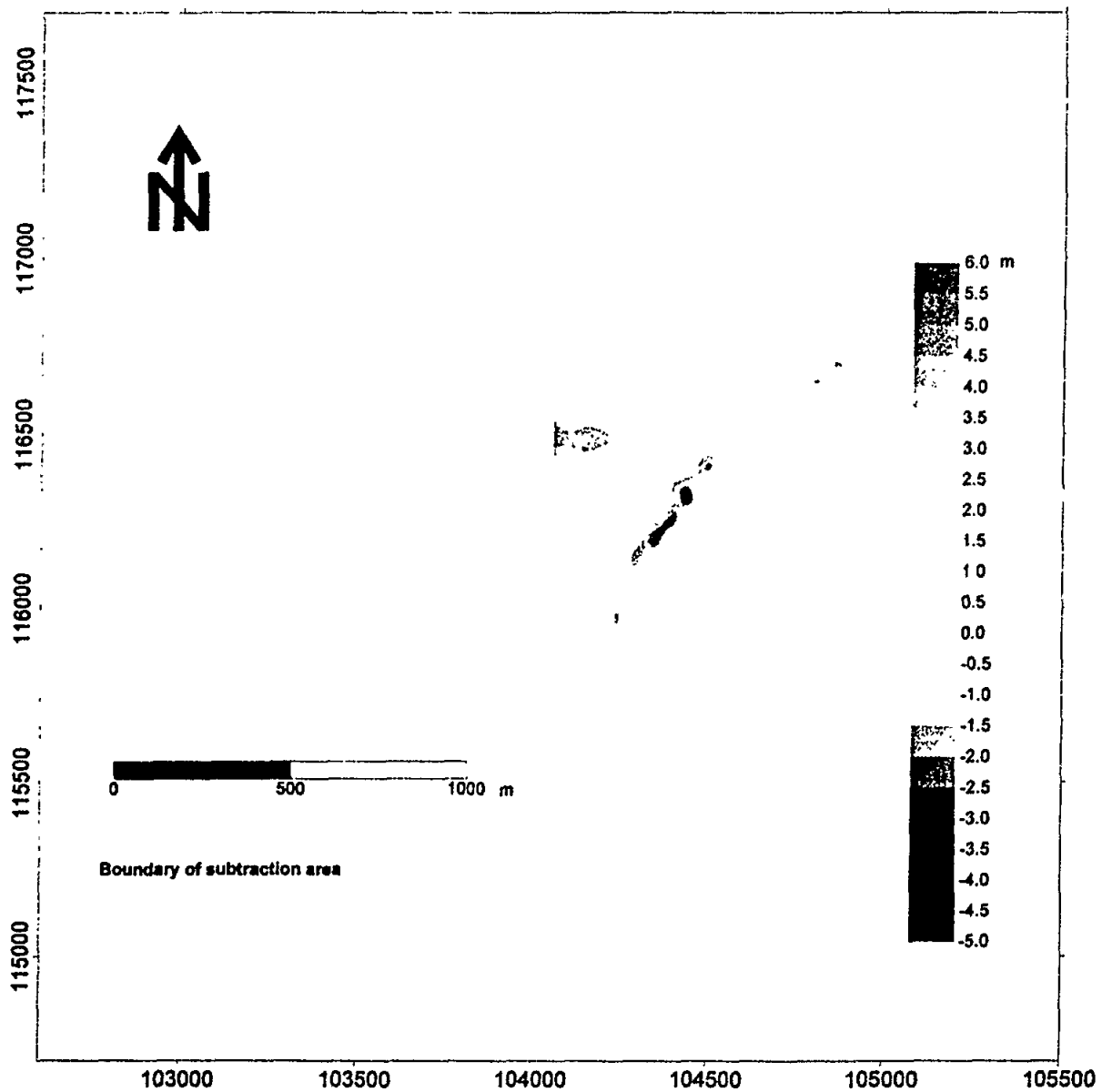


Figure 25. Depth differential map for the period of November 1976 to May 1982 in front of the EAOP boat anchorage.

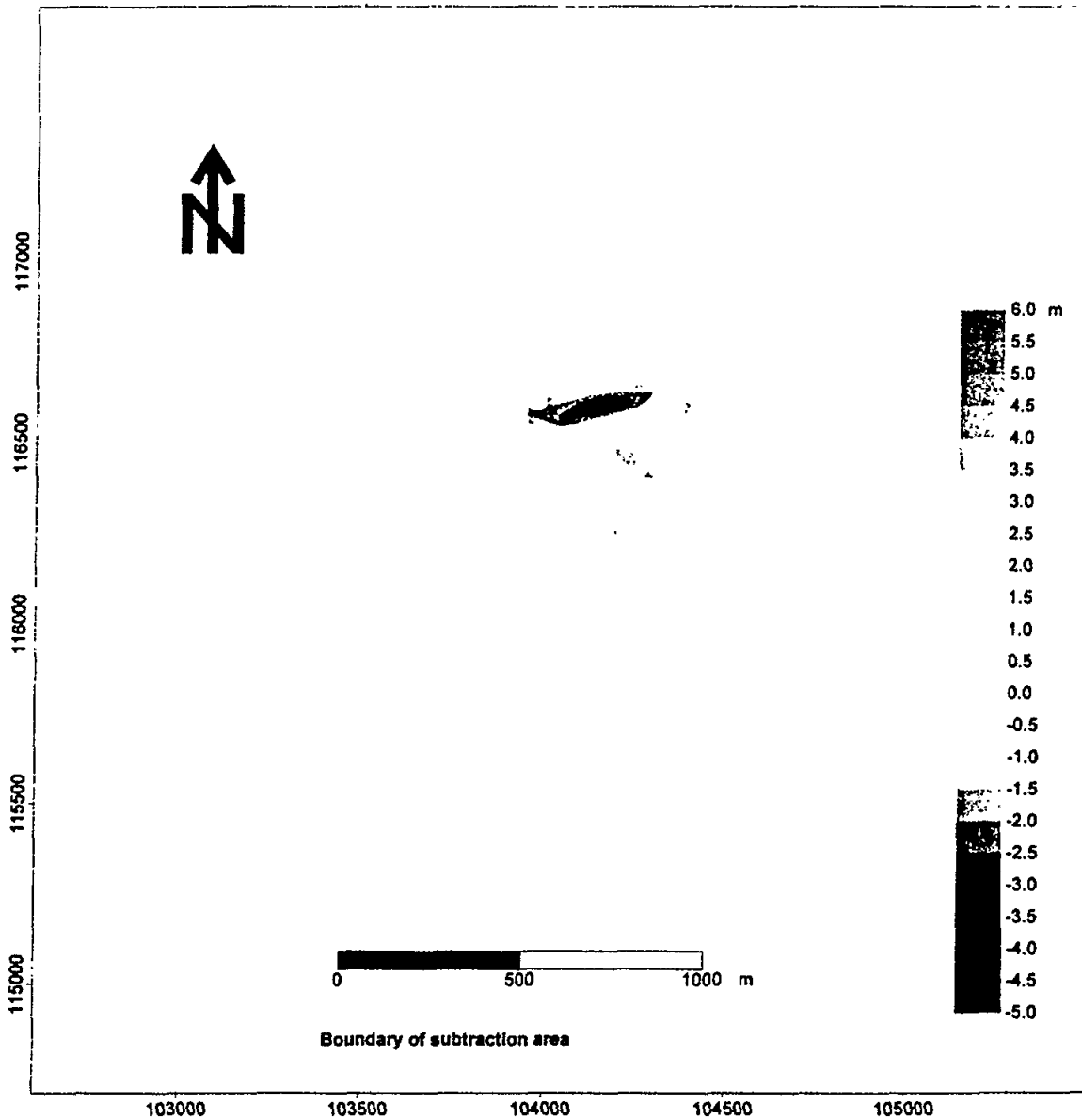


Fig 26. Depth differential map for the period May 1982 to November 1986 in front of the Rutenberg cooling basin.

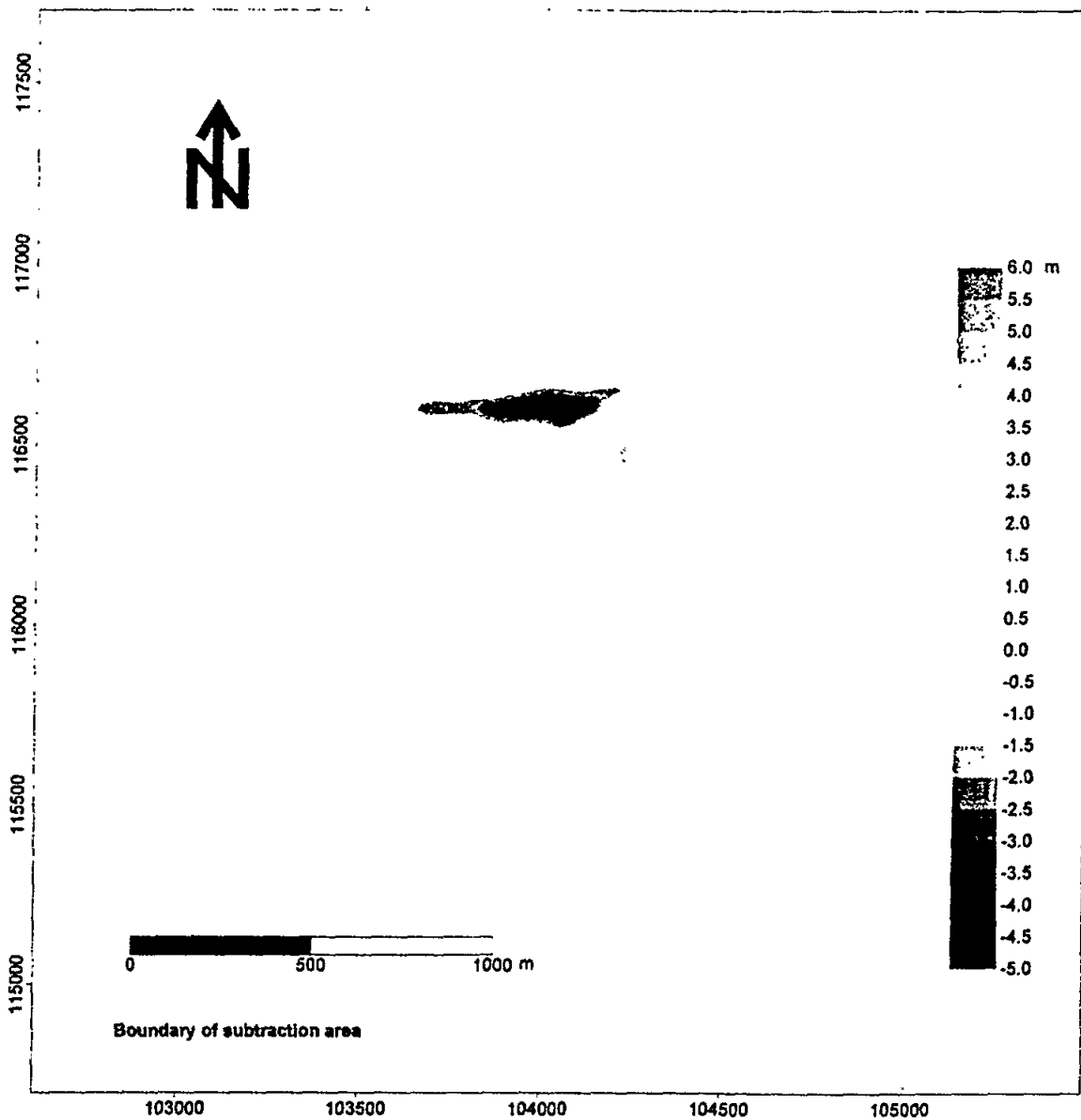


Figure 27. Depth differential map for the period May 1982 to December 1991 in front of the Rutenberg cooling basin.

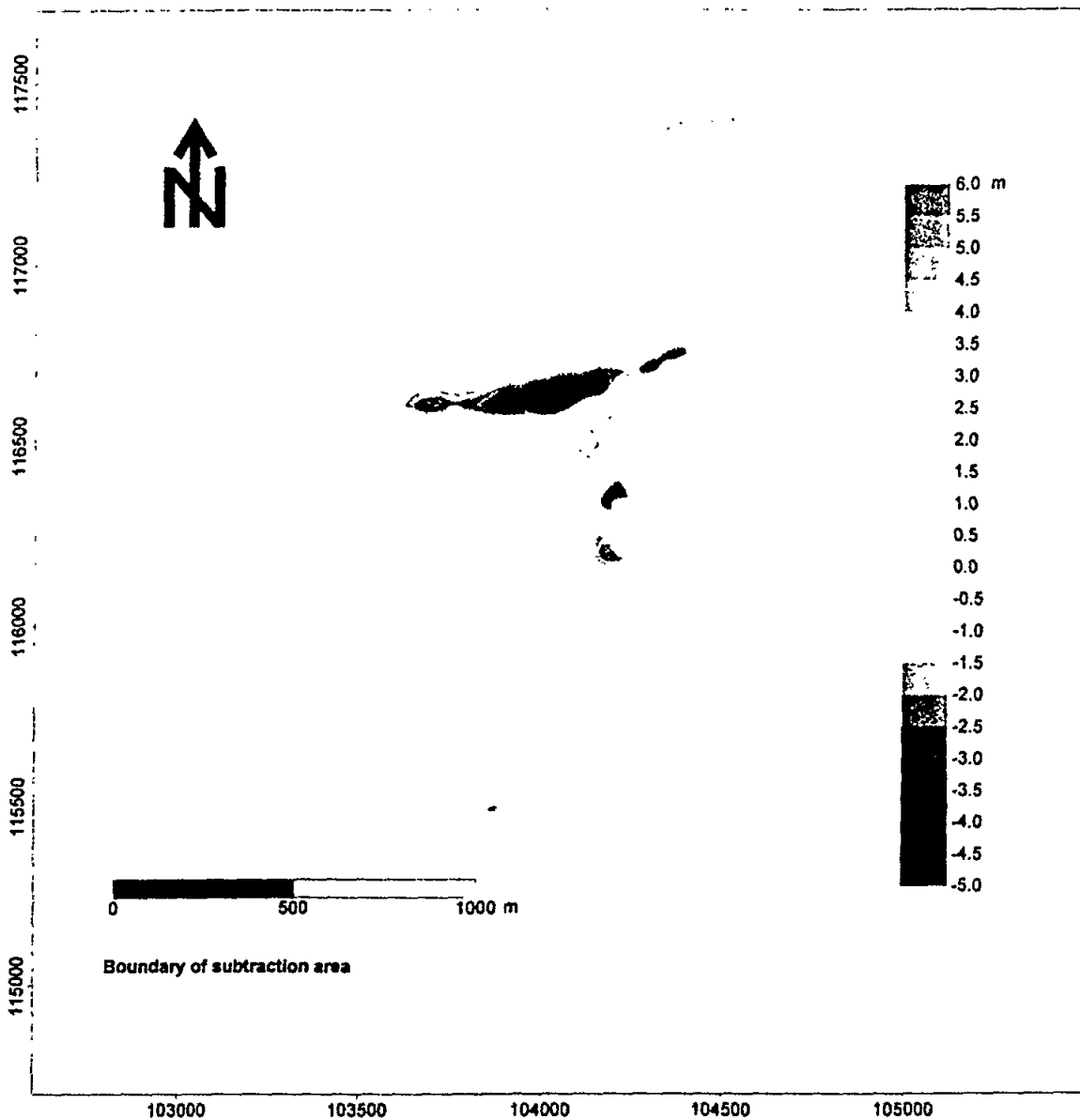


Figure 28. Depth differential map for the period of May 1982 to June 1992 in front of the Rutenberg cooling basin.

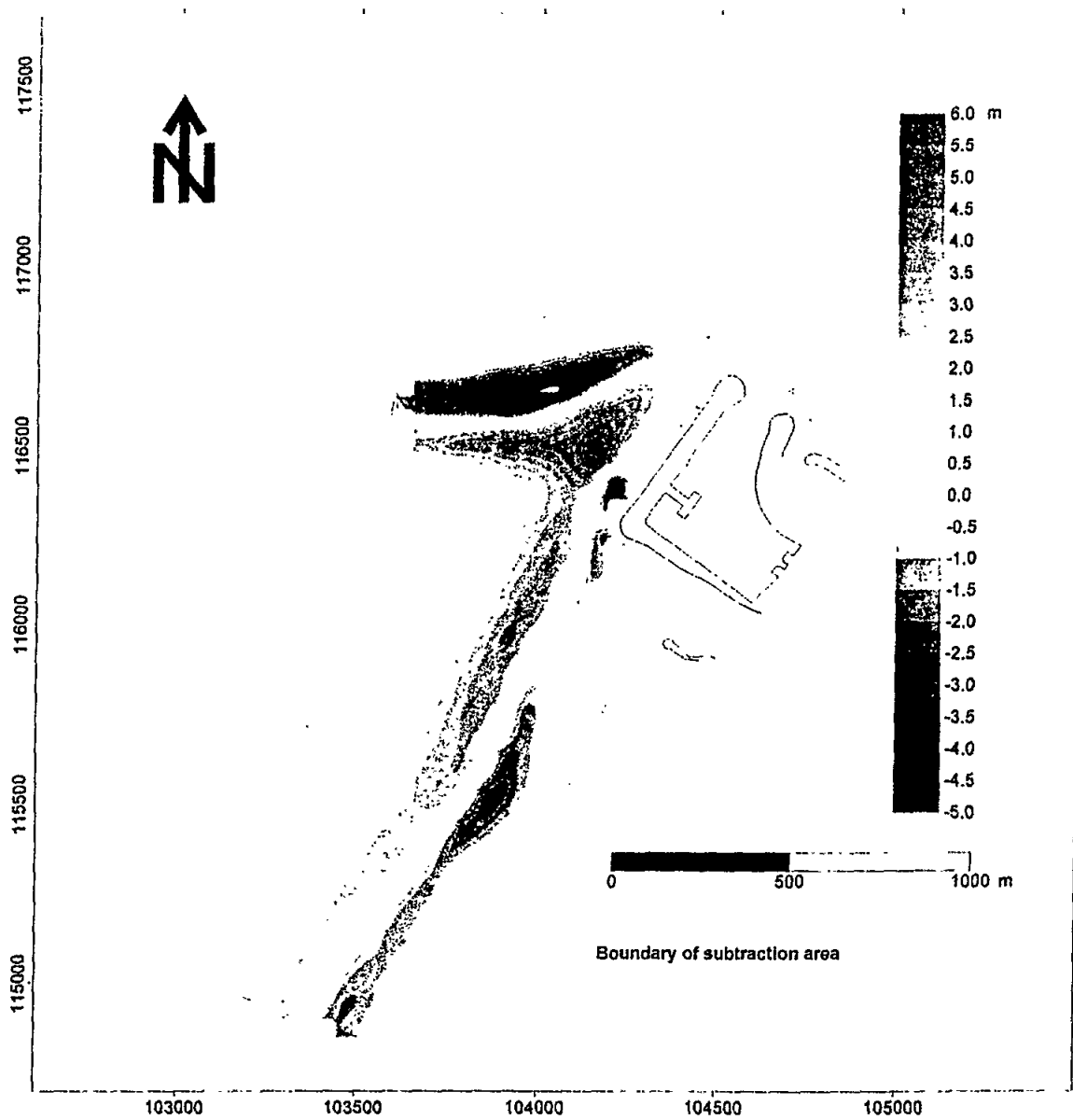


Figure 29. Depth differential map for the period of May 1982 to November 1995 in front of the Rutenberg cooling basin.

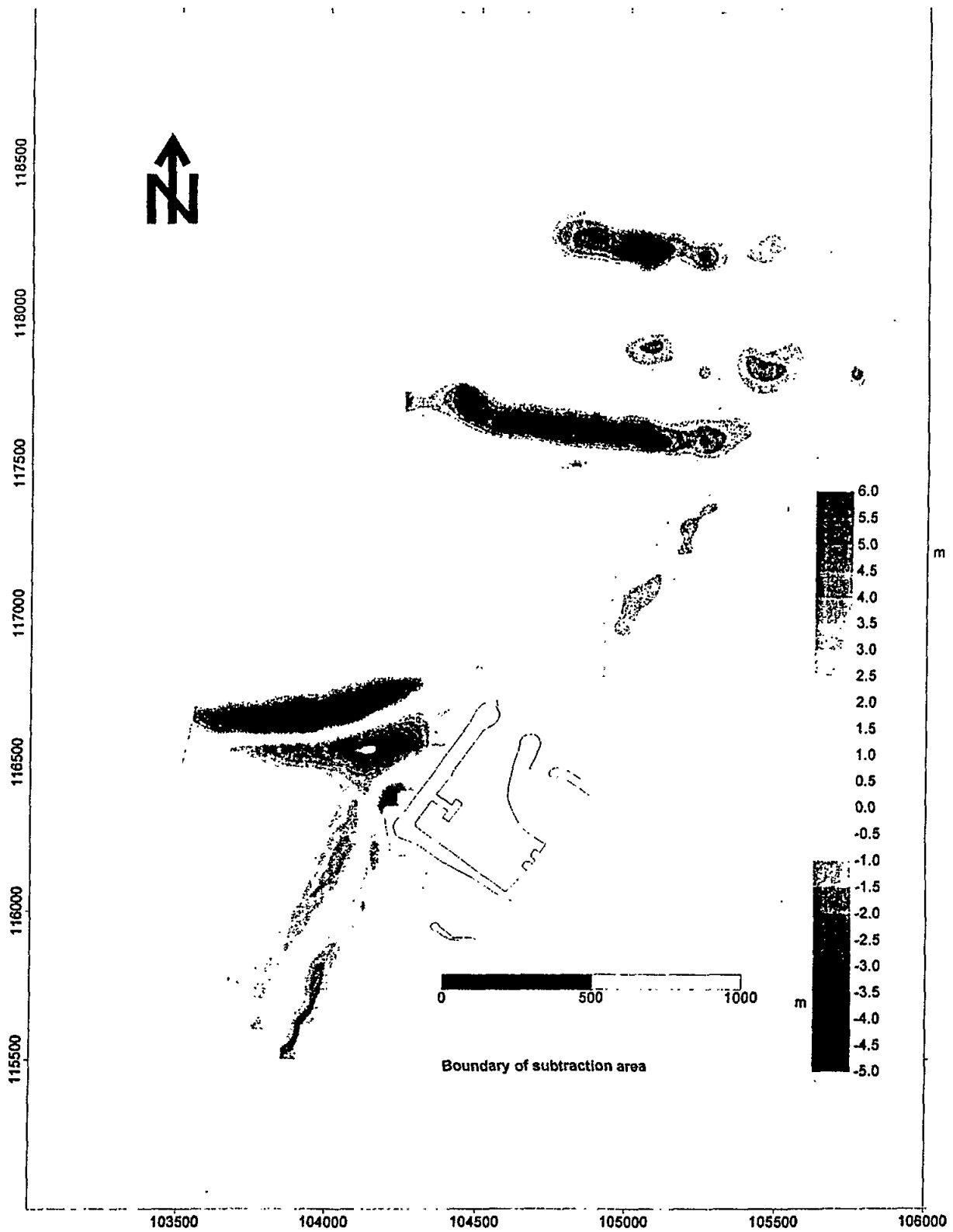
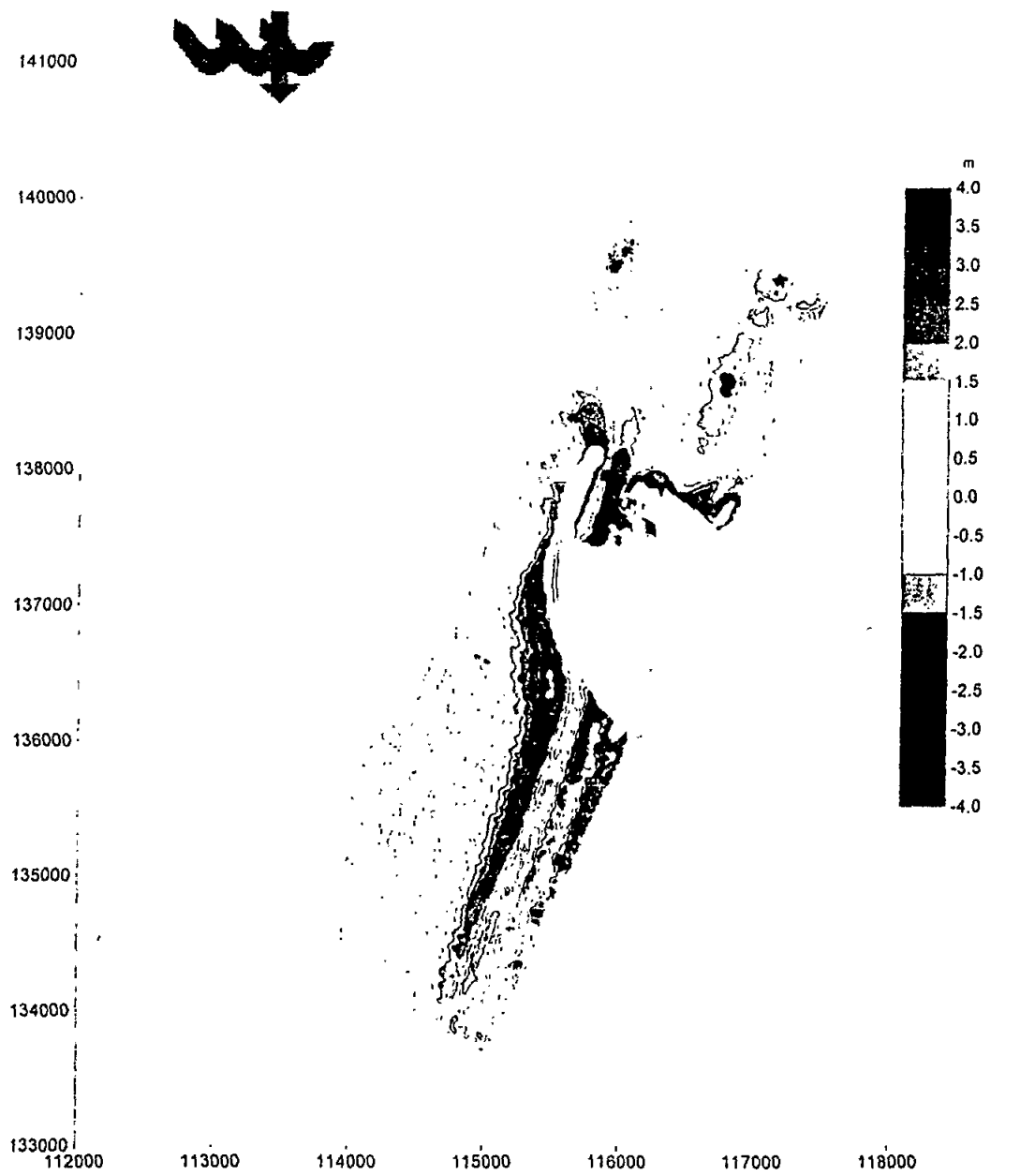


Figure 30. Depth differential map for the period of July 1986 to November 1995 in front of the Rutenberg cooling basin.



**Figure 31. Depth differential map for the period of 1957 to 1997 off Ashdod Port.
From Golik *et al.* (1996a).**

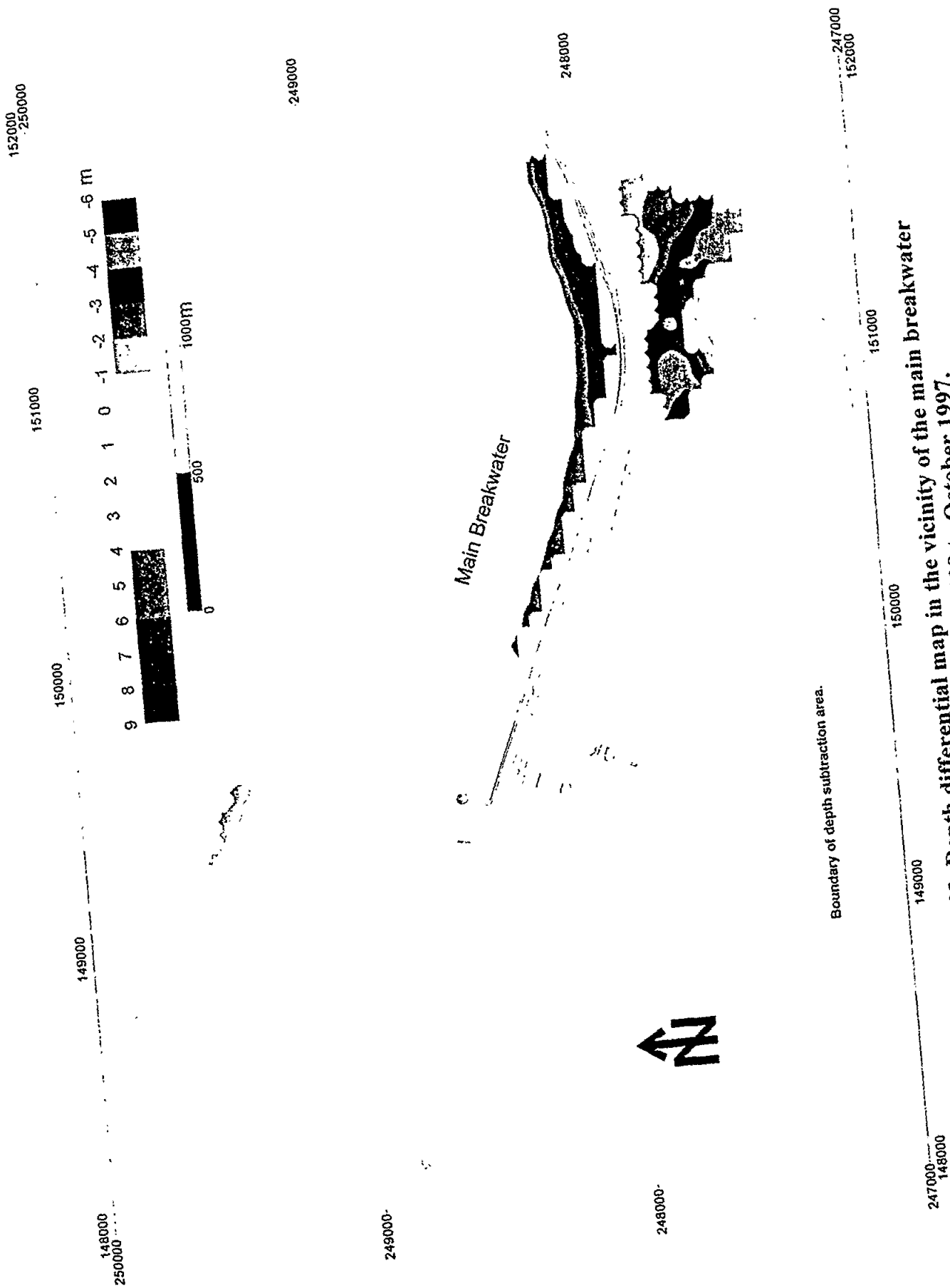


Figure 32. Depth differential map in the vicinity of the main breakwater of Haifa port, December 1928 to October 1997.
From Golik *et al.*, (1999b).

**AVERAGE GRAIN SIZE DISTRIBUTION AS FUNCTION OF WATER DEPTH
ON CENTRAL MEDITERRANEAN COAST OF ISRAEL**

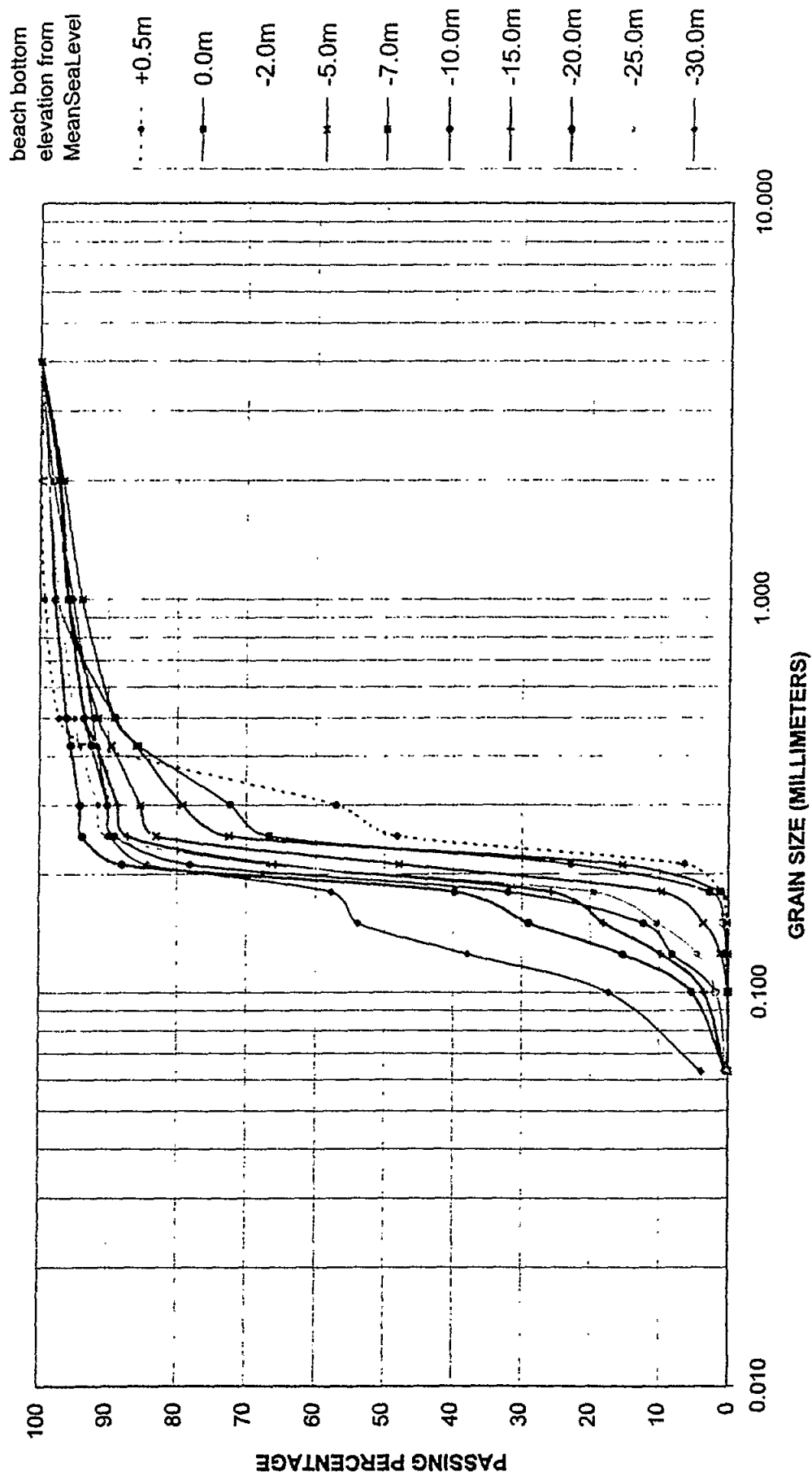


Figure 33. Characterization of average sand size distribution on the Mediterranean coast of Israel

Time history of sedimentological years yearly maxima of deep water characteristic wave heights ($H_{m,0}$) offshore Ashdod

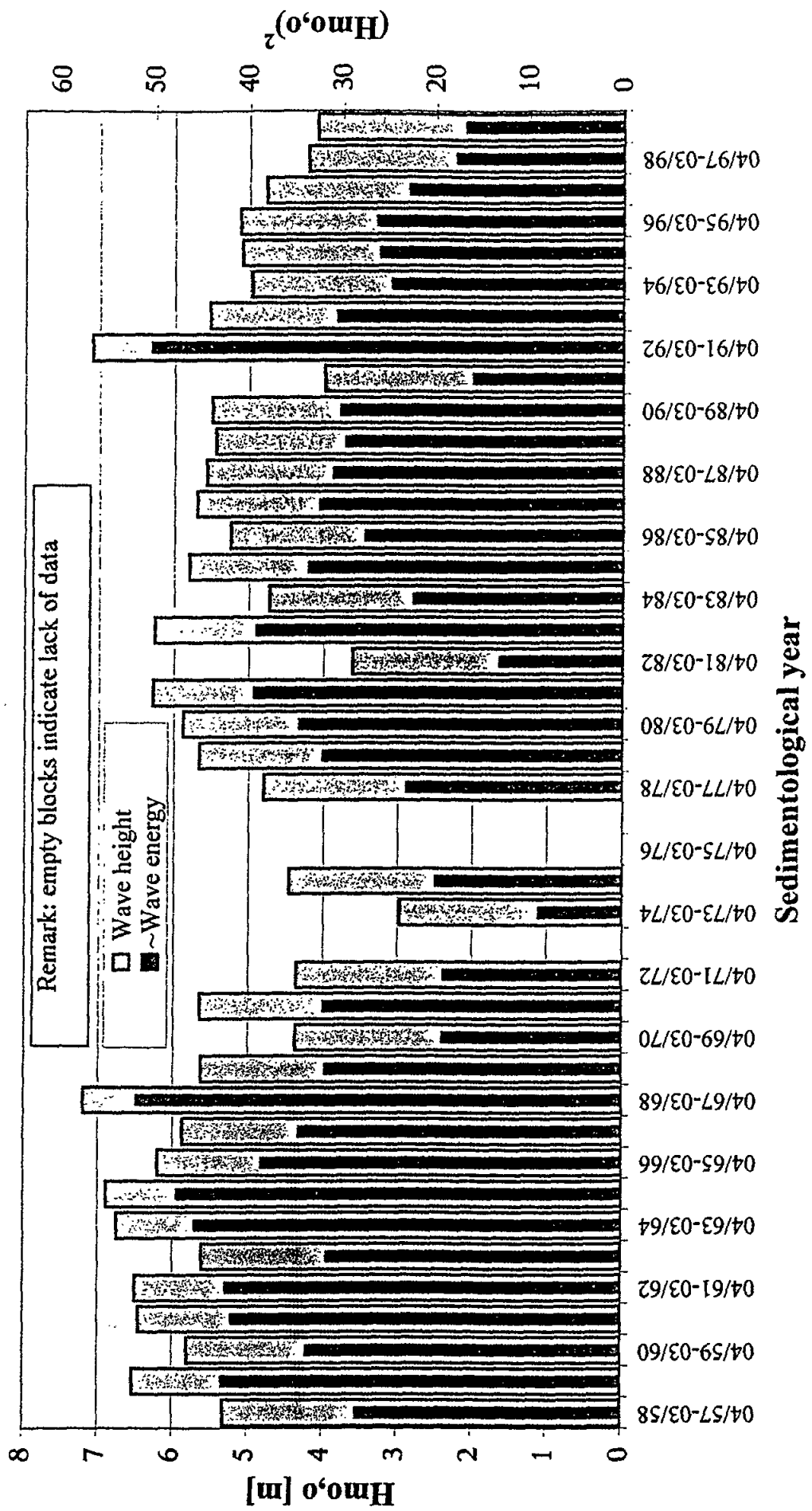


Figure 34. Time history of yearly maxima of deep water characteristic wave height for the coast of Israel

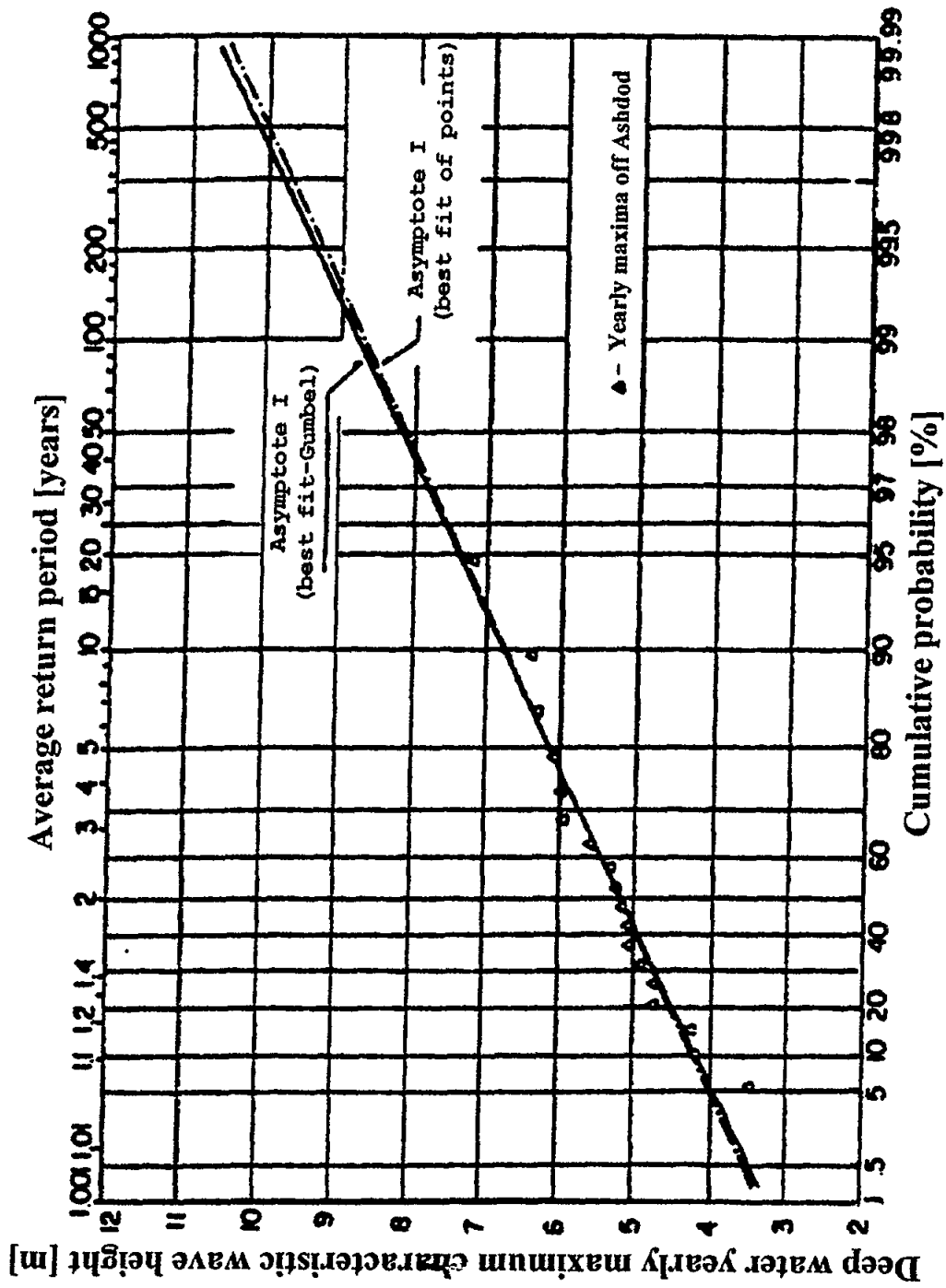


Figure 35. Average return periods of extreme deep water characteristic wave height on the Mediterranean coast of Israel

**Ashdod coast - Example of yearly longshore sediment transport cross shore distribution.
Assessment based on Bijker formula, without general currents, 04/1994-03/1995**

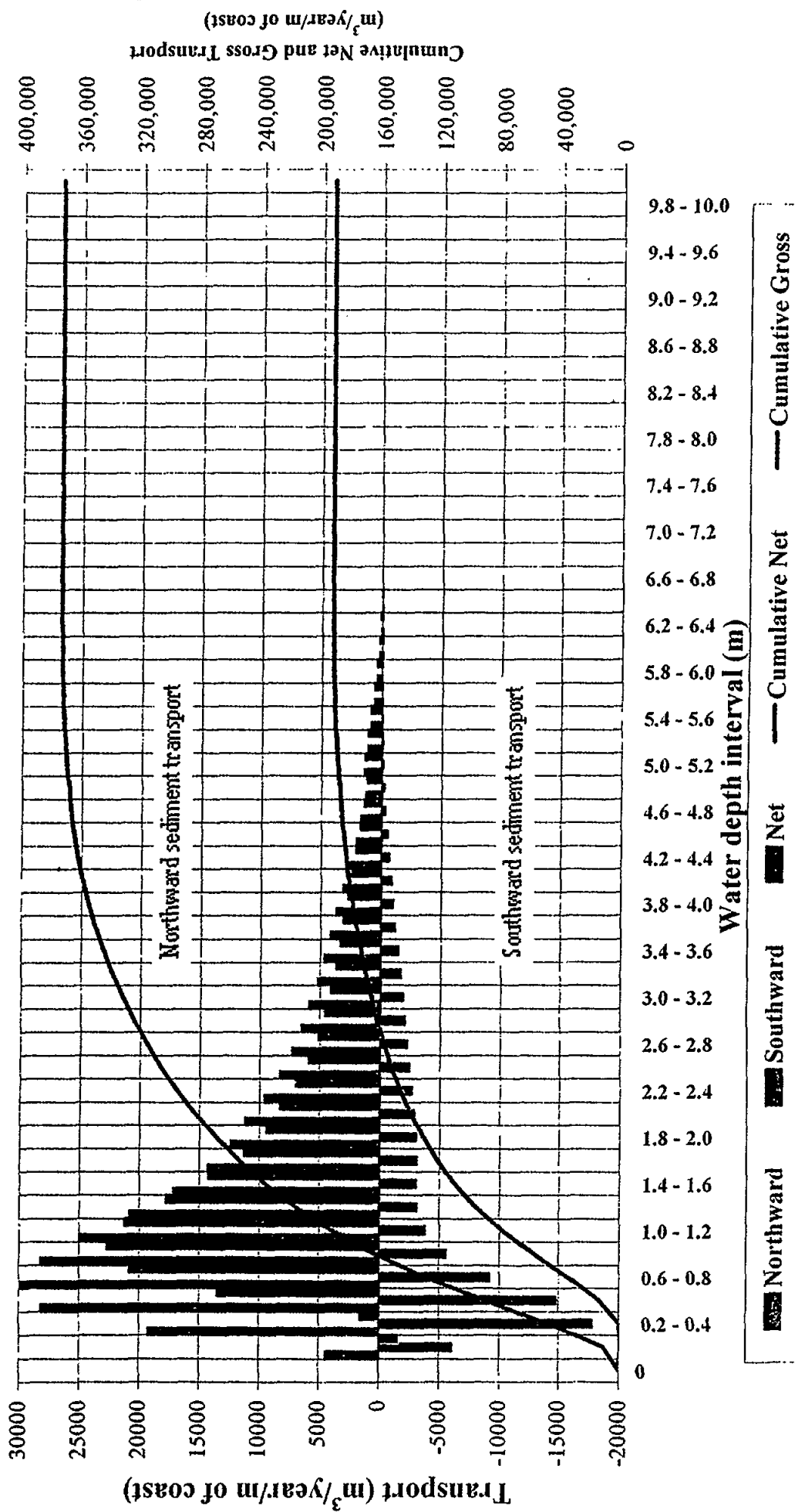


Figure 36. Example of cross shore profile of longshore sand transport at Ashdod

**Haifa coast - Example of yearly longshore sediment transport cross shore distribution.
Assessment based on Bijker formula, without general currents, 04/1994-03/1995**

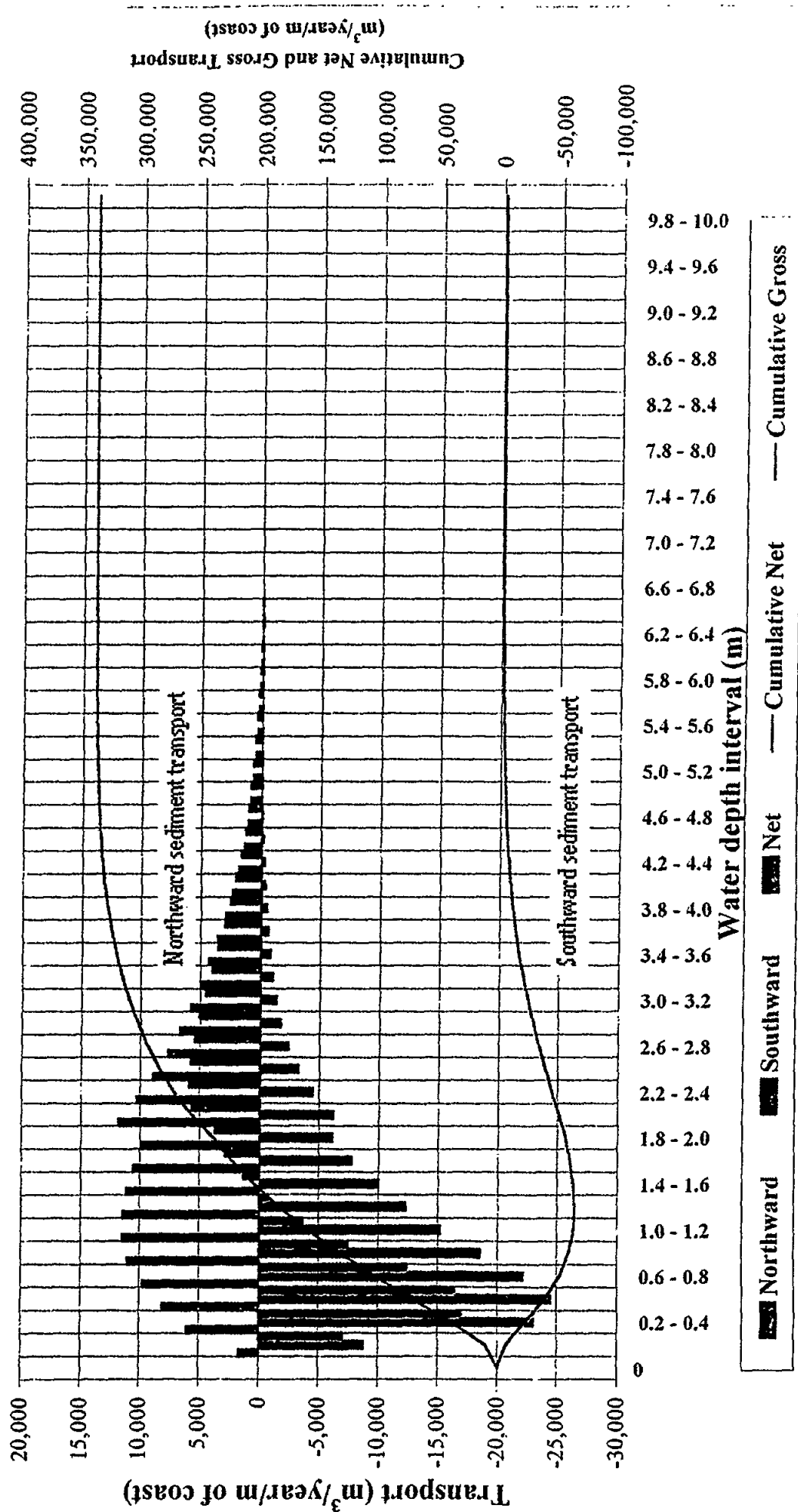


Figure 37. Example of cross shore profile of longshore sand transport at Haifa

Longshore sediment transport assessment for the Mediterranean coast of Israel using Bijker formula
Sedimentological years 04/1992-03/1993 trough 04/1998-03/1999

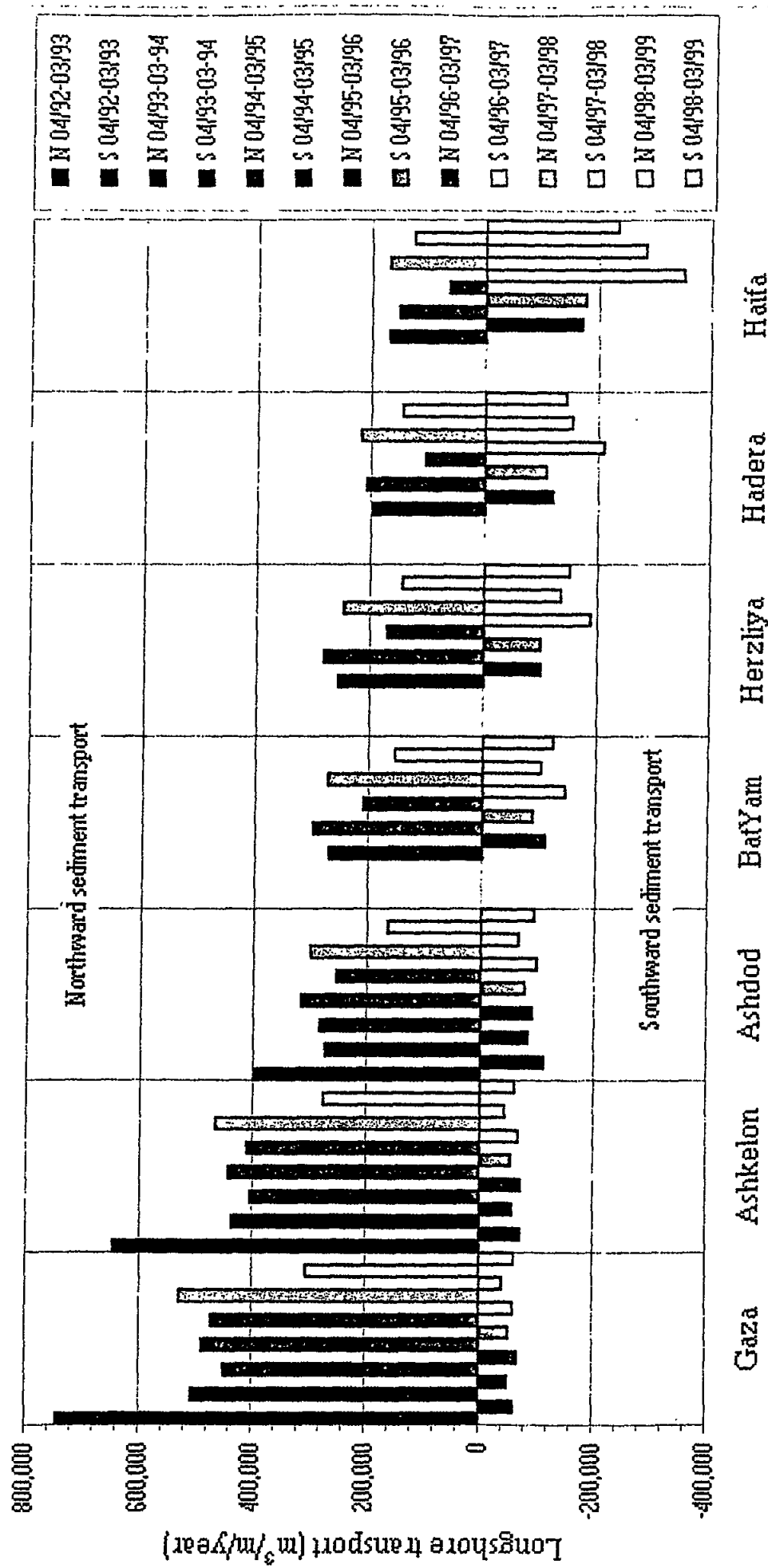


Figure 38. Northward and Southward yearly longshore transport recent history

**Net longshore yearly sediment transport at the Mediterranean coast of Israel
Sedimentological Years 04/1992-03/1993 through 04/1998-03/1999**

Assessment using Bijker formula excluding general circulation currents

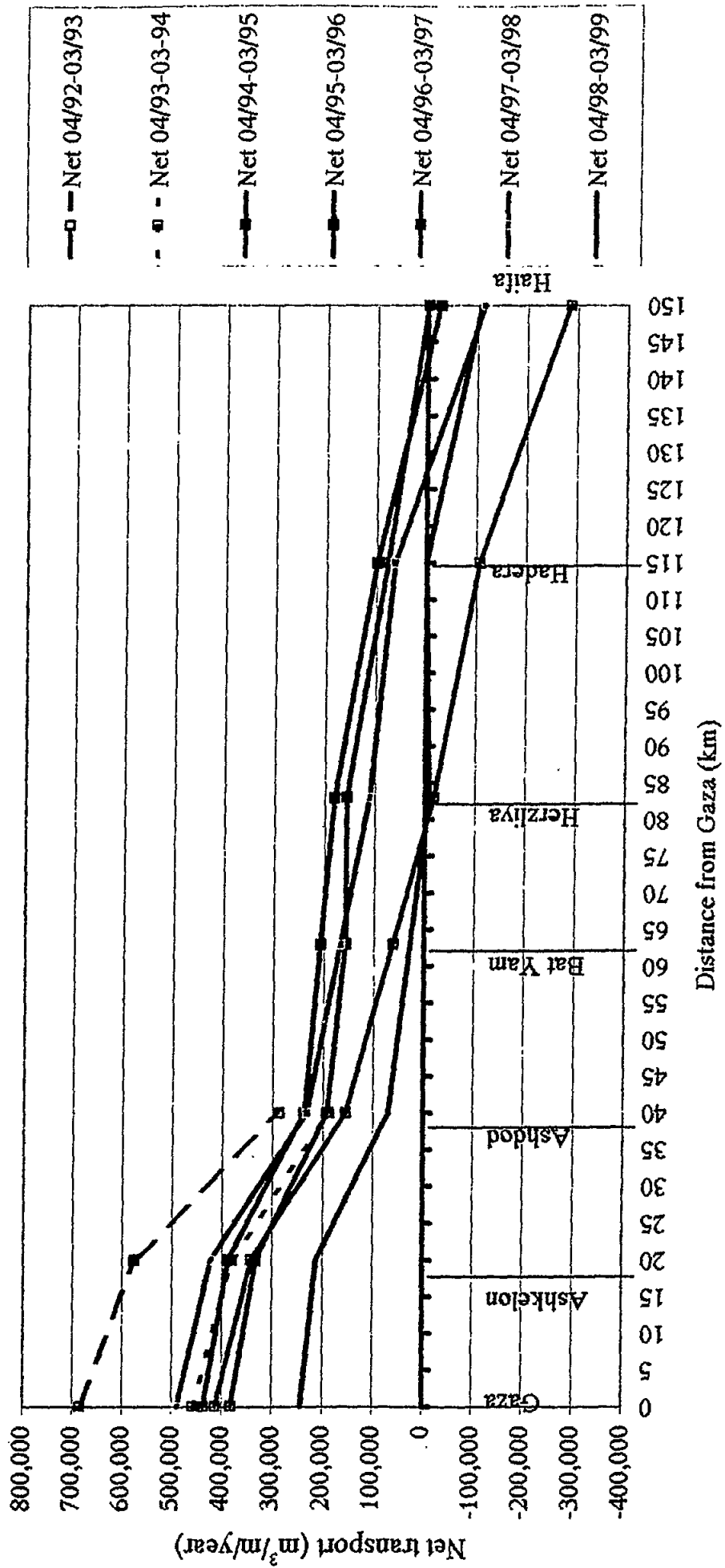


Figure 39. Net longshore sand transport recent history

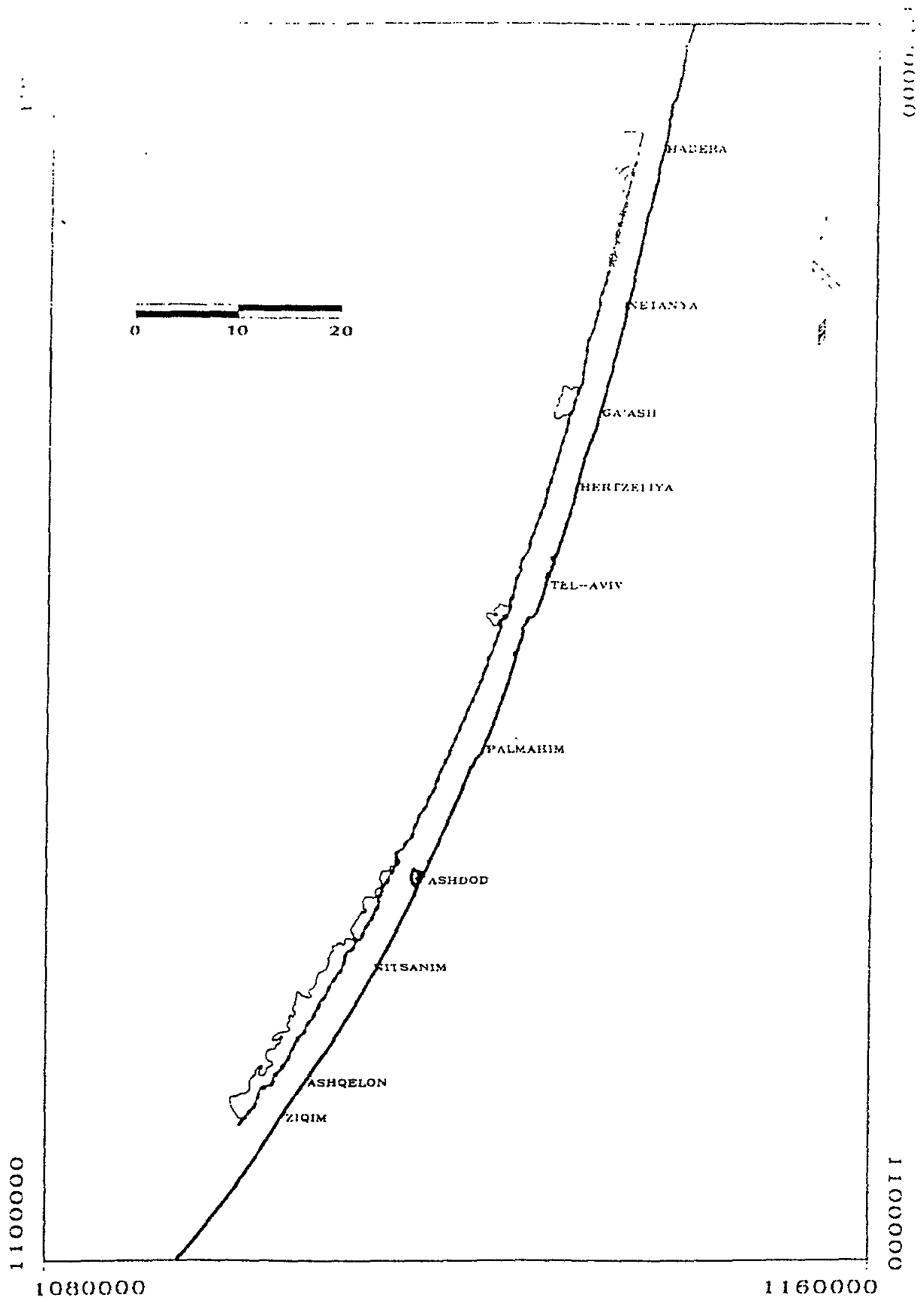


Figure 40. Distribution of sand reserves on the seabed between Hadera and Ziqim. Dashed line denote 30 m water depth contour and red line denotes areas with sand/silt thickness ratio greater than 1. From Golik *et al.* (1999a).

4. Approximately 12 million m³ of sand was entrapped near coastal structures, most of it in the vicinity of major structures such as ports. This sand was removed from the coastal system and the possibility of dredging it to artificially nourish dwindled beaches must be seriously investigated. Artificial beach nourishment should be complemented by proper means to prevent or minimize quick removal of the nourished sand.
5. The long-term mean rate of the net longshore sand transport, is assessed to be some 400,000 m³/year at Gaza going northward, decreasing to about 100,000 m³/year at Haifa, still northward. On the other hand, for the period 04/94-03/99 the approximate yearly averages were: at Gaza 400,000 m³/year northward, at Ashdod 188,000 m³/year northward at Hadera 26,000 m³/year northward and 100,000 m³/year southward at Haifa.
6. The longshore sand transport is a stochastic process. During a severe storm, such that may occur once in 10 years or more, the quantity of sand moved in the longshore direction during the storm period, may be equivalent to that of one or more "normal" years.
7. In view of the large quantity of sand trapped near coastal structures, permission to build new coastal constructions should be forbidden unless these are of national importance. Such structures should be permitted only if proper steps are taken to ensure bypassing of the natural longshore sand transport for the entire lifetime of the structure and prevention of reflection-induced erosion to neighboring beaches. Taking into account the stochastic nature of sand deposition, the bypassing rate should be based on a permanent monitoring program of the beach and seabed area in the surroundings of the structure.
8. The forecasted sea-level rise due to the greenhouse effect is expected to further deteriorate beach condition as well as increase cliff erosion. The locations of cliffs sited in coastal sectors, critically sensitive to sea-level rise, should be determined by an adequate sedimentological study, and prevention means for the future must be considered, such as low-reflection sea walls and cliff/dune buried sea-walls.

9. Apparent conflicting evidence as to the direction of the longshore sand flow was found in the vicinity of Haifa. The existence of Nilotic sand in Haifa Bay, deposition of sand in front of the main breakwater of Haifa Port and computed longshore sand transport indicate a long-term northward net transport. Beach accretions on the northern sides of coastal structures between Hadera and Haifa seem to indicate southward net sand transport. In view of the complicated bathymetry at the Carmel Cape coastal sector and the changing local coast orientation, further clarification of the three-dimensional sediment transport mechanism in this region is needed. Field experiments using sand tracers and wave measurements in the vicinity of Haifa are recommended to be carried out in order to clarify the pattern of sand flow in that region.

10. In order to enable reliable information and correct decision-making acts, a national, long-term, extensive coast monitoring program, financed by the government, must be conducted. This program should include aerial photography and orthophoto of the entire coast every two years, and next to major coastal structures every year. In addition aerial photography should be conducted in years with storms exceeding 6 m deep water characteristic wave height. Bathymetric charting of the entire coast should be carried out every several years. Environmental factors (sea level, winds, waves and currents) should be monitored continuously at sufficient sites for proper coverage of the whole coast.

11. A National Oceanographic Data Center (NODC), similar to those present in many other countries and advocated by UNESCO, should be established. This center should serve as Israel's repository and dissemination facility for oceanographic data and data products.

11. EPILOGUE

Management of Coastal Sand Resources

By V. Brachya

At the present time, the coastal sand resources are regarded as a free public good. The only restriction imposed on their use has been the prohibition of quarrying coastal sand for building purposes. It is now becoming increasingly clear that a management policy is required for defining property rights of the coastal sand resources, responsibility for their maintenance for public purposes and a definition of responsibility for damage. Consideration needs to be given to the institutional structure needed to the management of coastal sand resources and the economic measures necessary to ensure their conservation and maintenance.

Coastal structures have interfered with the natural longshore drift, creating accumulations of coastal sand resources on the upshore side and loss of sand supply on the downshore side. Ashdod Port is the first example of coastal sand management where the Ports Authority have been required to take action to bypass the trapped sand around the marine structure due to be extended. All previous decisions on marine structures related to preventing coastal erosion but did not require bypassing of trapped sand. It is now clear that the indication of damage to coastal sand resources is the level of sand accumulation and not the level of erosion on the immediate downshore coast. Hence a new approach to coastal sand management is necessary which ensures sand supply to waterlines, with due respect to the maintenance of beaches and to the prevention of coastal erosion.

Although the Israel Lands Authority is the official manager of public lands, and the shore is included in the definition of public lands, the Lands Authority has not so far shown any interest in the management of coastal sand resources. In fact the Authority has been a partner with Local Authorities and private developers in projects which have caused significant damage to coastal sand resources. Nor can the Local Authorities along the coastline be regarded as bodies representing the public interest in protecting coastal sand resources. They have frequently promoted projects which

have caused damage and have not taken steps to repair the damage or claim compensation for the damages. Moreover, each Local Authority is only concerned about the section of shore within its own boundaries and is not concerned whether remedial measures for its own shore will adversely affect the shore of a neighboring Local Authority. A national administration is therefore required.

A further complication is the definition of building rights along the coastal area. The statutory coastal masterplan prohibits building within 100 m of the waterline. There is no clear definition of the waterline and no directive on whether the prohibition relates to a specific date (e.g. 1983 when the plan was approved) or whether it is variable according to seasonal changes or as a result of sand accumulation or loss of beach width. The result is that where sand has accumulated, developers are claiming additional building rights. No developer will willingly forego any building rights given even if the waterline has retreated. It is therefore likely that claims for compensation for loss of building rights will be submitted to the Courts in the future.

Future issues on sand property rights may arise over proposals to use sand from offshore sources for fill material for constructing offshore islands. There is no current management policy which clarifies whether coastal sand resources can be used for such purposes or whether other public purposes, such as beach nourishment, should take preference.

The scientific information presented in this document on coastal sand movement and on the natural and anthropomorphic processes affecting its accumulation and loss along the shore will provide a solid basis on which deliberations concerning the management of coastal sand resources can take place.

12. LIST OF REFERENCES

- Almagor, G., Gill, D. and Golik, A., 1998a. Artificial island project geotechnical tests of vibracores. Israel Geological Survey, Report GSI/28/98: 45 p. with appendices.
- Almagor, G., Gill, D. and Perath, I., 1998b. Marine sand resources offshore Israel. Geological Survey of Israel, Report GSI/25/98: 63 p.
- Baird & Associates Ltd. (Ottawa, Ontario, Canada) and Research Planning Inc. (Columbia, South Carolina, USA), 1996. City of Herzliya: analysis of beach erosion. Report: 52 p.
- Baird W.F. & Associates Coastal Engineers Ltd., 1998. Design investigations for shore protection, wave agitation and sedimentation at Herzliya marina. Oakville, Ontario. December 11, 1998.
- Bosboom J., (1996). Port of Gaza, Morphological modeling. Delft Hydraulics, Delft, September 1996.
- Bowen, A.J. and Inman, D.L., 1966. Budget of littoral sands in the vicinity of Point Arguello, California. U.S. Army Coastal Engineering Research Center, Technical Memoir No.19: 56 p.
- Bowman D., Arad D., Rosen D. S., Kit E., Goldbery R., Szlavicz A., 1988. Flow characteristics along the rip current system under low-energy conditions. *Journal of Marine Geology*, 82: 149-167.
- Bowman D., Birkenfield H., Rosen D. S., 1992. The longshore flow component in low-energy rip channels: The Mediterranean, Israel. *Journal of Marine Geology*, 108: 259-274.
- Bowman D., Rosen D. S., Kit E., Arad D., Szlavicz A., 1988. Flow characteristics at the rip current neck under low energy conditions. *Journal of Marine Geology*, 79: 41-54.
- Bruins, B.F.P., 1976. Offshore dredging study. Feasibility report. Israel Geological Survey, Report UN/UNDP - GSI Offshore Dredging Project ISR/71/522: 55 p.
- Carmel, Z., Inman, D.L. and Golik, A., 1985. Directional wave measurement at Haifa, Israel, and sediment transport along the Nile littoral cell. *Coastal Engineering*, 9: 21-36.
- Carmel, Z., Inman, D.L. and Golik, A., 1984. Transport of the Nile sand along the southeastern Mediterranean coast. Proceedings, 19th Coastal Engineering Conference, American society of Civil Engineers, September 3-7, 1984, Houston, Texas: 1282-1290.
- Carmel, Z., Inman, D.L. and Golik, A., 1985. Directional wave measurement at Haifa, Israel, and sediment transport along the Nile littoral cell. *Coastal Engineering*, 9: 21-36.
- Chesher T., 1996. Haifa Marina numerical sediment transport study, Storm wave tests. HR Wallingford, Report EX3513.

- Chesher T., Dearnaley M., 1997. Haifa Marina Studies Quantification of impact of marina on adjacent coastline. HR Wallingford, Report EX3640.
- Dearnaley, M.P., 1996. Ashdod sedimentological study, Final report. HR Wallingford, Report EX3518.
- Delft Hydraulics, 1994. Port of Gaza, Basic engineering study, Final Report part 11, Coastal Impact Study. Delft: 85pp.
- Dolan, R., Hayden, B. and Heywood, J., 1978. A new photogrammetric method for determining shoreline erosion. *Coastal Engineering*, 2: 21-39.
- Eitam Y., 1974. Variations in relief and sand distribution in Ma'agan Michael Beach. M.Sc. thesis, Hebrew University, Jerusalem, 89pp (in Hebrew).
- Emery, K.O. and Neev, D., 1960. Mediterranean beaches of Israel. Israel Geological Survey, Bulletin 26: 1-23.
- ENOSH Environmental Systems, 1995. Environmental impact statement, local master plan no. 2666, Yarkon estuary.
- Finkelstein A., Vajda M., 1982. Cooling basin for the southern power station, Sedimentologic model study, Interim report, Stage a-1, Feasibility Study. CAMERI, PN 114/82.
- Finkelstein, A., 1980. Development of Ashdod Port, research in a sedimentological model; model calibration. Coastal and Marine Engineering Research Institute, Report P.N. 74/80: 1-49 (in Hebrew).
- Fredsoe J., and Deigaard R., 1992. Mechanics of coastal sediment transport. World Scientific, Singapore.
- Fugro Engineers B.V., 1998. Geotechnical survey offshore sand resources Israel. Fugro Report N3607/01: 5 p. with appendices and enclosures.
- Galili, E., Weinstein-Evron, M., Hershkovitz, I., Gopher, A., Kislev, M., Lernou, O., and Kolska-Hershkovitz, L. and Lernou, II., 1993. Atlit Yam: a prehistoric site on the sea floor off the Israeli coast. *Journal of Field Archaeology*, 20: 133-157.
- Goldsmith, V. and Sofer, S., 1983. Wave climatology of the southeastern Mediterranean. *Israel Journal of Earth Sciences*, 32: 1-15.
- Goldsmith, V., Rosen, P. and Gertner, Y., 1990. Eolian transport measurements, winds and comparison with theoretical transport in Israeli coastal dunes. *In* Nordstrom, K.F., Psuty, N.P. and Carter R.W.G. (eds.), *Coastal Dunes. Form and Processes*, John Wiley and Sons Inc: 79-101.
- Golik, A., 1997a. Dynamics and management of sand along the Israeli coastline. *Bulletin de l'Institut oceanographique, Monaco*, no. special 18 - Transformation and Evolution of the Mediterranean Coastline: 97-110.
- Golik, A., 1997b. The effect of the Ashdod Port on the sediment characteristics of the nearby beach and sea bottom. Israel Oceanographic and Limnological Research, Report H08/97: 14p.
- Golik A., Auerbach S., and Amir S., 1986. Monitoring the coal fall-out on the sea bottom and at neighboring beach of the Hadera offshore coal unloading terminal. *Proc. 5th Symposium of Israel Coast Research*: 9-18.

- Golik, A., Gardosh, M., Gill, D. and Almagor, G., 1999a. Artificial islands project - prospection for offshore aggregates. Israel Oceanographic and Limnological Research, Report H 19/99: 1-27 and appendices.
- Golik, A., Nir, Y. and Lozon Y., 1993. The reservoir of unconsolidated sediment on the inner continental shelf of Israel. Israel Oceanographic and Limnological Research, Report H14/93: 23 p.
- Golik, A., Rosen, D.S., Golan, A. and Shoshany, M., 1996a. The effect of Ashdod Port on the surrounding seabed, shoreline and sediment. Israel Oceanographic and Limnological Research, Report H02/96: 66 p.
- Golik, A., Rosen, D.S., Golan, A., Shoshany, M., DiCastro, D. and Harari P. 1996b. Ashdod Port's effect on the shoreline, seabed and sediment. Proceedings, 25th International Conference Coastal Engineering, Coastal Engineering Research Council, American Society of Civil Engineers, September 2-6, 1996, Orlando, Florida, USA, chapter 339: 4376-4389.
- Golik, A., Shoshany, M., Golan, A. and Haimi, O., 1999b. Sediment dynamics in Haifa Bay. Israel Oceanographic and Limnological Research, Report H17/99: 1-23.
- Hall, J. K. and Bakler, N., 1975. Detailed bathymetric and shallow seismic surveys at five locations along the Mediterranean coast of Israel. Israel Geological Survey, Field Report 1/75: 21 p.
- Hershkovitz, I. and Galili, E., 1990. 8,000 year old human remains on the sea floor near Atlit, Israel. Jour of Human Evolution, 5: 319-358.
- Jensen O.J., 1990. Report on hydraulic studies for the planned marina at Ashqelon. Seatech Consulting Engineers A/S Copenhagen.
- Kamphuis J.W., 1998. Sedimentological Aspects for the Israeli Mediterranean Coast and for the Ashdod Port Expansion. J.W. Kamphuis Associates Ltd., Report ISR-01.
- Kit E., and Pelinovsky E., 1998. Dynamical models for cross-shore transport and equilibrium bottom profiles. Journal Waterways, Port, Coastal and Ocean Engineering. 124, No. 3: 138-146.
- Komar P.D., 1977. Beach Sand Transport: Distribution and Total Drift. Journal Waterway, Port Coastal and Ocean Division, 103: 225-240.
- Levine E., 1996. Ashdod North Port Development – Current Meter Operation Annual Report for the Period 13.5.95 – 16.5.96. Oceana Marine Research, Report L9612.
- Linder, E., 1992. Ma'agan Michael ship wreck. Excavating an ancient merchantman. Biblical Archaeology Review, 18: 24-35.
- Marine Advisers Inc., 1965 Oceanographic problems involved in the design and maintenance of the Israel desalting project: 40pp.
- Migniot C., 1966 Reading Power station cooling water basin Report on natural phenomena. Laboratoire Centrale d'Hydraulique de France: 71pp.
- Migniot C., 1974. Creation of a new power station North of Hadera, cooling water basin, natural phenomena study and sediment movement study with radioactive

- tracers and fluorescent tracers. Laboratoire Centrale d'Hydraulique de France, France: 34p.
- Migniot C., and Manoujan S., 1968. Reading Power station cooling basin, Three dimensional model studies. Laboratoire Centrale d'Hydraulique de France: 142.
- Migniot C., and Manoujan S., 1975. Sedimentological study in three dimensional model. Laboratoire Centrale d'Hydraulique de France.
- Migniot C., and Manoujan S., 1983. Ashdod port extension. Laboratoire Centrale d'Hydraulique de France: 79pp.
- Neev, D., Bakler, N., and Lidsky, S., 1970. Survey for location of offshore building sand deposits; Stage A. Israel Geological Survey, Report MG/1/70: 1-9.
- Neev, D., Nir, Y. and Pomerancblum, M., 1963. The problem of zifzif mining along the Mediterranean coast of Israel (in Hebrew). Israel Geological Survey, Report QGR/1/63 in the Report of the Zifzif Commission submitted to the Minister of Development and Housing, Jerusalem, Appendix 1: 19 p.
- Nir, Y., 1984. Recent sediments of the Israel Mediterranean continental shelf and slope. Ph.D. thesis, University of Gothenburg, Sweden, Department of Marine Geology: 211 p.
- Perath, I., 1982. Rate of retreat of the Sharon Escarpment – a new method of measurement. Israel Geological Survey, Current Research 1982: 62-65.
- Perlin A., Kit E., 1999. Longshore sediment transport on the Mediterranean coast of Israel, ASCE Journal of Waterway, Port, Coastal and Ocean Engineering: 80-87.
- Pomerancblum, M., 1966. The distribution of heavy minerals and their hydraulic equivalents in sediments of the Mediterranean continental shelf of Israel. J. Sed. Pet. 36:162-174.
- PortConsult. 1987. Assistance to the fisherman, Gaza strip, Final report of study on fishery port-Gaza. Port Consult Consulting Engineers. A/S, Copenhagen.
- Ron, Z. D., 1982. Destruction and retreat of the coastal cliff at Netanya (in Hebrew). In Shmueli, A., and Braver, M. (eds), Netanya. Am Oved, Tel Aviv. Israel: 45-67.
- Rosen, D.S., 1982. Ashdod Port expansion project. wave disturbance and sea keeping model study, progress report no. 1: A new deep water wave climate evaluation for Ashdod. CAMERI, P.N. 100/82, Technion City, Haifa: p. 105.
- Rosen, D.S., 1985 Assessment and Consultation on the Operability of the Coal Unloading Terminal at Ashdod Port North - Stage A, Final Report. CAMERI. P.N. 160/85: 13-15. (in Hebrew).
- Rosen, D. S. 1990. Engineering consultation regarding long-term sedimentological processes in the Hadera-Sdot Yam coastal area. (in Hebrew). P.N. 242/90 Haifa. Unpublished report to IEC.
- Rosen, D.S., 1992. Study of 50 years coastal changes in Hadera. Proceedings, 23rd International Conference on Coastal Engineering, Coastal Engineering Research Council, Venice Italy, October 4-9, 1992, Chapter 259: 33999-3412.

- Rosen, D.S., 1993. Offshore coal unloading terminal for Rutenberg power station, Ashqelon wave and current program. Israel Oceanographic and Limnological Research, Report H05/93
- Rosen, D.S., 1998. Assessment of marine environmental impacts due to construction of artificial islands on the coast of Israel. Present sedimentological assessment in the study sector. Israel Oceanographic and Limnological Research, Report H17/98: 1-72.
- Rosen D.S., Vajda M., 1979 Hadera Offshore Coal Unloading Terminal – Wave Disturbance Model Investigation – Hadera Wind and Wave Climate. CAMERI, P. N. 47/79, Technion City, Haifa.
- Sauzay G., Gilath Ch., Meltzer M., Courtois G., Frenkel I., Levin A., and Blit S., 1974 Study of sediment transport on the sea and on the beach at the site of the Hadera power plant. Israel Atomic Energy Commission: 59p.
- Schwartz, J., 1997. Geomorphic processes along the coastal cliff Michmoret-Givat Olga (in Hebrew). M.A. thesis, University of Haifa, Department of Geography: 90 p.
- Shoshany, M. and Degani, A., 1992. Shoreline detection by digital image processing of aerial photography. *Journal of Coastal Research*, 8: 29-34.
- Shoshany, M., 1991. Mapping the shoreline in the Rutenberg Station-Katza area in the years 1956-1989. Bar Ilan University, Geography Dept. Report, 8 pp. (in Hebrew).
- Shoshany, M., Golik, A., Degani, A., Lavee, H. and Gvirtzman, G. 1996. New evidence for sand transport direction along the coastline of Israel. *Journal of Coastal Reserch*, 12: 311-325.
- Smith, G.L. and Zarillo, G.A., 1990. Calculating long-term shoreline recession rates using aerial photographic and beach profiling techniques. *Journal of Coastal Research*, 6: 111-120.
- Striem, H.L., 1963. Determination of changes in the position of the shoreline by means of aerial photographs (in Hebrew) *in* the Report of the Zifzif Commission submitted to the Minister of Development and Housing, Jerusalem, Appendix 4: 1-7.
- Toms G., van Holland G., 1999 Assessment of morphological impacts due to construction of artificial islands along the coast of Israel, Review and evaluation of three detailed schemes. WL Delft Hydraulics, Report Z2080/Z2631.
- U.S. Army Corps of Engineers, Coastal Engineering Research Center, (1984). "Shore Protection Manual", vol I, II, 2nd ed.
- Vajda, M.L., 1972 Tel-Aviv shore development model study. Hydrodynamics and Hydraulic Engineering Lab., Technion R&D Found.. Interim report no 15: 24 p.
- Vajda, M.L., 1973 Marina City model study.", Coastal and Ocean Engineering Research Center., Technion R&D Foundation, Progress report No. 2: 25 p.
- Vajda, M.L., 1980. Sedimentological developments around M.D. Hadera power station, follow-up period 1973-1980. CAMERI, P. N. 71/80: 29 p. (in Hebrew).

- Vajda, M.L., 1980. Sedimentological developments around M.D. Hadera power station, follow-up period 1973-1980. CAMERI, P. N. 71/80: 29 p., (in Hebrew).
- Vajda M.L., Rosen D. S., 1987. Ashqelon marina and shore development, Consultation regarding sedimentological influences. CAMERI, P. N. 191/87: 36 pp., (in Hebrew).
- Vajda, M., Mechrez, E. and Etrog, U., (1988), "Disposal of sand from deepening dredging in Ashdod Port in connection with the construction of quay no. 9; examination of alternative solution and analysis of the port impact on the environment", CAMERI, Report No. P.M. 201/88: 1-46 (in Hebrew).
- Vajda, M.L., and Finkelstein A., (1984), "South power station cooling basin, Environmental Impact Statement regarding sedimentological aspects", CAMERI, Haifa, September 1984, 17pp +4 plates and 6 drawings.
- Verner A., and Fried J., (1986), "Marina Ashqelon, Environmental Impact Statement", Civil and Marine Engrng Ltd., Haifa, September 1986, 72pp. +19 drawings, (in Hebrew).
- Zifzif Commission, 1964. Report submitted to the Minister of Development and Housing, Jerusalem(in Hebrew): 33 p and appendices.
- Zviely, D., (in press). The impact of Herzliya Marina on the width of its neighboring beaches. MA thesis submitted to Haifa University, Department of Geography.



Figure 1. Skeleton of a neolithic man found on the seabed off Athlith. From Galili *et al.*(1993).

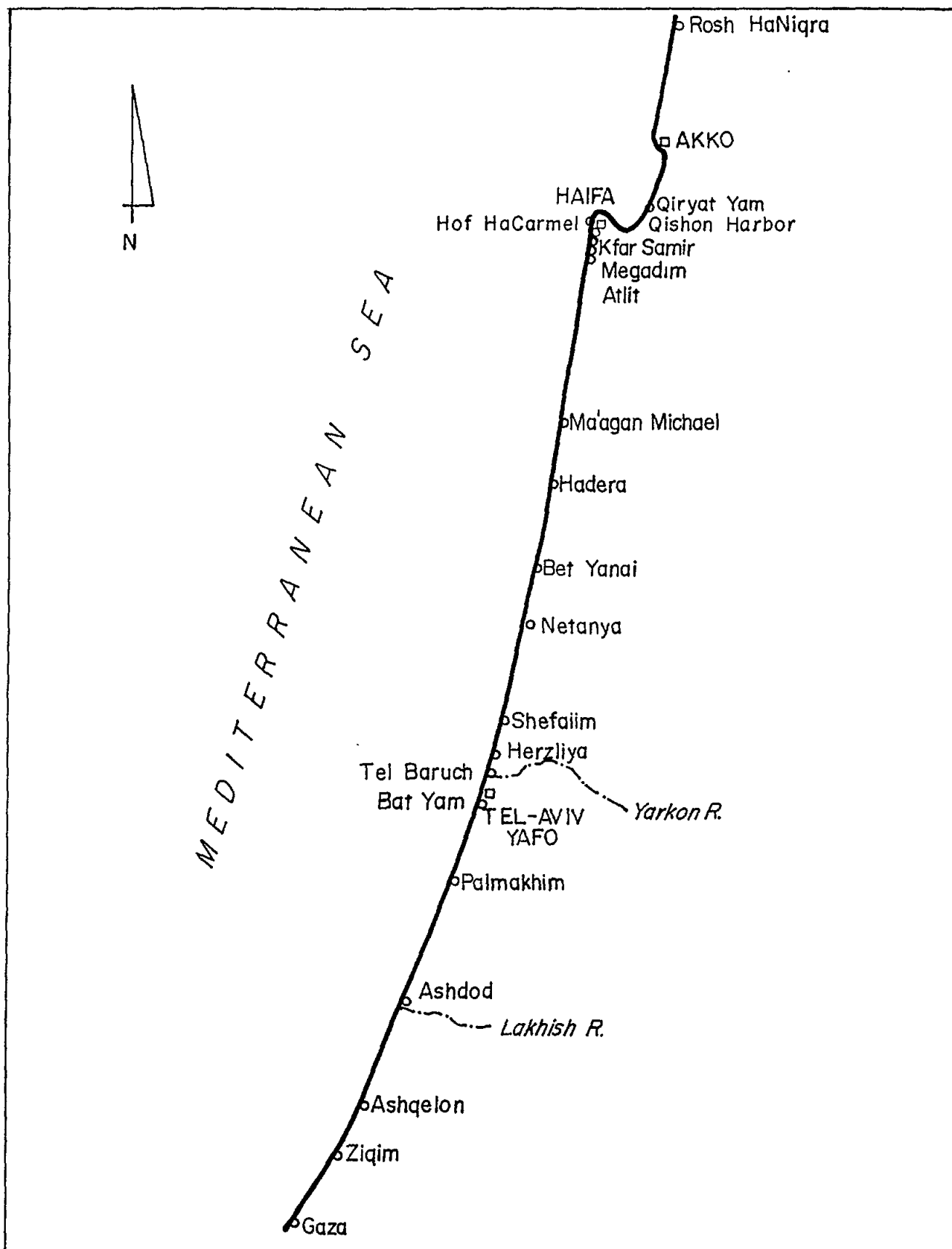


Figure 2. The Israeli Coast. Location map

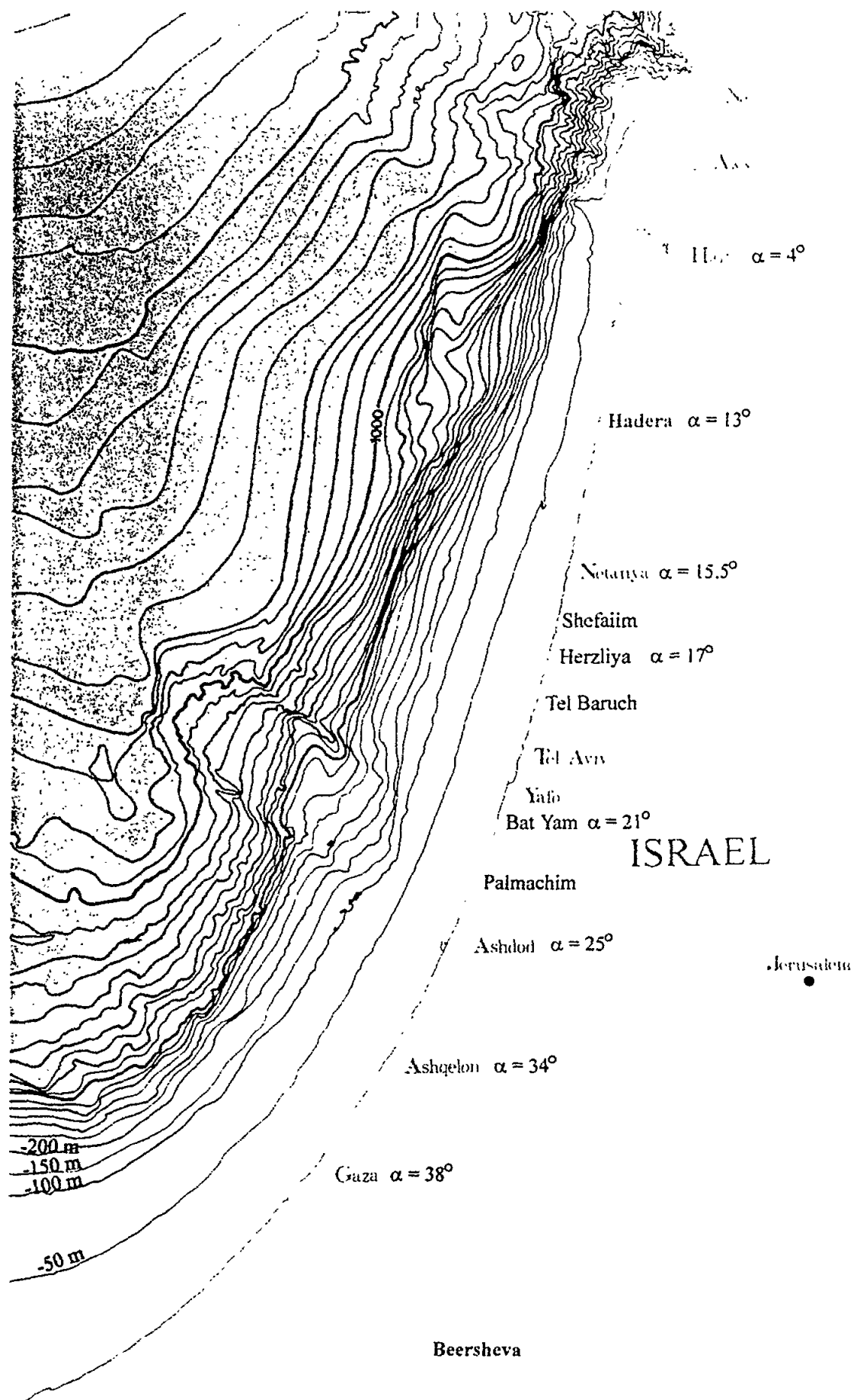


Figure 3. Bathymetric map of the continental terrace of Israel. α is local azimuth of coastal orientation. After Hall (1994).

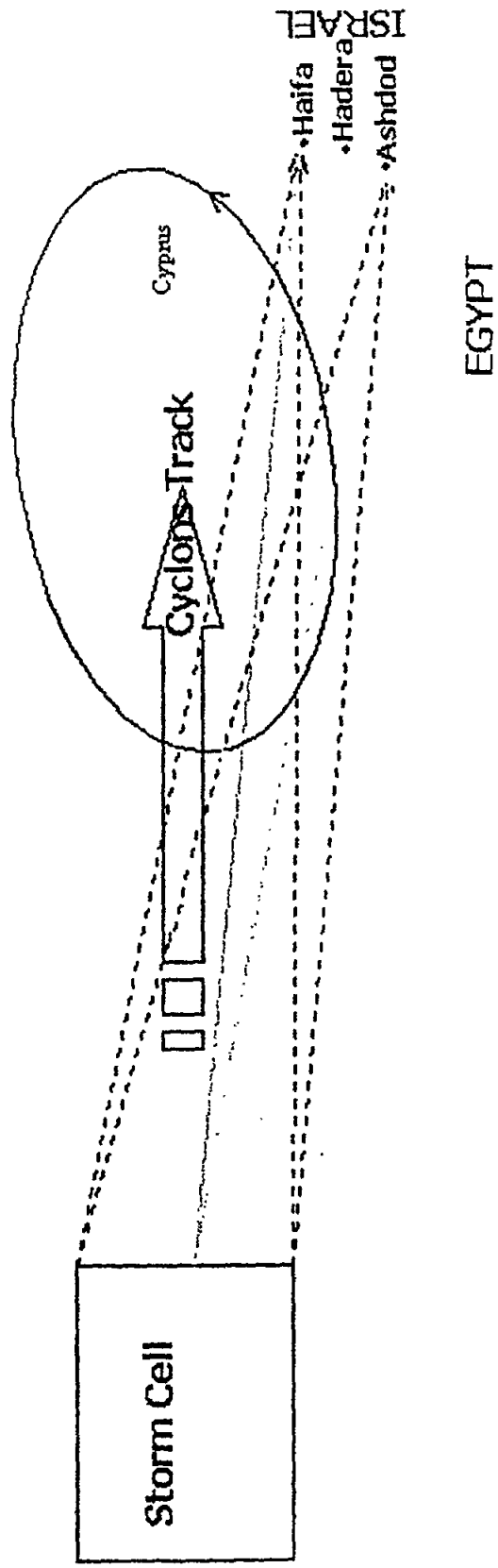


Figure 4. Track of cyclons in winter and explanation of wave direction change along the Mediterranean coast of Israel

FREQUENCY DISTRIBUTION OF DEEP WATER CHARACTERISTIC WAVE HEIGHTS AT ASHDOD
ALL WAVES (04/92-01/98)

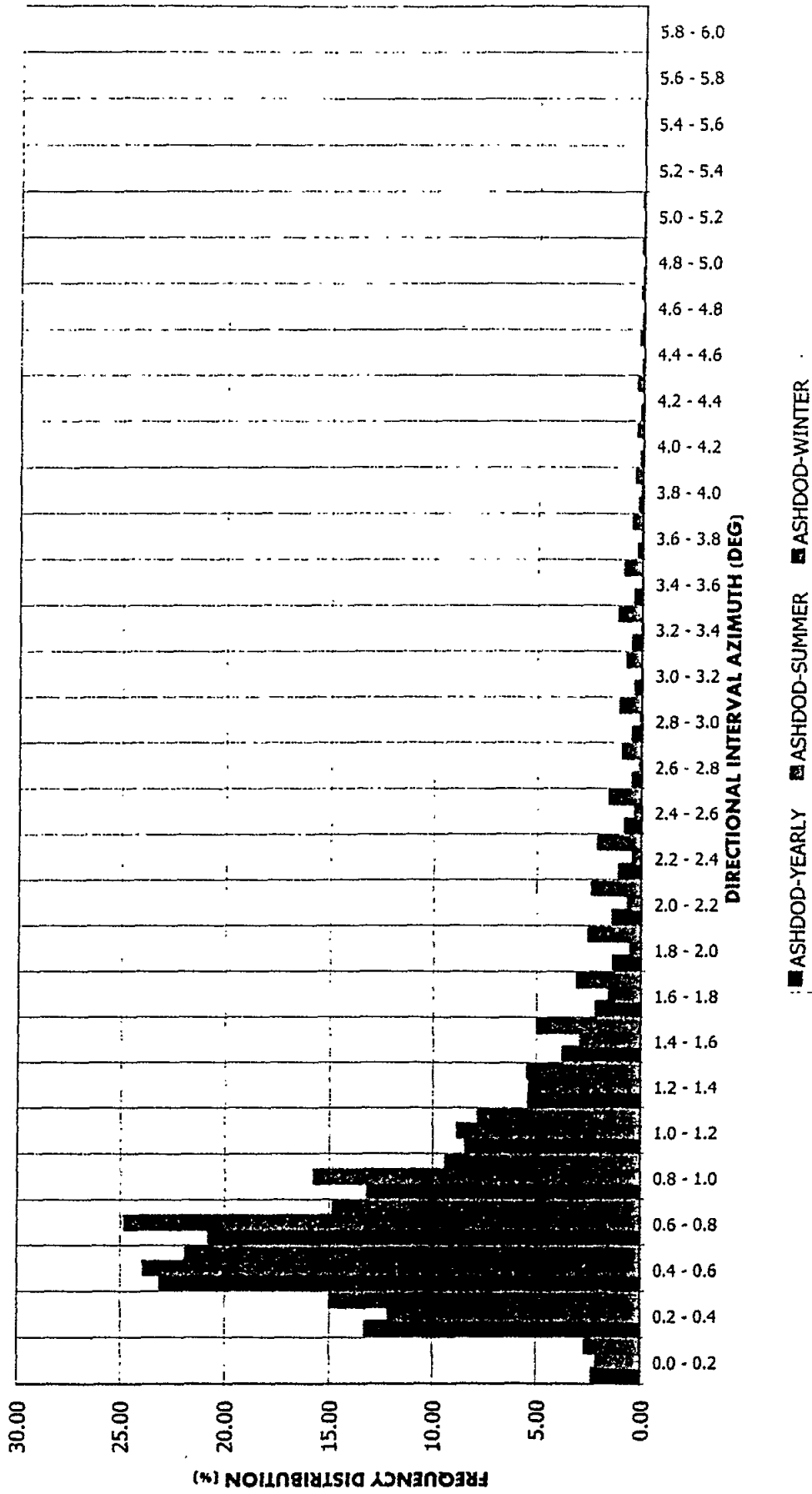
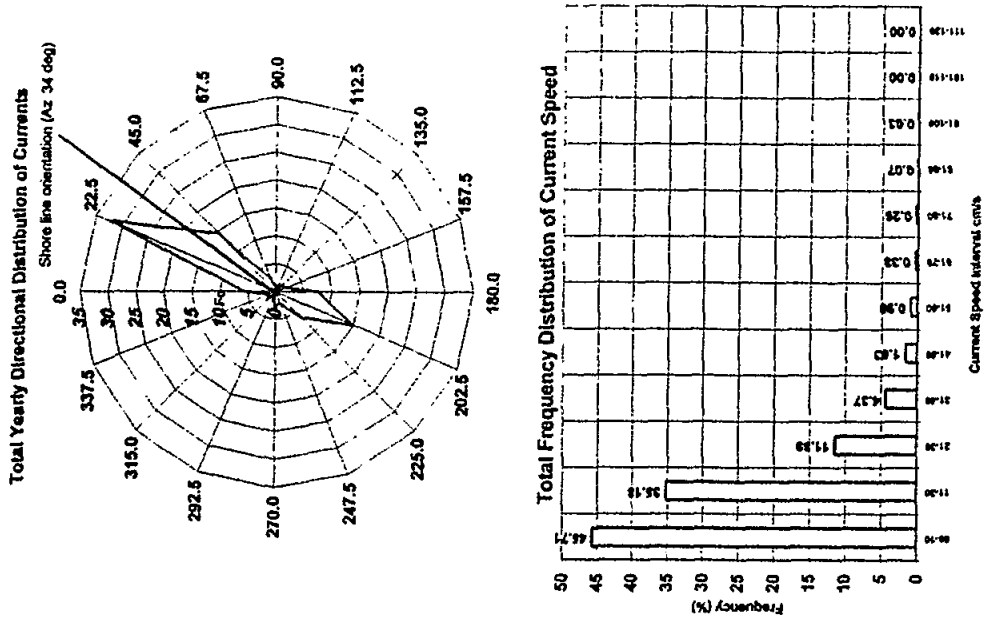


Figure 5. Deep water seasonal characteristic wave height distribution on the Mediterranean coast of Israel

Extreme wind statistics at Ashdod shore based on hourly wind data

Current Statistics - Ashqelon at 12m below sea surface
(Water Depth 27m) 1992



REMARKS :

1. A point on this contour represents a mean wind speed which is expected to be exceeded for the fraction of time indicated (10E-5) from angles over a 22.5o sector centered at this point. For the shaded sector shown, the wind speed is 21.5m/s.
2. Probability contours $P(>V)$ per 22.5o directional sector have been derived from analysis of full scale observations of wind speed and direction at 10m above ground at Ashdod shore for the period 1958-1970, fitted by Weibull distribution.

Figure 6. Characteristic current and wind statistics on the Mediterranean coast of Israel

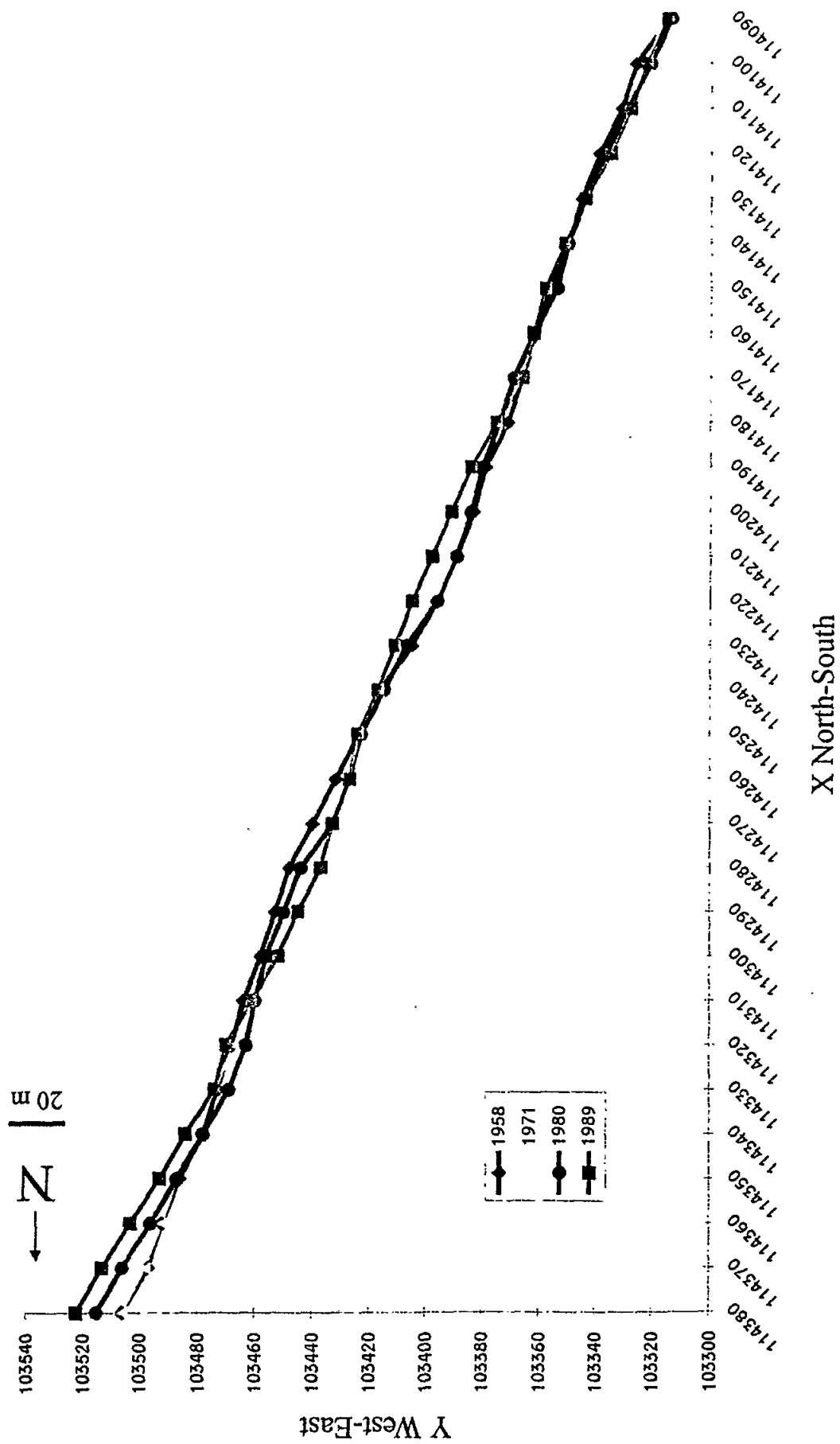


Figure 7. Waterline positions of the northern part of Ziqim Coast between 1958 and 1995

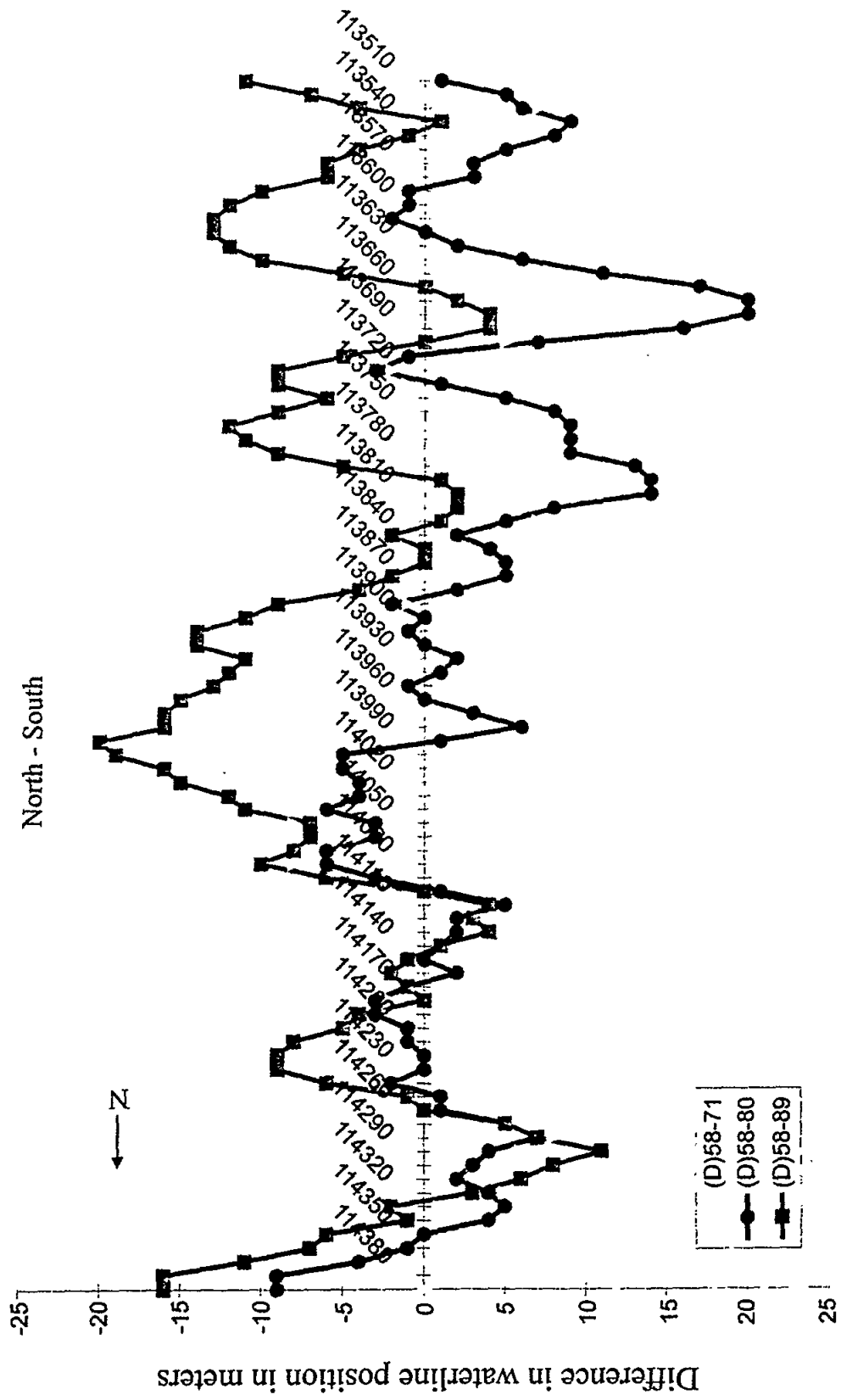


Figure 8. Distance of waterline positions of Ziqim Coast, for each sortie, from that of 1958.

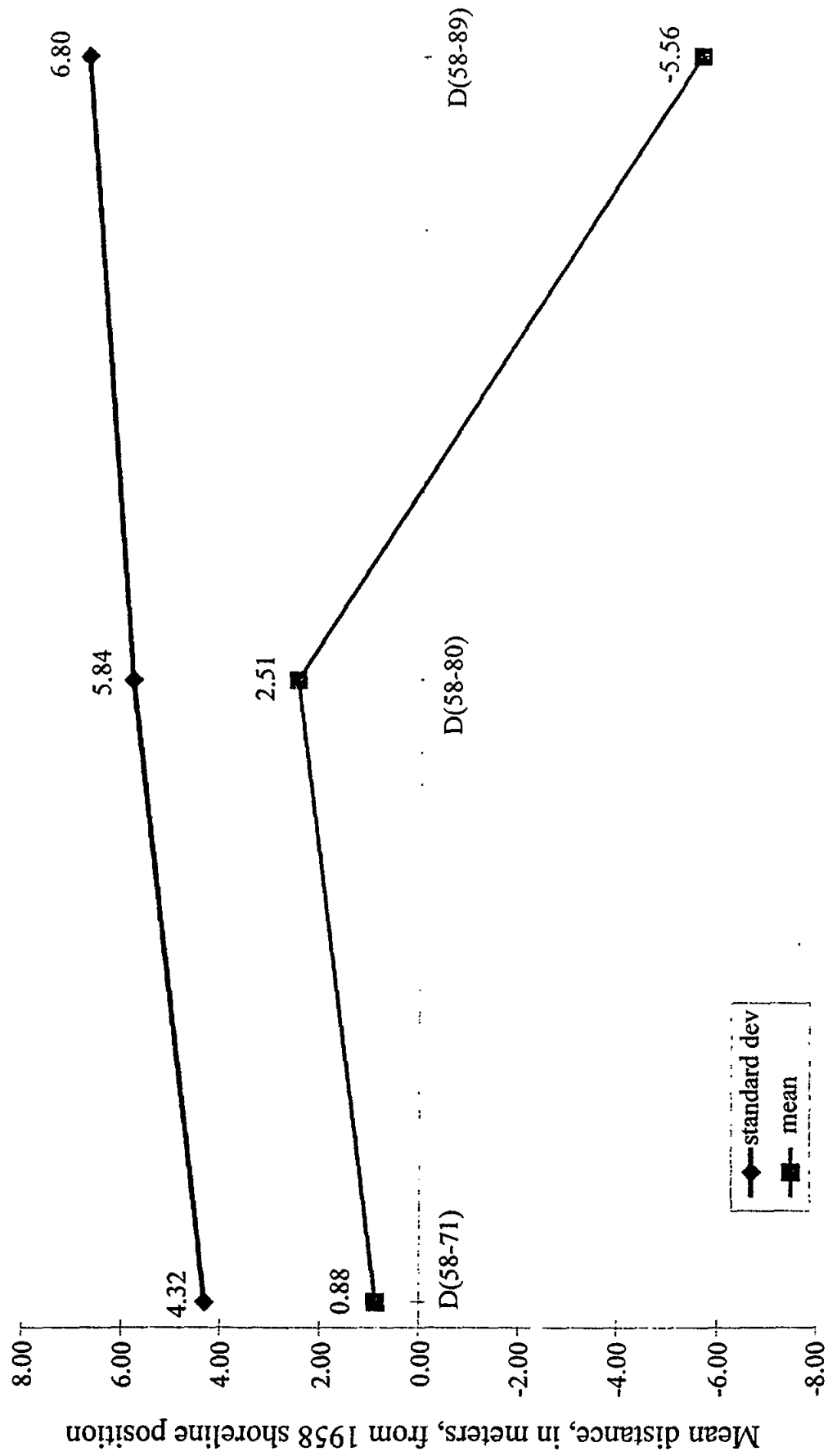


Figure 9. Change in the mean waterline position with time, relative to 1958, for Ziqim Coast.

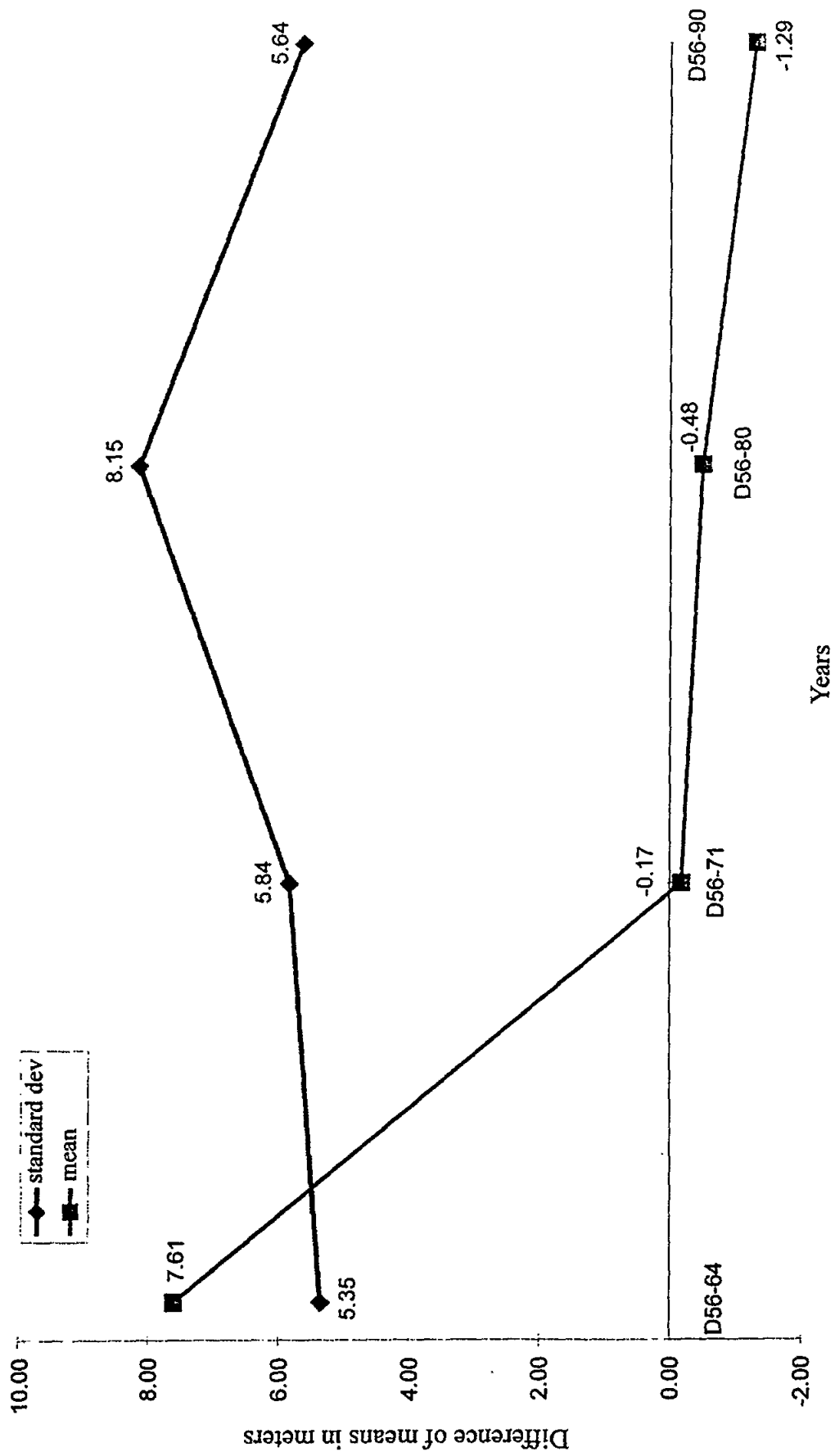


Figure 10. Change in the mean waterline position with time, relative to 1956, for Palmakhim Coast

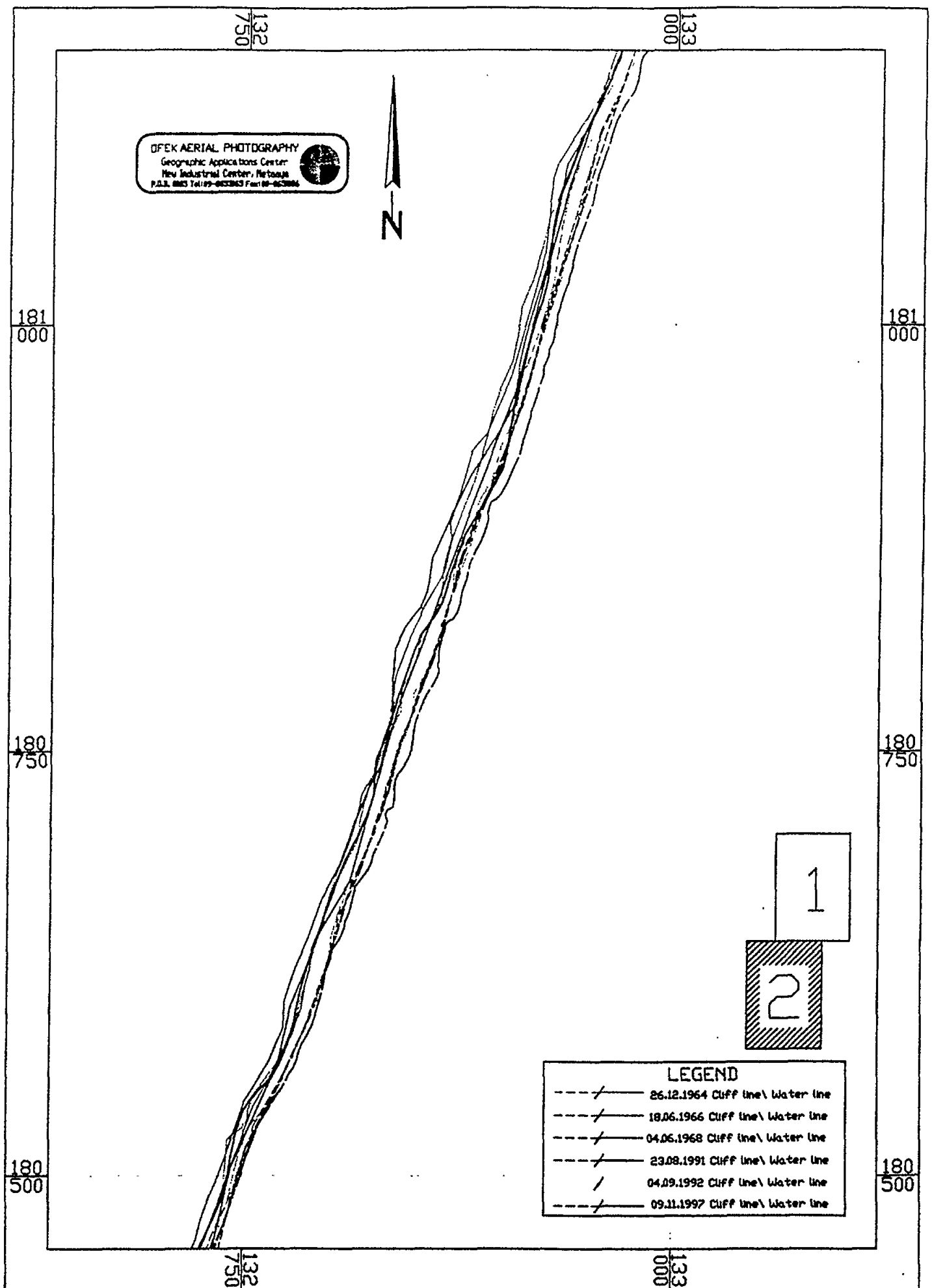


Figure 11. Positions of waterline and cliff line between 1964 and 1997, Shefallm

LIST OF MAP TECHNICAL REPORTS

Please note that you can access many of the MTS Reports on the MAP Web Site at www.unepmap.org

()Not currently available in hard copy.*

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MTS 2. (*) UNEP/FAO: Baseline studies and monitoring of metals, particularly mercury and cadmium, in marine organisms (MED POL II). MAP Technical Reports Series No. 2. UNEP, Athens, 1986 (220 pgs.) (Parts in English, French or Spanish only). PNUE/FAO: **Etudes de base et surveillance continue des métaux, notamment du mercure et du cadmium, dans les organismes marins (MED POL II).** MAP Technical Reports Series No. 2. UNEP, Athens, 1986 (220 pgs.) (Parties en anglais, français ou espagnol seulement).

MTS 3. (*) UNEP/FAO: Baseline studies and monitoring of DDT, PCBs and other chlorinated hydrocarbons in marine organisms (MED POL III). MAP Technical Reports Series No. 3. UNEP, Athens, 1986 (128 pgs.) (Parts in English, French or Spanish only). PNUE/FAO: **Etudes de base et surveillance continue du DDT, des PCB et des autres hydrocarbures chlorés contenus dans les organismes marins (MED POL III).** MAP Technical Reports Series No. 3. UNEP, Athens, 1986 (128 pgs.) (Parties en anglais, français ou espagnol seulement).

MTS 4. (*) UNEP/FAO: Research on the effects of pollutants on marine organisms and their populations (MED POL IV). MAP Technical Reports Series No. 4. UNEP, Athens, 1986 (118 pgs.) (Parts in English, French or Spanish only). PNUE/FAO: **Recherche sur les effets des polluants sur les organismes marins et leurs peuplements (MED POL IV).** MAP Technical Reports Series No. 4. UNEP, Athens, 1986 (118 pgs.) (Parties en anglais, français ou espagnol seulement).

MTS 5. (*) UNEP/FAO: Research on the effects of pollutants on marine communities and ecosystems (MED POL V). MAP Technical Reports Series No. 5. UNEP, Athens, 1986 (146 pgs.) (Parts in English or French only). PNUE/FAO: **Recherche sur les effets des polluants sur les communautés et écosystèmes marins (MED POL V).** MAP Technical Reports Series No. 5. UNEP, Athens, 1986 (146 pgs.) (Parties en anglais ou français seulement).

MTS 6. (*) UNEP/IOC: Problems of coastal transport of pollutants (MED POL VI). MAP Technical Reports Series No. 6. UNEP, Athens, 1986 (100 pgs.) (English only).

MTS 7. (*) UNEP/WHO: Coastal water quality control (MED POL VII). MAP Technical Reports Series No. 7. UNEP, Athens, 1986 (426 pgs.) (Parts in English or French only). PNUE/OMS: **Contrôle de la qualité des eaux côtières (MED POL VII).** MAP Technical Reports Series No. 7. UNEP, Athens, 1986 (426 pgs.) (Parties en anglais ou français seulement).

MTS 8. (*) UNEP/AEA/IOC: Biogeochemical studies of selected pollutants in the open waters of the Mediterranean (MED POL VIII). MAP Technical Reports Series No. 8. UNEP, Athens, 1986 (42 pgs.) (parts in English or French only). PNUE/AIEA/COI: **Etudes biogéochimiques de certains polluants au large de la Méditerranée (MED POL VIII).** MAP Technical Reports Series No. 8. UNEP, Athens, 1986 (42 pgs.) (parties en anglais ou français seulement).

MTS 8. Add. (*)UNEP: Biogeochemical studies of selected pollutants in the open waters of the Mediterranean (MED POL VIII). Addendum, Greek Oceanographic Cruise 1980. MAP Technical Reports Series No. 8, Addendum. UNEP, Athens, 1986 (66 pgs.) (English only).

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