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Programme

MEDITERRANEAN ACTION PLAN

First Meeting of the Task Team on
Implications of Climatic Changes
on the Coastal Area of Fuka-Matrouh, Egypt

Matrouh, 28-30 November 1993

REPORT
OF THE FIRST MEETING OF THE TASK TEAM ON IMPLICATIONS OF CLIMATIC CHANGES ON THE COASTAL AREA OF FUKA-MATROUH

UNEP
Athens, 1993

TABLE OF CONTENTS

BACKGROUND

As part of the efforts of the United Nations Environment Programme (UNEP) to analyze the potential implications of predicted climate change and to assist the governments in designing policies and measures which may avoid or mitigate the expected negative effects of this change, or to adapt to them, Task Teams on the implications of climate change were established in 1987 for six regions covered by the UNEP-sponsored Regional Seas Programme (Mediterranean, Wider Caribbean, South Pacific, East Asian Seas, South Asian Seas, and South East Pacific regions), with the initial objective of preparing regional studies on expected climate change on coastal and marine ecosystems, as well as on the socio-economic structures and activities within these regions. Additional Task Teams were later established for the West and Central African, Eastern African, Persian/Arabian Gulf and Black Sea regions.

During the work on the Mediterranean regional study [1], in the period from 1987 to 1989, it was felt that while the general effects might be similar throughout the Mediterranean region, the response to these effects would have to be highly site-specific. Therefore in the framework of the Mediterranean Task Team six specific case studies were prepared (deltas of the rivers Ebro, Rhone, Po and Nile; Thermaikos Gulf and Ichkeul/Bizerte lakes) in 1989. The final results of the work on the Mediterranean regional studies and on the six case studies were published in the book "Climatic Change and the Mediterranean" (L. Jeftic, J.D. Milliman, G. Sestini, Eds.), Edward Arnold Publ., London, 1992.

In preparing these case studies it had become apparent that prediction of impacts was constrained by the absence of scenarios of future climates on a regional, sub-regional and local scale. Accordingly the Climatic Research Unit of the University of East Anglia had been commissioned by UNEP to attempt to produce a Mediterranean Basin scenario and to develop scenarios of future local climate for the selected case study areas.

Using the experience of the "first generation" case studies, in 1990 the preparation of the "second generation" of site-specific case studies was initiated for the Island of Rhodes, Kastela Bay, the Syrian coast, the Maltese islands, the Cres-Losinj Islands and the Bay of Izmir.

The objectives of these studies were:

- to identify and assess the possible implications of expected climate change on the terrestrial, aquatic and marine ecosystems, population, land- and sea-use practices, and other human activities;

- to determine areas or systems which appear to be most vulnerable to the expected climate change; and

- to suggest policies and measures which may mitigate or avoid the negative effects of the expected impact, or adapt to them, through planning and management of coastal areas and resources;

using the presently available data and the best possible extrapolations from these data.

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1 Implications of expected climate changes in the Mediterranean. MAP Technical Reports Series No. 27. UNEP, Athens, 1989.

The final results of these five case studies were presented at the meeting on Implications of Climatic Changes on the Mediterranean Coastal Areas (Island of Rhodes, Kastela Bay, Syrian Coast, Malta and Cres/Losinj), held in Malta in September 1992. The report of this meeting, containing the main findings, conclusions and recommendations of the five studies, was published as document UNEP(OCA)/MED WG.55/7.

A third generation of case studies was launched, in 1993, in the framework of the site-specific Coastal Areas Management Programme (CAMP). So far two such studies are being developed (Fuka-Matrouh coastal region and Albanian coast). For each of the second generation of case studies Task Teams were established and the same procedure will be followed for the third generation of case studies.

This meeting is the first meeting of the Task Team for Fuka-Matrouh case study.

REPORT OF THE MEETING

Opening of the Meeting - Agenda item 1

The meeting was opened on 28 November 1993 by Mr M. A. Allam, Representative of the Governorate of Matrouh in the Steering Committee of the Fuka-Matrouh CAMP, and Chairman of the North-West Coastal Zone Authority for Developing and Rehabilitation, who welcomed the participants on behalf of the Governor of the Matrouh Governorate and expressed appreciation for the support of the United Nations Environment Programme (UNEP) and of the Co-ordinating Unit for the Mediterranean Action Plan in preparing for the first meeting of the Task Team on the Implications of Climatic Changes on Fuka-Matrouh coastal region.

Mr A.A. Khafagy welcomed the participants on behalf of the Egyptian Environment Affairs Agency.

Mr L. Jeftic, Deputy Co-ordinator of the Mediterranean Action Plan (MAP) welcomed the participants on behalf of Ms E. Dowdeswell, Executive Director of UNEP. He expressed his appreciation for the support provided by the Egyptian authorities and thanked Mr M.A. Allam for providing premises and facilities for the meeting. He continued by briefly outlining the background and scope of the meeting and expressed the hope that both the meeting and the work of the Task Team on the implications of climatic changes on Fuka-Matrouh coastal region would be successful.

The meeting was held in the premises of the North-West Coastal Zone Authority for Developing and Rehabilitation. The meeting's participants are listed in Annex I to this report.

In view of its relevance to the work of the Task Team, the participants visited the Qasr Rural Development Project, where Mr P. Klemann, the Project's Team Leader, gave an overview of the Project's objectives and results. In addition, an extensive field trip was undertaken by the participants of the meeting in order to visit some of the characteristic sites and coastal areas which will be covered by the study expected to be prepared by the Task Team.

Election of Officers - Agenda Item 2

The meeting unanimously elected Mr A.A. Khafagy, Coordinator of the Task Team as Chairman, and Mr S. Keckes as Rapporteur of the meeting. Mr L. Jeftic acted as technical secretary.

Adoption of the Agenda - Agenda Item 3

The provisional agenda as proposed by the secretariat was adopted and appears as Annex II to this report.

Overview of greenhouse effect and its implications - Agenda Item 4

Mr L. Jeftic presented an overview of the current consensus views concerning the greenhouse effect; past and predicted changes in global mean temperature and sea level; as well as the range of possible climatic change impacts which might occur in the case study area (Annex III). He also referred to the activities organised by the Oceans and Coastal Areas Programme Activity Centre (OCA/PAC) of UNEP and MAP concerning the evaluation of the implications of climatic changes.

Mr L. Jeftic informed the meeting that the Climate Research Unit of the University of East Anglia (CRU) prepared a set of regional scenarios of climatic changes for the Mediterranean region and had agreed to provide sub-regional scenarios in support of the Mediterranean case studies. As part of this work, sub-regional scenarios of future climate for the Island of Rhodes, Kastela Bay, the Island of Malta, Syrian Coast and Cres-Losinj Islands were already prepared. Such scenario for Fuka-Matrouh region was prepared by CRU and will be presented under Agenda item 6.

Coastal Area Management Programme (CAMP) for the coastal area of Fuka-Matrouh - agenda item 5

Mr L. Jeftic gave an overview of the Coastal Areas Management Programme (CAMP) for the coastal area of Fuka-Matrouh giving short descriptions of all activities (Annex IV).

Climatic changes scenario for the coastal area of Fuka-Matrouh - agenda item 6

Ms J. Palutikof presented the high resolution scenarios of the change in temperature and precipitation due to the enhanced greenhouse effect which were prepared for the region. These indicate a warming less than the global level. Precipitation is suggested to decrease slightly over the year as a whole. Reduced precipitation in winter and autumn is responsible for this annual change. Scenario show wetter conditions in spring.

The detailed temperature and precipitation scenarios for northern Egypt are shown in Annex V. Operative scenarios for temperature, precipitation and sea-level rise for time horizons 2030 and 2100 to be used by the Task Team are presented in Annex VI.

Implications of expected climatic changes on Fuka-Matrouh region - agenda item 7

Project outline - Agenda Item 7.1.

Basic information on the Fuka-Matrouh region was provided by Mr M.A. Allan (Annex VII). The geographic coverage of the study area was discussed and it was decided that it should go around 80 km from Marsa Matrouh eastward to Fuka, and 70 km southward to the limit of the rainfall, as indicated in the two maps (Annex VIII).

Mr L. Jeftic then made a detailed presentation of the objectives, assumptions and outputs of the study (Annex IX), and proposed an outline for the final report of the project. The outline was discussed in details and was adopted, with changes agreed by the meeting and an indication of Task Team members responsible for the various sections of the report (Annex X of this report).

General workplan and timetable - Agenda Item 7.2.

The proposed general workplan and timetable for the project was presented by Mr L. Jeftic and was discussed and amended. The final agreed workplan and timetable appear in Annex XI of this report.

Detailed workplan for each Task Team member - Agenda Item 7.3.

Tasks and workplan for each Task Team member were briefly discussed and the lead authors for individual sections of the report were agreed by the meeting (Annex X). Details of the approaches to be used during the study were also agreed upon. These would include, where possible, approximate cost-benefit analyses for alternative response options and an integrated approach to impact assessment and sectorial evaluations.

The need for close cooperation between the various Task Teams established in the framework of CAMP for Fuka-Matrouh (discussed under agenda item 5) was emphasized, and the Chairman was requested to ensure, through EEAA, that this cooperation is established and effectively implemented.

The meeting emphasized the importance of using the existing information base relevant to the study, and in this respect the special value of the information contained in the reports and publications resulting from the Qasr Rural Development Project (see Annex XII) was recognized.

Concern was expressed by the meeting about the expenses which will have to be met by the members of the Task Team in performing their tasks (i.e., additional travel to the study area, acquisition of documentation, stationary, telecommunication costs, etc.), as well as for the next meetings of the Task Team. It was stressed that these expenses are expected to be covered by the funds which were agreed to be provided by the Egyptian authorities as their counterpart contribution to the funds provided by UNEP. The Co-ordinator of the Task Team, and Mr M.A. Allam, as member of the Fuka-Matrouh CAMP Steering Committee, were asked to clarify the issue with Mr M. Fawzi, representative of the EEAA.

Adoption of the report - Agenda Item 8

The draft report, including its substantive annexes, was considered and adopted by the meeting, as it appears in this document.

Closure of the Meeting - Agenda Item 9

In his closing remarks, Mr L. Jeftic expressed satisfaction with the results of the meeting, with the enthusiasm expressed by the Municipality of Matrouh and the Task Team members for the study and the constructive spirit in which the meeting had been conducted. He also thanked the participants, Chairman and Rapporteur for their hard work, and the representative of the Egyptian Environment Affairs Agency and the representatives of the Municipality of Matrouh.

An exchange of courtesies followed after which the Chairman closed the meeting on 30 November 1993.

ANNEX I

LIST OF PARTICIPANTS

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ANNEX II

AGENDA

1. Opening of the Meeting

2. Election of Officers

3. Adoption of the Agenda

4. Overview of greenhouse effect and its implications

5. Coastal Area Management Programme (CAMP) for the coastal area of Fuka-Matrouh

6. Climatic changes scenario for the coastal area of Fuka-Matrouh

7. Implications of climatic changes on the coastal area of Fuka-Matrouh

   6.1. Project outline
   6.2. General workplan and timetable
   6.3. Detailed workplan for each Task Team member

8. Adoption of the report

9. Closure of the Meeting

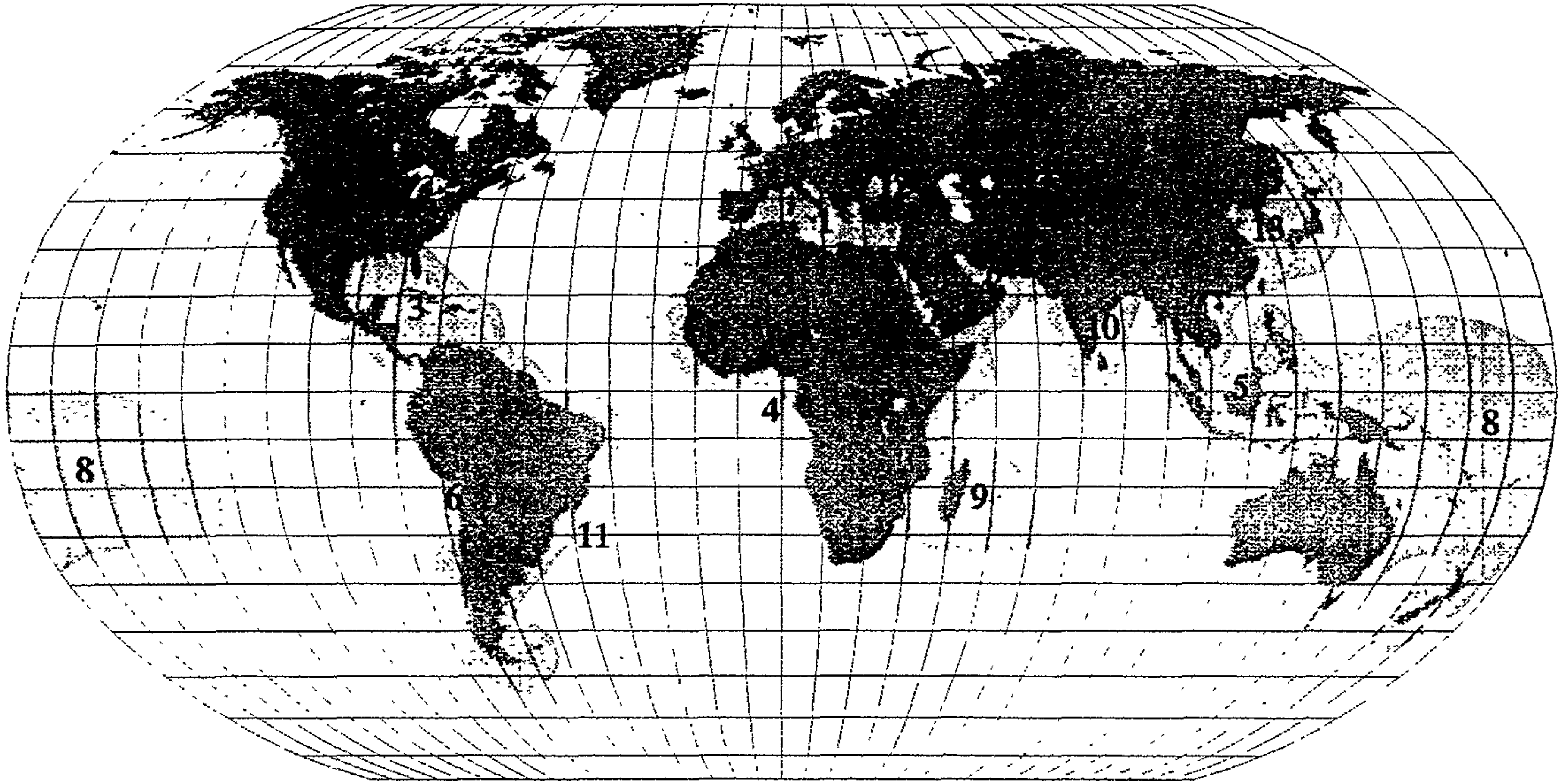
ANNEX III

OVERVIEW OF THE GREENHOUSE EFFECT AND ITS IMPLICATIONS

This Annex contains copies of transparencies reviewing:

- the basic information on UNEP and MAP;
- description of the Coastal Areas Management programme of MAP;
- the basics of the greenhouse effect;
- past and predicted changes in temperatures and sea level;
- possible implications of climatic changes;
- work carried out by the Mediterranean Task Team on climatic changes and its results;
- work of the Climatic Research Unit (CRU) of the East Anglia University, UK, on the development of Mediterranean scenarios (with sub-regional specifics) of future changes in temperature and precipitation.

Since these transparencies were prepared for oral presentations only, by using various sources of open and grey literature, in a number of transparencies the source of information was not cited.



1. Mediterranean Region
2. Kuwait Action Plan Region
3. Wider Caribbean Region
4. West and Central African Region
5. East Asian Seas Region
6. South East Pacific Region
7. Red Sea and Gulf of Aden Region
8. South Pacific Region
9. Eastern African Region
10 South Asian Seas Region
11. South West Atlantic Region
12 Black Sea Region
13 North West Pacific Region

UNEP/MEDU
3 September 1993
Internal Code REGSEAS3

Geographic coverage of UNEP Regional Seas Programme

COMPONENTS OF THE MEDITERRANEAN ACTION PLAN

- INTEGRATED PLANNING OF THE DEVELOPMENT AND MANAGEMENT OF THE RESOURCES OF THE MEDITERRANEAN BASIN (BLUE PLAN AND PRIORITY ACTIONS PROGRAMME);

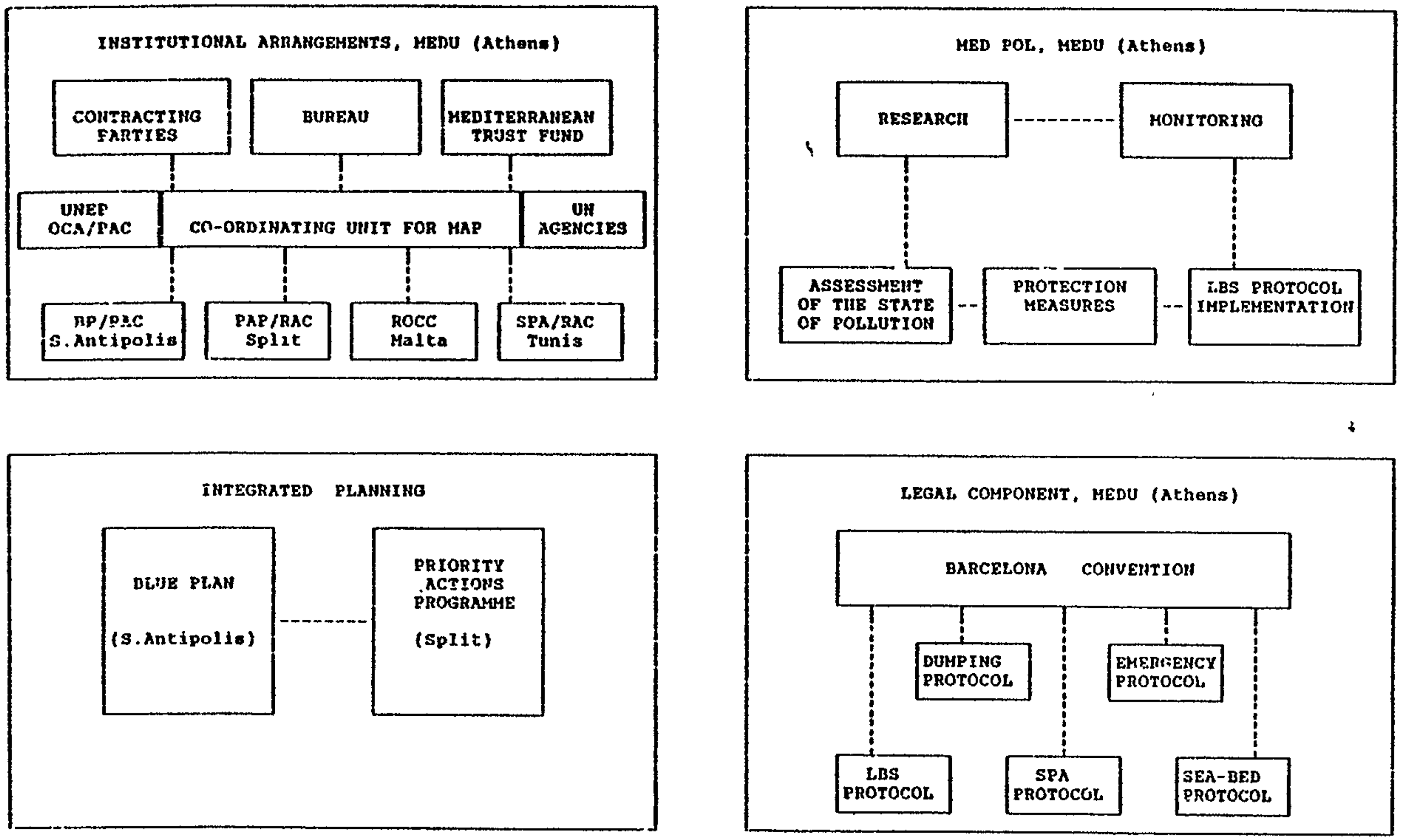
- CO-ORDINATED PROGRAMME FOR RESEARCH, MONITORING AND EXCHANGE OF INFORMATION AND ASSESSMENT OF THE STATE OF POLLUTION AND OF PROTECTION MEASURES (MED POL);

- FRAMEWORK CONVENTION AND RELATED PROTOCOLS WITH THEIR TECHNICAL ANNEXES FOR THE PROTECTION OF THE MEDITERRANEAN ENVIRONMENT;

- INSTITUTIONAL AND FINANCIAL ARRANGEMENTS.

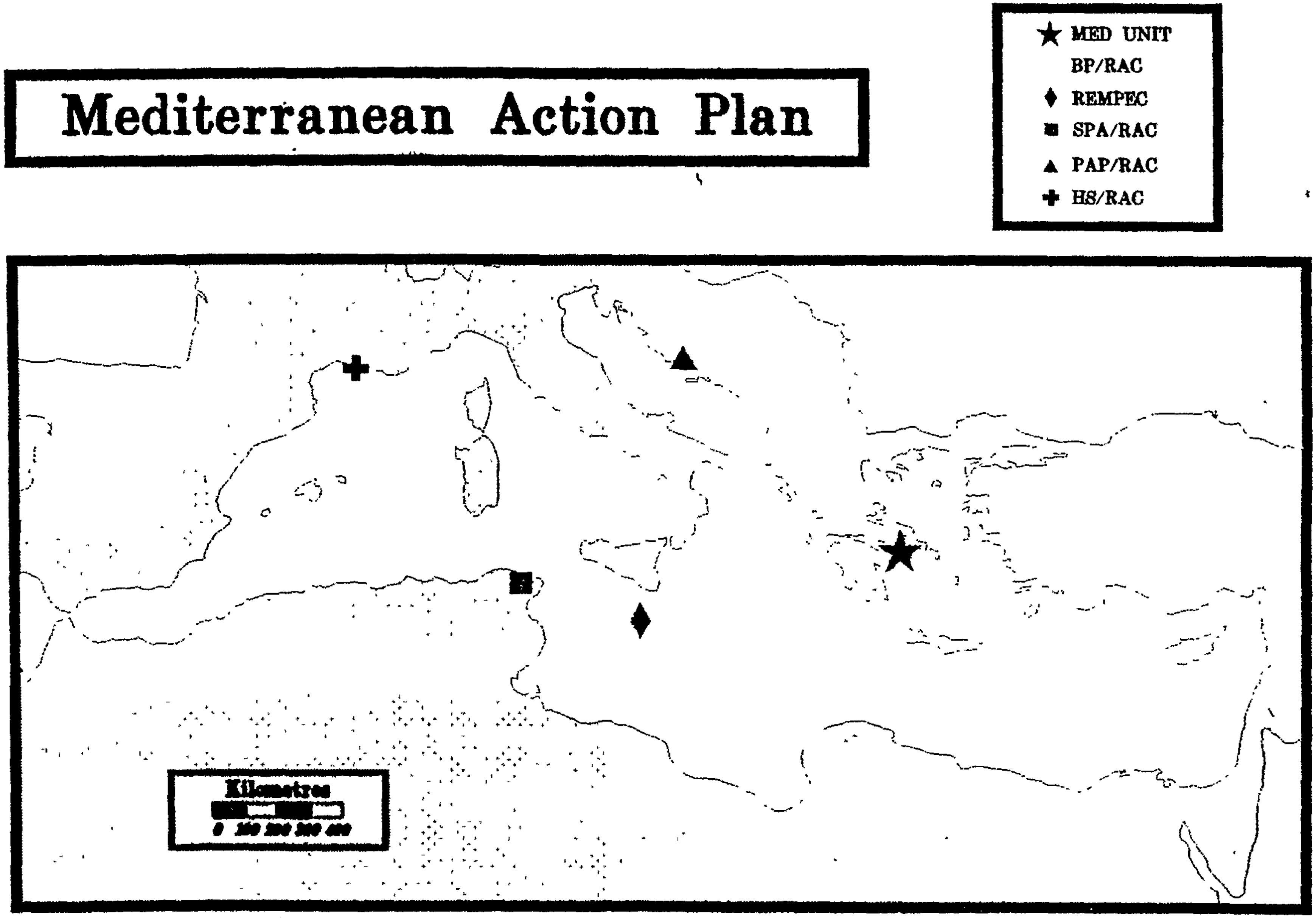
MEDITERRANEAN ACTION PLAN (MAP)

CO-ORDINATION OF ALL FOUR COMPONENTS BY THE CO-ORDINATING UNIT FOR MAP (MEDU), Athens



MEDU = CO-ORDINATING UNIT FOR MAP; OCA/PAC = OCEANS AND COASTAL AREAS PROGRAMME ACTIVITY CENTRE; BP = BLUE PLAN; RAC = REGIONAL ACTIVITY CENTRE: PAP = PRIORITY ACTIONS PROGRAMME; ROCC = REGIONAL OIL COMBATING CENTRE; SPA = SPECIALLY PROTECTED AREAS; MED POL = CO-ORDINATED PROGRAMME FOR RESEARCH, MONITORING, ASSESSMENT OF THE STATE OF POLLUTION AND PROTECTION MEASURES; LBS = LAND-BASED SOURCES; SEA-BED = EXPLORATION AND EXPLOITATION OF SEA-BED.

Mediterranean Action Plan



UNEP/MEDU June 1992 Internal Code REGCEN6 Scale 1:16000000

PROTOCOLS RELATED TO THE BARCELONA CONVENTION

PROTOCOL FOR THE PREVENTION OF POLLUTION OF THE MEDITERRANEAN SEA BY DUMPING FROM SHIPS AND AIRCRAFT (DUMPING PROTOCOL)

ADOPTED 18 FEBRUARY 1976 ENTRY INTO FORCE 12 FEBRUARY 1978

PROTOCOL CONCERNING CO-OPERATION IN COMBATING POLLUTION OF THE MEDITERRANEAN SEA BY OIL AND OTHER HARMFUL SUBSTANCES IN CASES OF EMERGENCY (EMERGENCY PROTOCOL)

ADOPTED 18 FEBRUARY 1976 ENTRY INTO FORCE 12 FEBRUARY 1978

PROTOCOL FOR THE PROTECTION OF THE MEDITERRANEAN SEA AGAINST POLLUTION FROM LAND-BASED SOURCES (LBS PROTOCOL)

ADOPTED 17 MAY 1980 ENTRY INTO FORCE 17 JUNE 1983

PROTOCOL CONCERNING MEDITERRANEAN SPECIALLY PROTECTED AREAS (SPA PROTOCOL)

ADOPTED 2 APRIL 1982 ENTRY INTO FORCE 23 MARCH 1986

PROTOCOL CONCERNING THE PROTECTION OF THE MEDITERRANEAN SEA AGAINST POLLUTION RESULTING FROM EXPLORATION AND EXPLOITATION OF THE CONTINENTAL SHELF AND THE SEA-BED AND ITS SUB-SOIL

(IN PREPARATION)

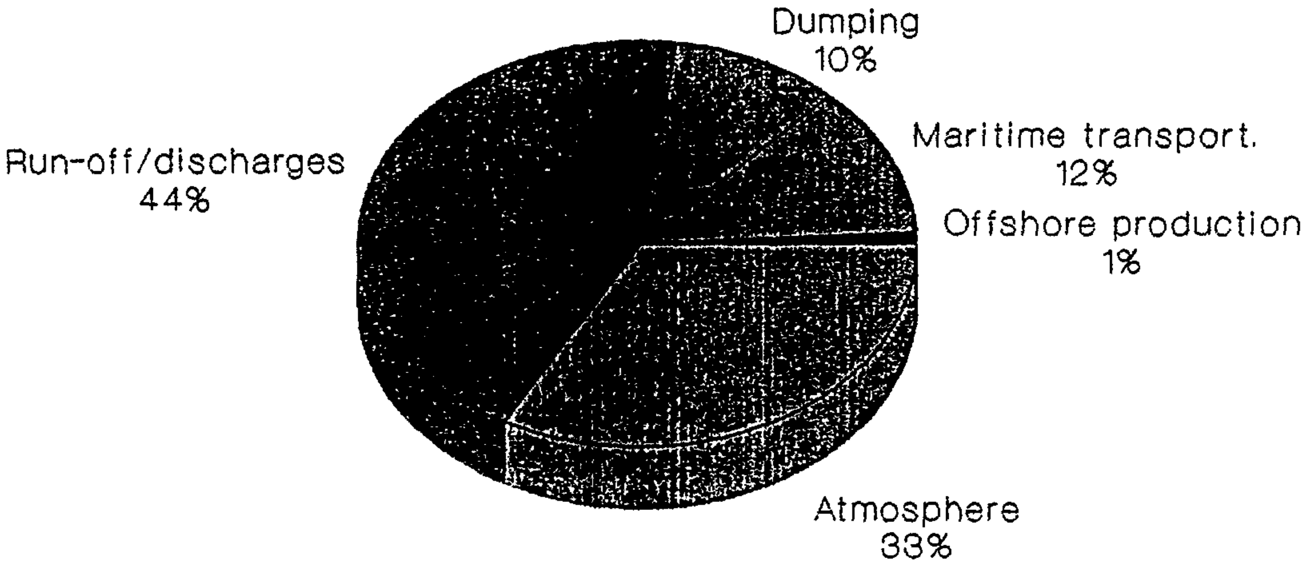
IMPLEMENTATION WORKPLAN FOR LAND-BASED SOURCES PROTOCOL

1.	USED LUBRICATING OILS	1986
2.	SHELL-FISH AND SHELL-FISH GROWING WATERS	1986
3.	CADMIUM AND CADMIUM COMPOUNDS	1987
4.	MERCURY AND MERCURY COMPOUNDS	1987
5.	ORGANOHALOGEN COMPOUNDS	1987
6.	PERSISTENT SYNTHETIC MATERIALS WHICH MAY FLOAT, SINK OR REMAIN IN SUSPENSION	1988
7.	ORGANOPHOSPHOROUS COMPOUNDS	1988
8.	ORGANOTIN COMPOUNDS	1988
9.	RADIOACTIVE SUBSTANCES	1989
10.	CARCINOGENIC, TERATOGENIC OR MUTAGENIC SUBSTANCES	1989
11.	PATHOGENIC MICROORGANISMS	1989
12.	CRUDE OILS AND HYDROCARBONS OF ANY ORIGIN	1990
13.	ZINC, COPPER AND LEAD	1990
14.	NICKEL, CHROMIUM, SELENIUM AND ARSENIC	1990
15.	INORGANIC COMPOUNDS OF PHOSPHOROUS AND ELEMENTAL PHOSPHOROUS	1991
16.	NON-BIODEGRADABLE DETERGENTS AND OTHER SURFACE-ACTIVE SUBSTANCES	1991
17.	THERMAL DISCHARGES	1991
18.	ACID OR ALKALINE COMPOUNDS	1992
19.	SUBSTANCES HAVING ADVERSE EFFECT ON THE OXYGEN CONTENT	1992
20.	BARIUM, URANIUM AND COBALT	1992
21.	CYANIDES AND FLUORIDES	1993
22.	SUBSTANCES OF A NON-TOXIC NATURE, WHICH MAY BECOME HARMFUL OWING TO THE QUANTITIES DISCHARGED	1993
23.	ORGANOSILICON COMPOUNDS	1993
24.	ANTIMONY, TIN AND VANADIUM	1994
25.	SUBSTANCES WHICH HAVE A DELETERIOUS EFFECT ON THE TASTE AND/OR SMELL OF PRODUCTS FOR HUMAN CONSUMPTION	1994
26.	BIOCIDES AND THEIR DERIVATIVES NOT COVERED IN ANNEX I	1994
27.	TITANIUM, BORON AND SILVER	1995
28.	MOLYBDENUM, BERYLLIUM, THALLIUM AND TELLURIUM	1995

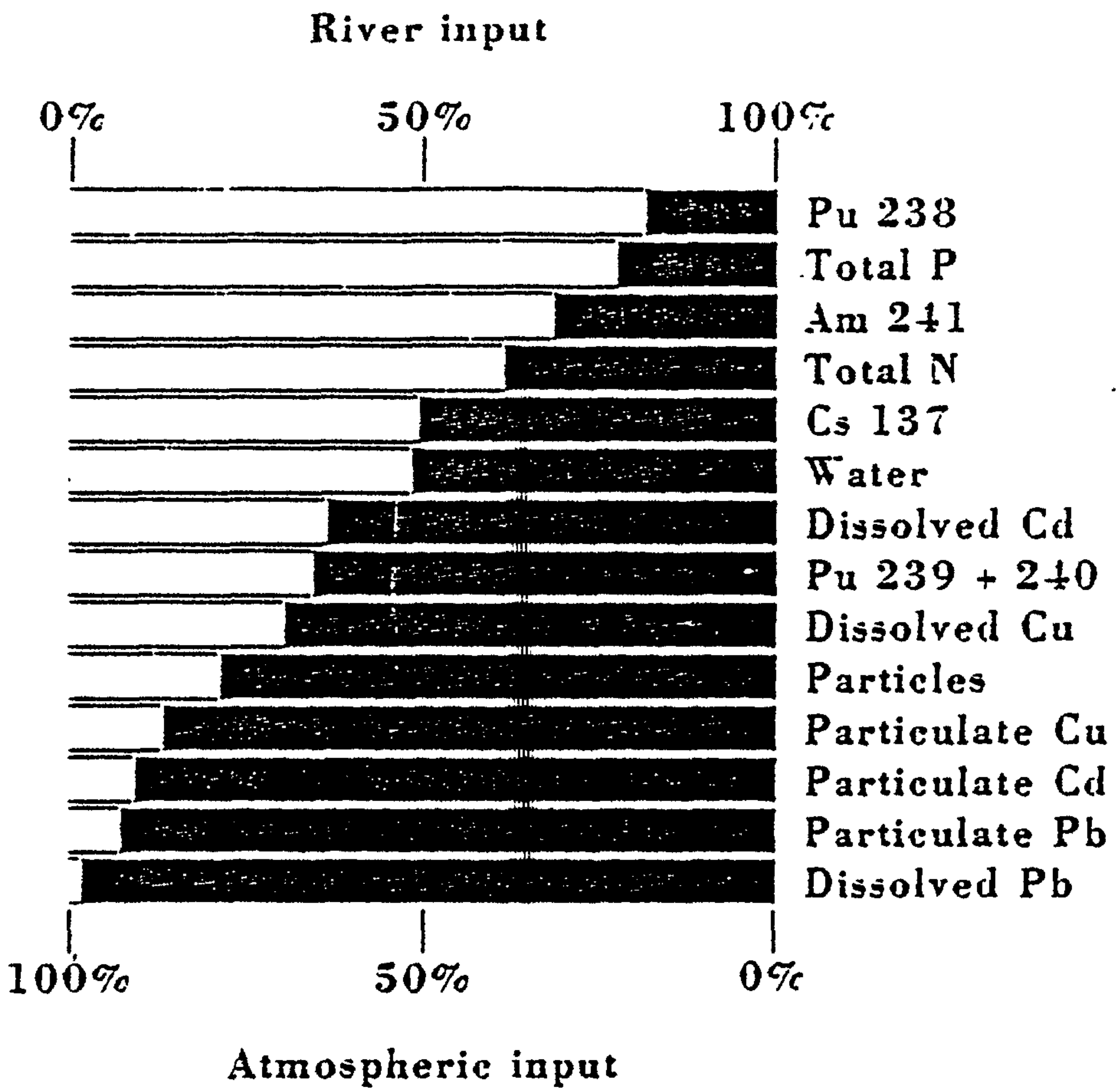
COMMON MEASURES ADOPTED BY THE CONTRACTING PARTIES TO THE BARCELONA CONVENTION

INTERIM ENVIRONMENTAL QUALITY CRITERIA CONCERNING MERCURY CONTENT OF SEAFOOD	SEPT. 1985
INTERIM ENVIRONMENTAL QUALITY CRITERIA CONCERNING MICROBIAL CONCENTRATIONS OF BATHING WATERS	SEPT. 1985
MAXIMUM CONCENTRATION OF MERCURY IN EFFLUENT DISCHARGES	SEPT. 1987
ENVIRONMENTAL QUALITY CRITERIA CONCERNING MICROBIAL CONCENTRATIONS OF SHELLFISH WATERS	SEPT. 1987
CONTROL OF POLLUTION BY USED LUBRICATING OILS	OCT. 1989
CONTROL OF POLLUTION BY CADMIUM AND CADMIUM COMPOUNDS	OCT. 1989
CONTROL OF POLLUTION BY ORGANOTIN COMPOUNDS	OCT. 1989
CONTROL OF POLLUTION BY ORGANOHALOGEN COMPOUNDS	OCT. 1989
CONTROL OF POLLUTION BY ORGANOPHOSPHORUS COMPOUNDS	OCT. 1991
CONTROL OF POLLUTION BY PERSISTENT SYNTHETIC MATERIALS	OCT. 1991
CONTROL OF POLLUTION BY RADIOACTIVE SUBSTANCES	OCT. 1991
CONTROL OF POLLUTION BY PATHOGENIC MICROORGANISMS	OCT. 1991

Relative contribution of contaminants to the marine environment

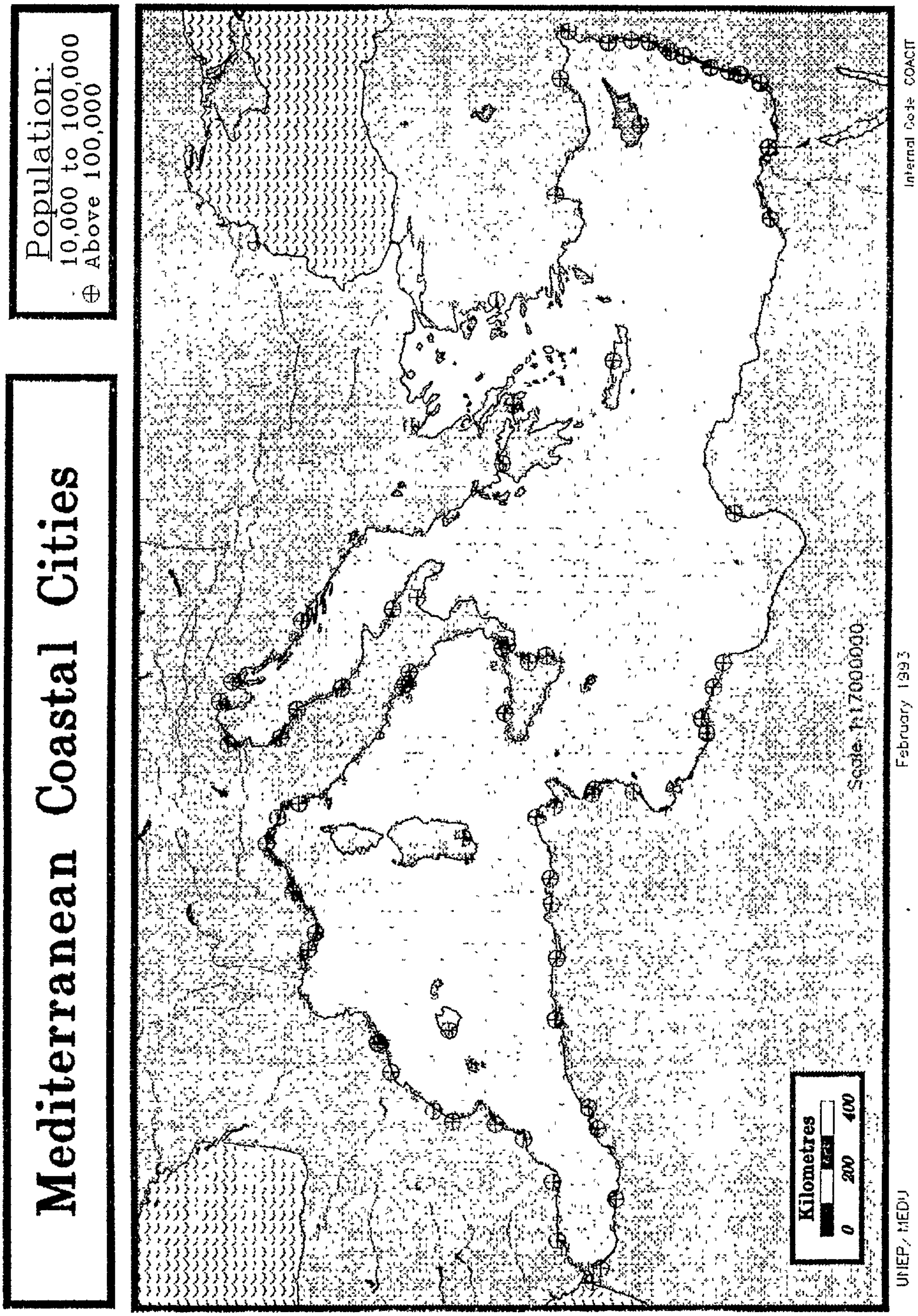


(based on GESAMP 1990)

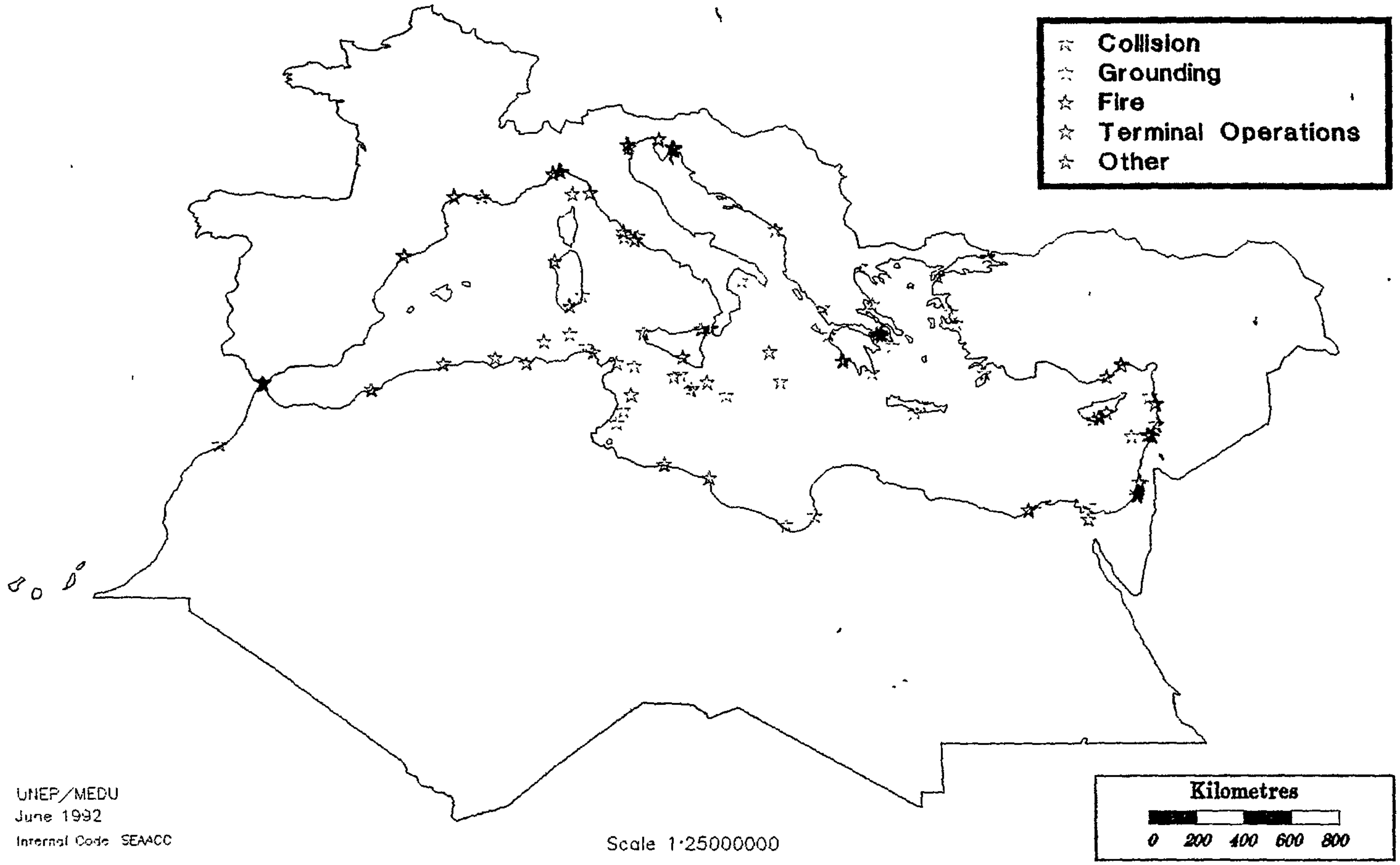

River input
0%
50%
100%
Pu 238
Total P
Am 241
Total N
Cs 137
Water
Dissolved Cd
Pu 239 + 240
Dissolved Cu
Particles
Particulate Cu
Particulate Cd
Particulate Pb
Dissolved Pb
100%
50%
0%
Atmospheric input

LENGTH OF MEDITERRANEAN COASTLINE

COUNTRIES	CONTINENT	ISLANDS	TOTAL	%
SPAIN	1,679	910	2,589	5.74
FRANCE	901	802	1,703	3.77
MONACO			5	0.01
ITALY	4,184	3,766	7,950	17.61
SLOVENIA			41	0.09
CROATIA	1,745	4,028	5,773	12.79
BOSNIA			24	0.05
MONTE NEGRO			278	0.62
ALBANIA			470	1.04
GREECE	7,300	7,700	15,000	33.23
TURKEY	4,141	499	4,640	10.28
CYPRUS			537	1.20
SYRIA			152	0.34
LEBANON			195	0.43
ISRAEL			222	0.49
EGYPT			996	2.21
TUNISIA			1,028	2.29
LIBYA			1,685	3.73
MALTA			190	0.42
ALGERIA			1,300	2.88
MOROCCO			352	0.78
TOTAL	19,950	17,705	45,130	100.00


Mediterranean Coastal Cities
Population:
10,000 to 100,000
Above 100,000
Kilometres
0 200 400
Scale 1:17000000
February 1993
UNEP/MEDU
Internal Code COACIT

Mediterranean Sea Accidents



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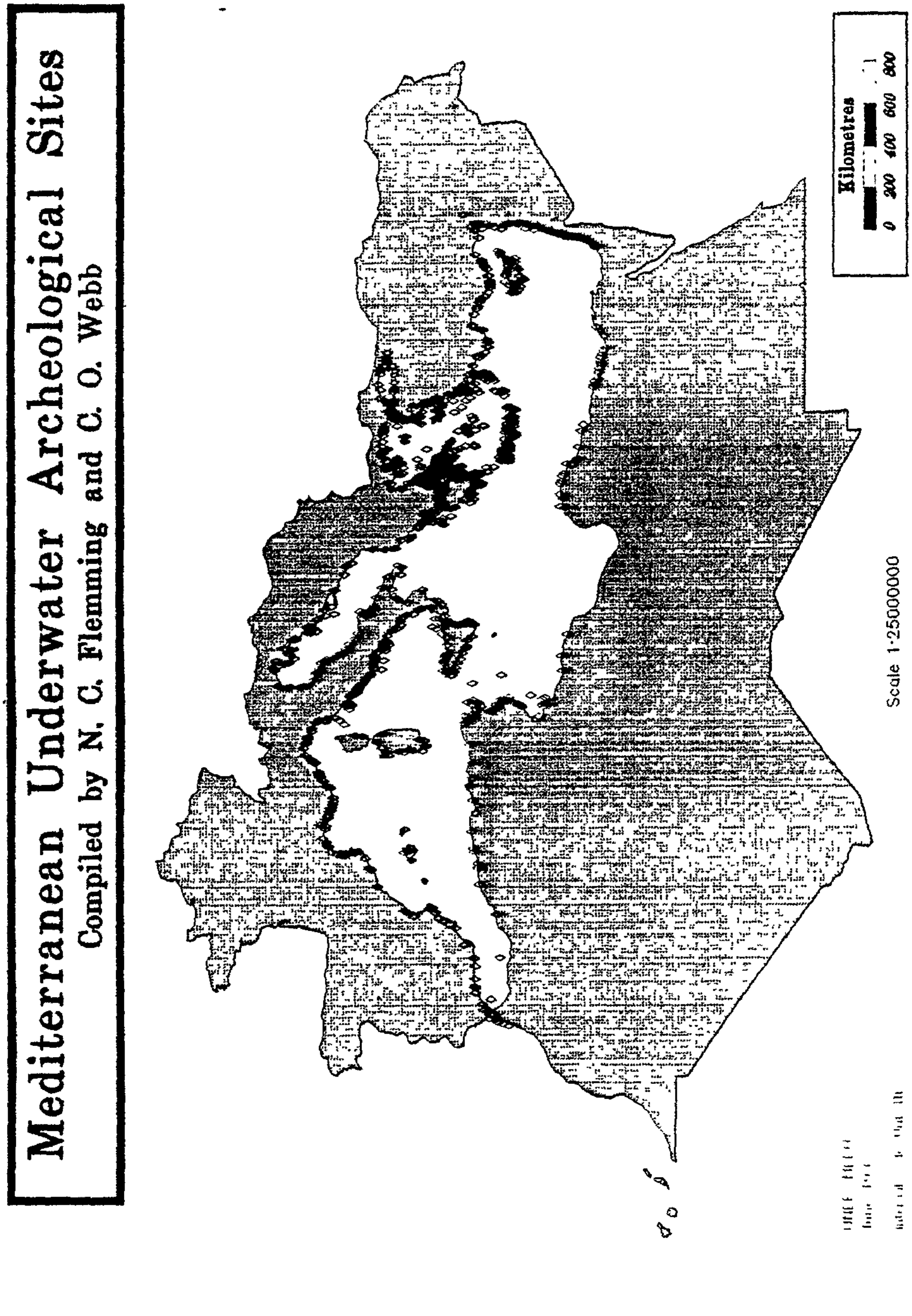
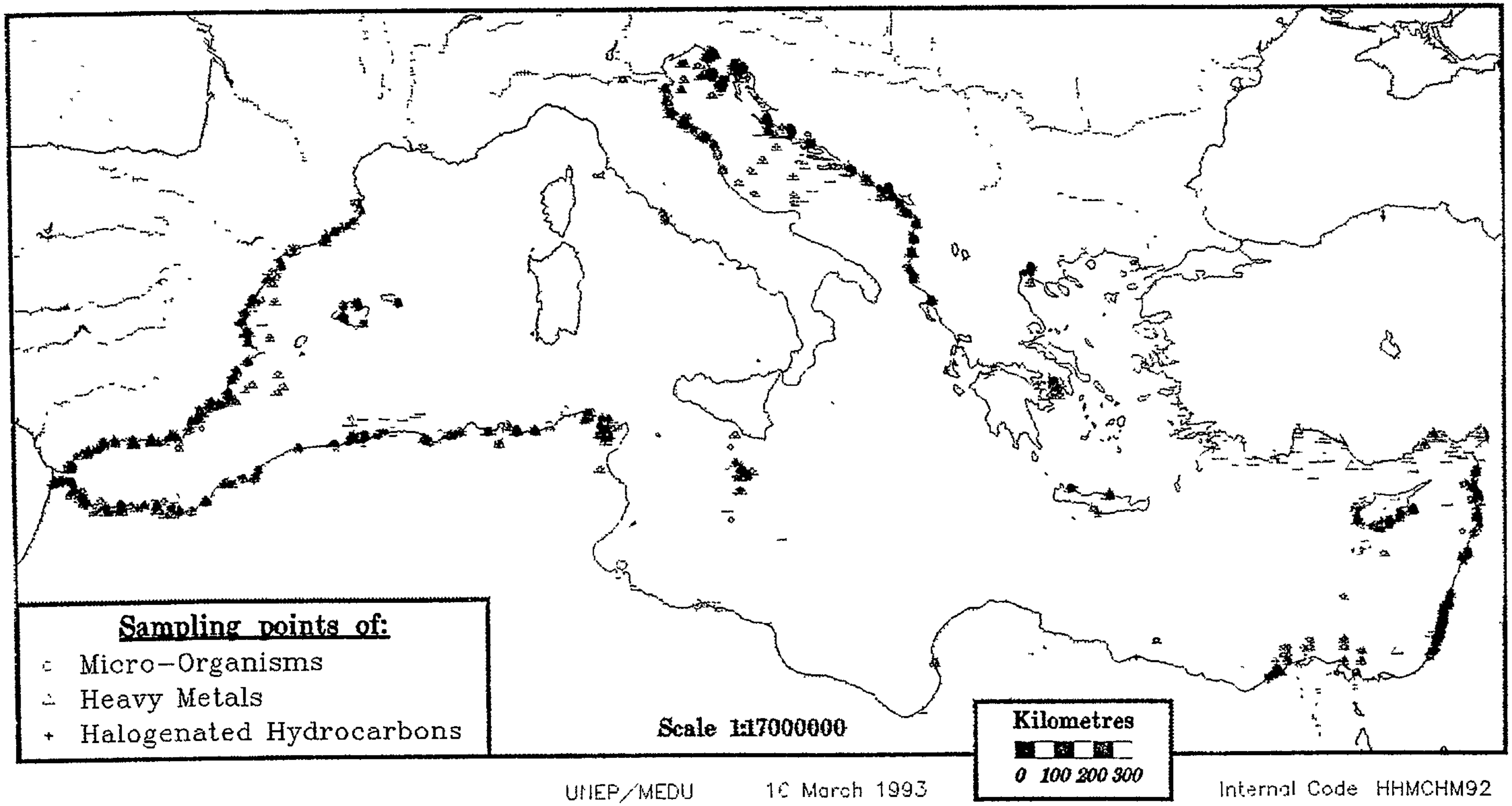
UNEP/MEDU
June 1992
Internal Code SEAACC


Mediterranean Underwater Archeological Sites
Compiled by N. C. Flemming and C. O. Webb
Kilometres
0 200 400 600 800
Scale 1:25000000

MONITORING STATIONS

Mediterranean Pollution Monitoring

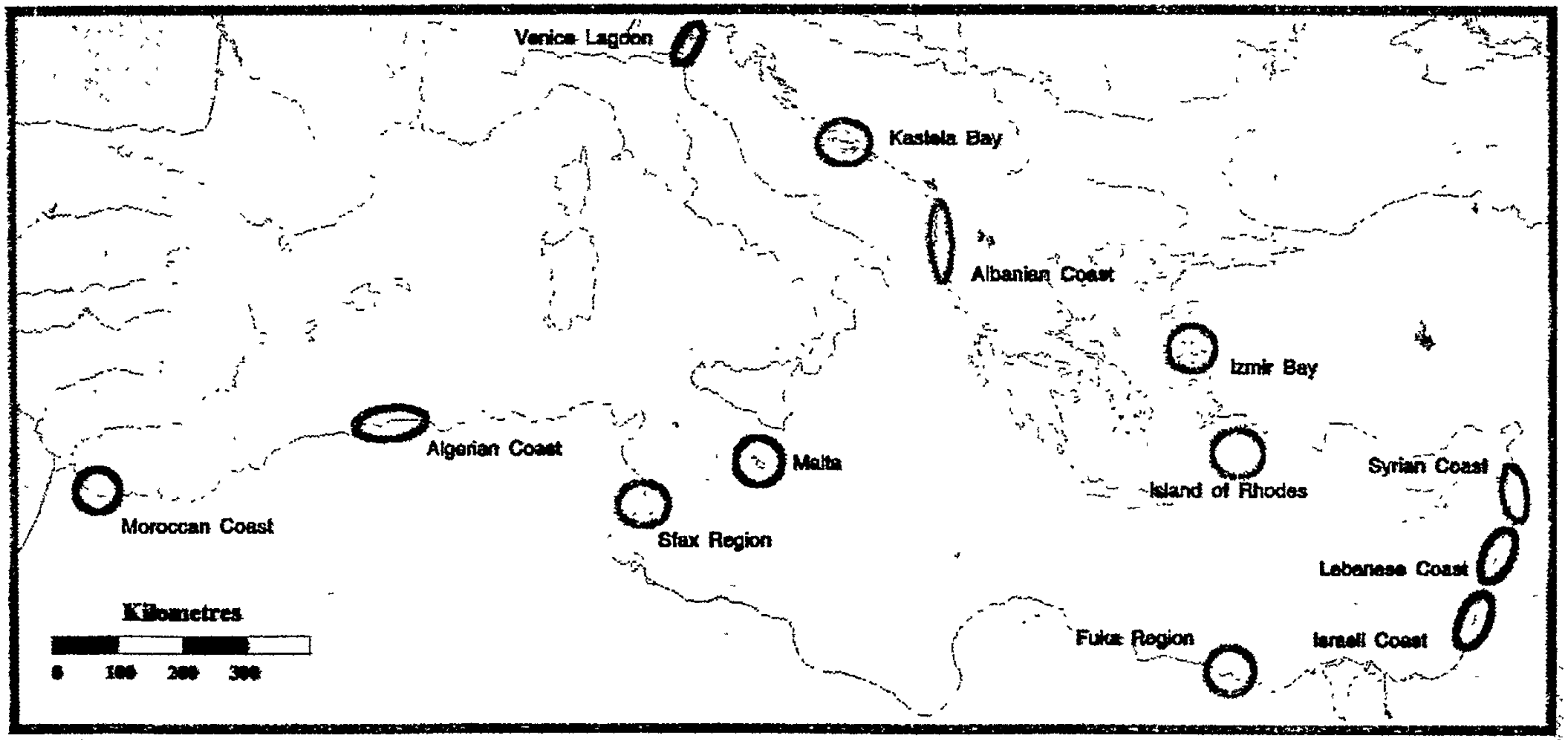
MED POL Phase II - 1983 to 1992



UNEP/MEDU 10 March 1993 Internal Code HHMCHM92

Coastal Area Management Programmes

TO BE FINALIZED
INITIATED
TO BE INITIATED
TO BE APPROVED



UNEP/MEDU 5 July 1993 Scale 1:18000000 Internal Code. CAMPNOB2

DEFINITION	A form of advanced collaboration with national and local authorities and institutions based on principles of sustainable development and integrated coastal zone management
MAIN OBJECTIVES	to introduce or develop the process of integrated planning and management of Mediterranean coastal zones, to contribute to a sustainable development and environment protection
CAMP PHASES: 1. PREPARATORY	 - data collection - upgrading of institutional capacities - environmental knowledge (assimilative capacity, identification of problems and climatic impacts - programme formulation
2. IMPLEMENTATION	- database - training - coastal zone scenarios (development, climatic changes) - integrated planning studies (resource evaluation, impact assessment, development outlook, immediate and long-term mitigation measures) - programme of an integrated plan
3. FOLLOW-UP	- preparation of an integrated plan - implementation - monitoring - re-evaluation

Methodological Framework for MAP Coastal Area Management Programmes

1 **IMPLEMENTATION OF LEGAL INSTRUMENTS**

LBS Protocol (monitoring, survey of pollution, common control measures); Emergency Protocol; Dumping protocol, MARPOL Convention)

2 **RESOURCE EVALUATION, PROTECTION AND MANAGEMENT**

Water; Soil; Forests; Coastline; Marine ecosystems; Protected areas

3 **ACTIVITIES**

Evaluation and trends

4 **NATURAL HAZARDS AND PHENOMENA**

Seismic risk; Implications of climatic changes

5 **PLANNING AND MANAGEMENT TOOLS**

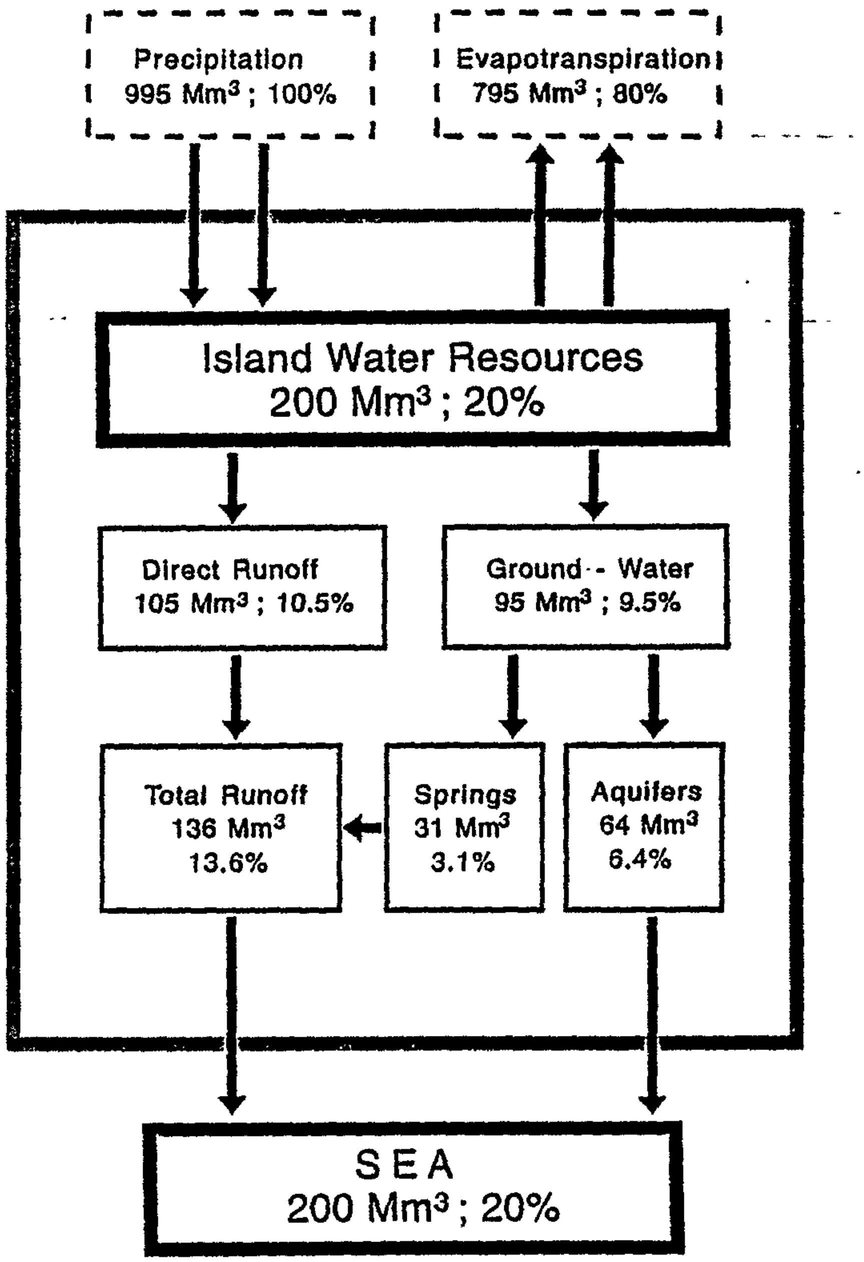
Database; GIS; EIA; Carrying Capacity Assessment for tourism activities

6 **DEVELOPMENT-ENVIRONMENT SCENARIOS**

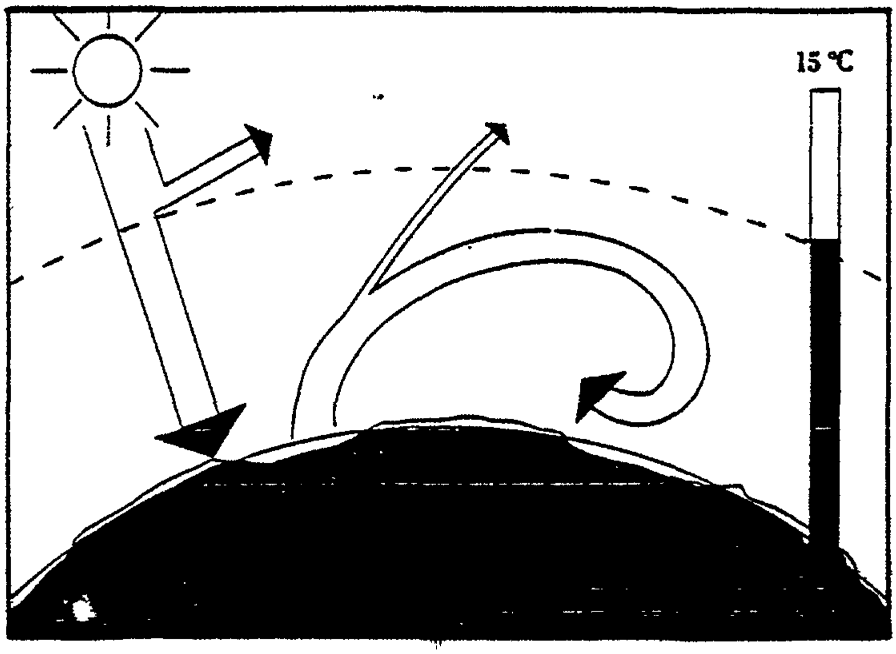
7 **INTEGRATED PLANNING AND MANAGEMENT**

Integrated planning studies; Resources protection and management plans

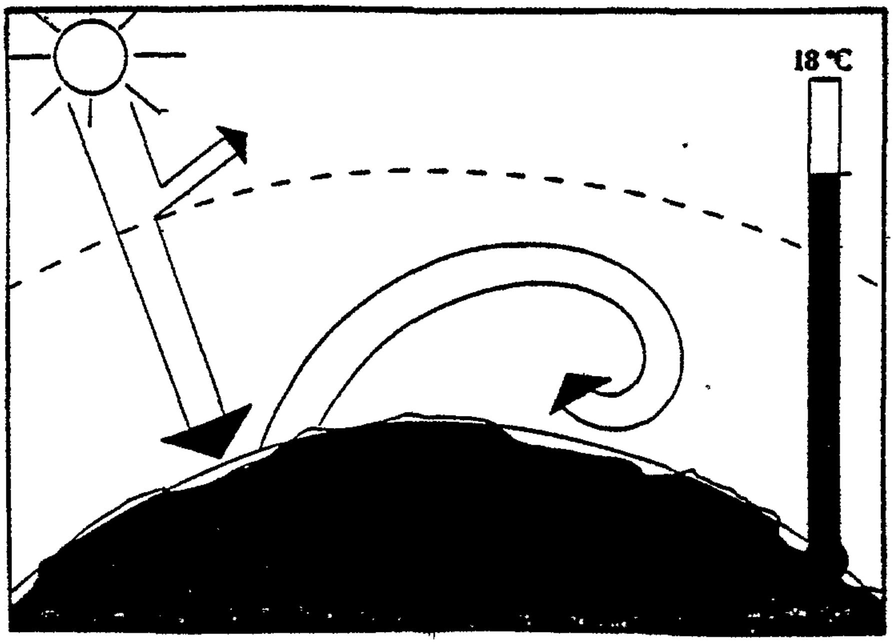
Standard Content of CAMPs



Schematic Diagram of Water Resources Balance of the Island of Rhodes



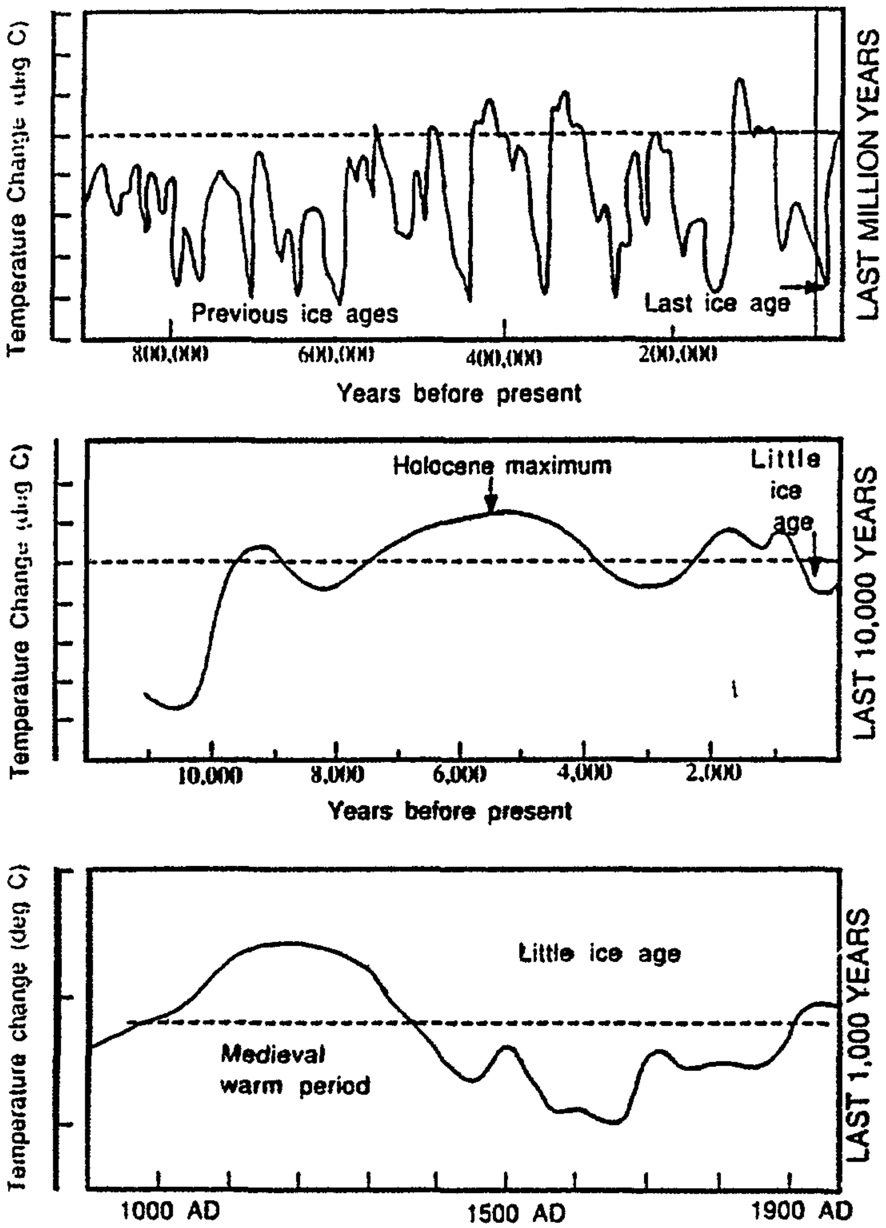
GREENHOUSE EFFECT AT PRESENT



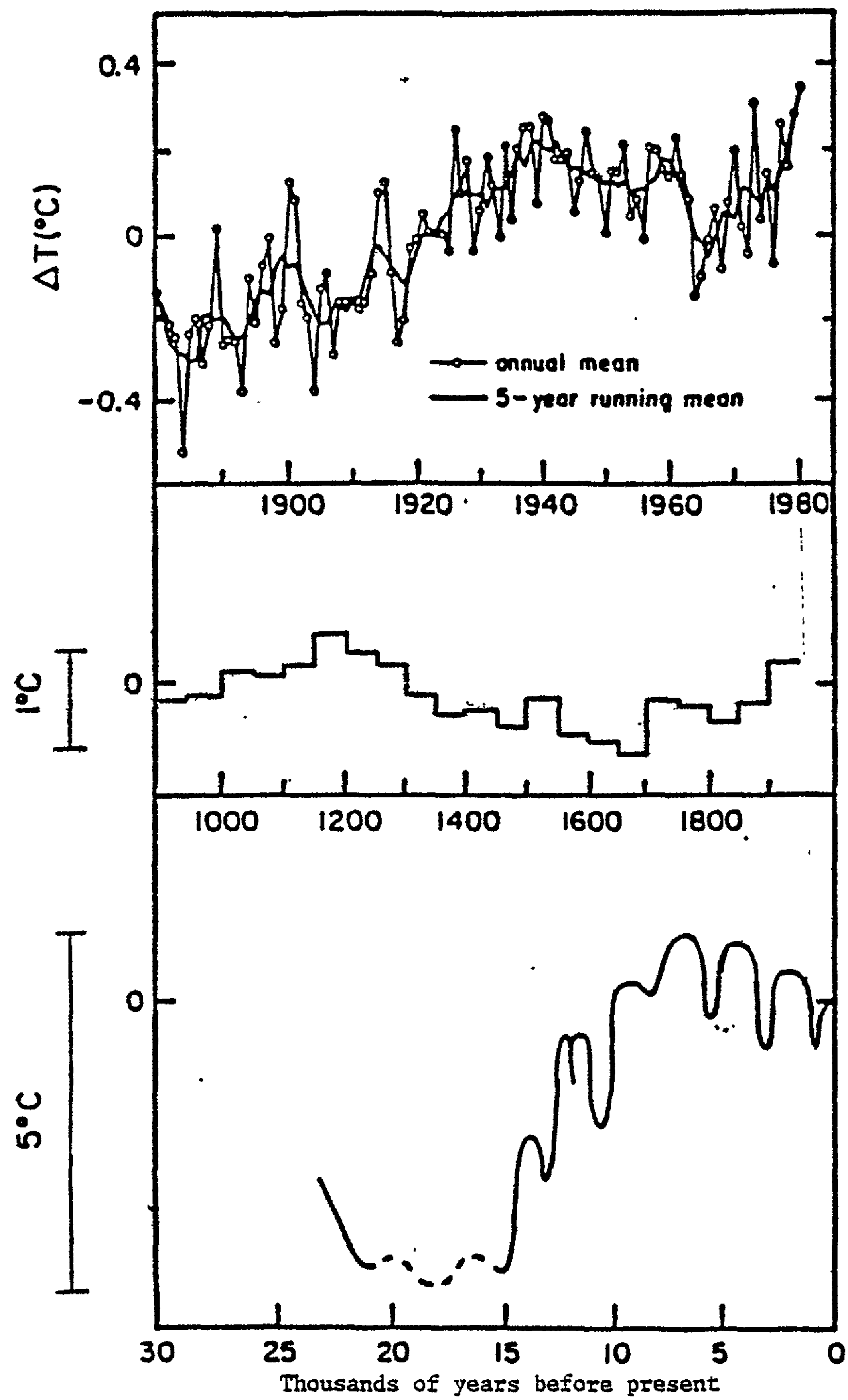
GREENHOUSE EFFECT IN THE FUTURE

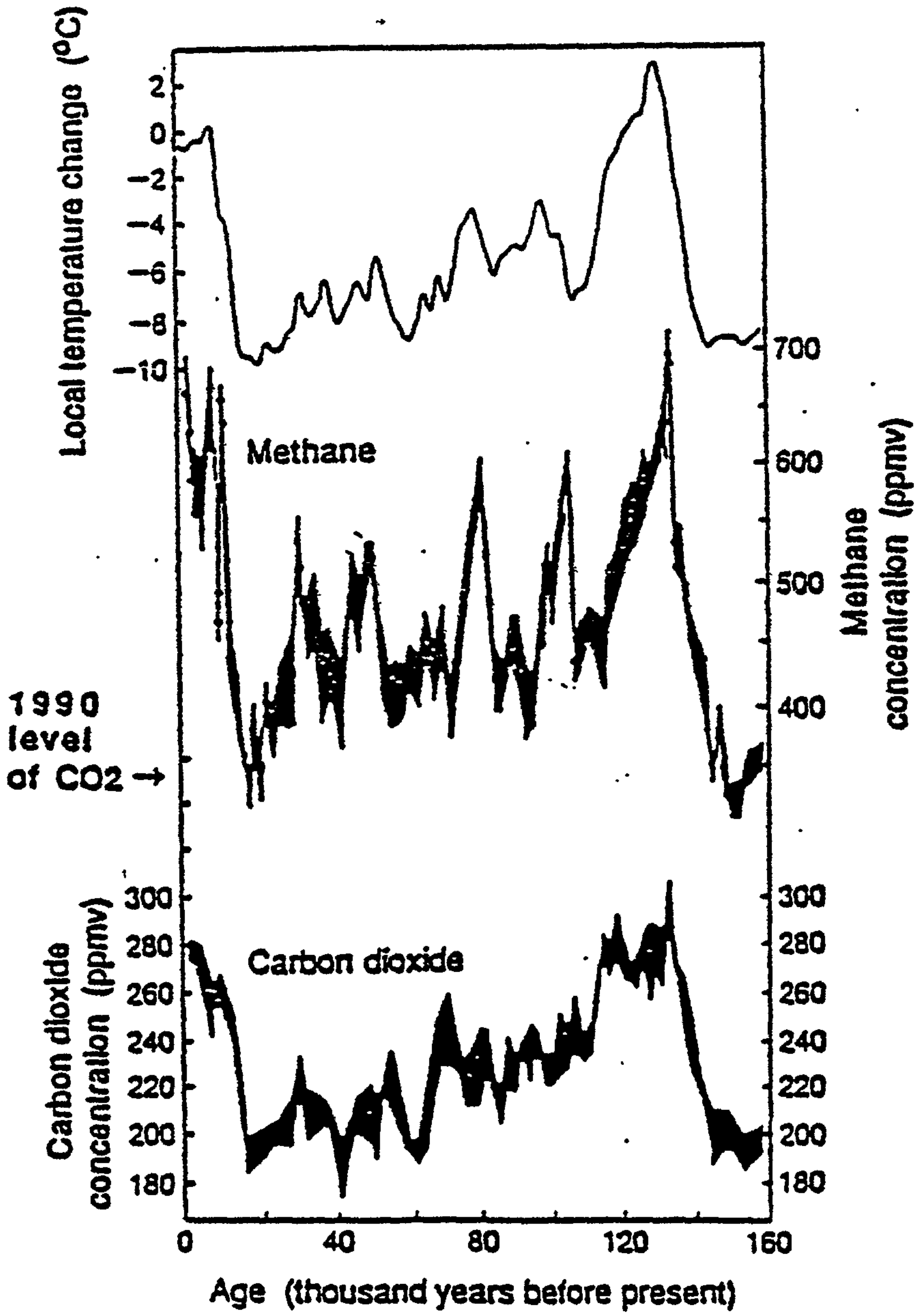
(From Maîtriser le réchauffement de la planète, Agence pour la Qualité de L'air, Paris)

Proceedings of the Second World Climate Conference

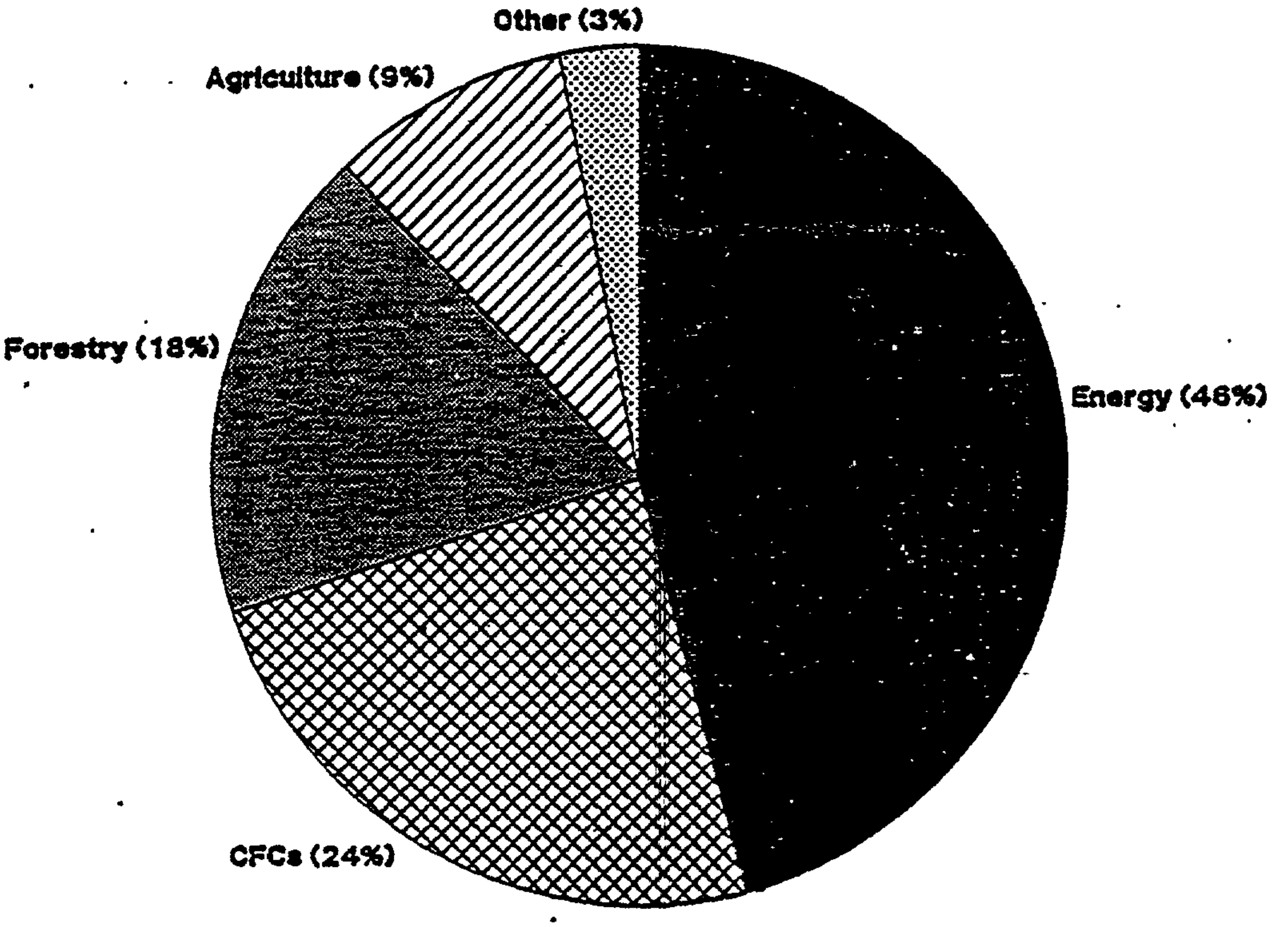


Schematic diagrams of global temperature variations since the Pleistocene on time-scales. The dashed line nominally represents conditions near the beginning of the twentieth century


0.4
0
-0.4
ΔT(°C)
annual mean
5-year running mean
1900
1920
1940
1960
1980
1°C
0
1000
1200
1400
1600
1800
5°C
0
30
25
20
15
10
5
0
Thousands of years before present

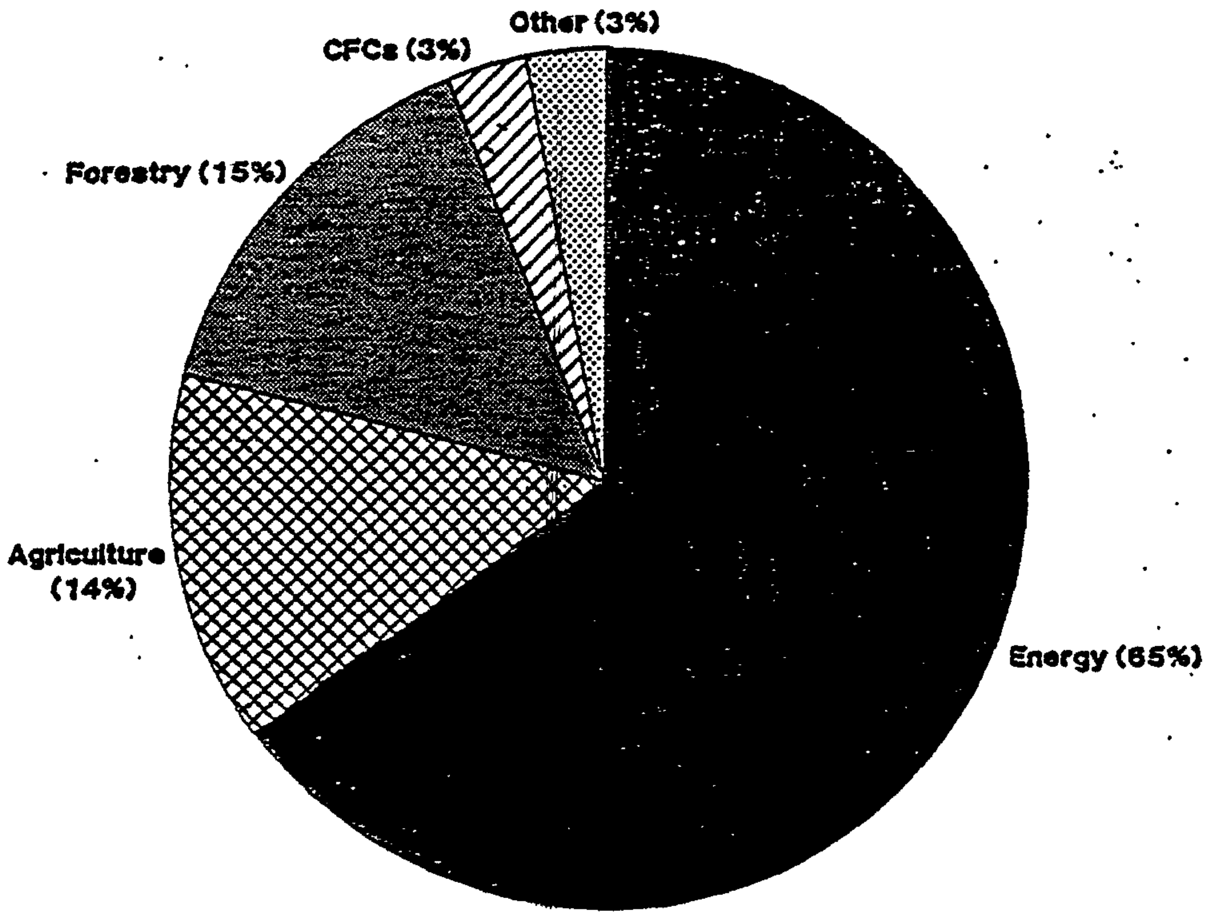

Local temperature change (°C)
2
0
−2
−4
−6
−8
−10
Methane
700
600
500
400
Methane concentration (ppmv)
1990 level of CO2 →
300
280
260
240
220
200
180
Carbon dioxide
Carbon dioxide concentration (ppmv)
0
40
80
120
160
Age (thousand years before present)

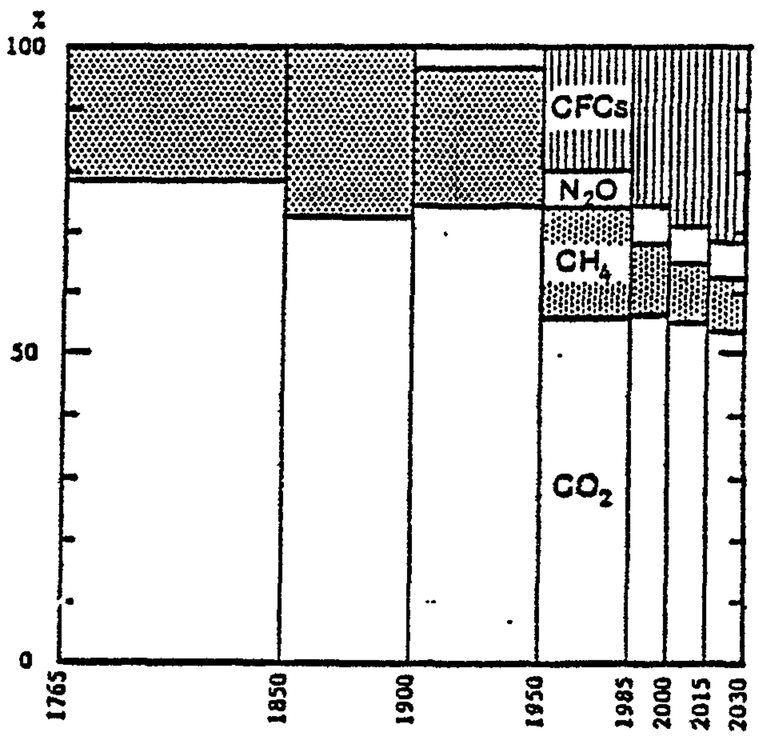
CONTRIBUTION TO RADIATIVE FORCING BY SECTOR 1980s



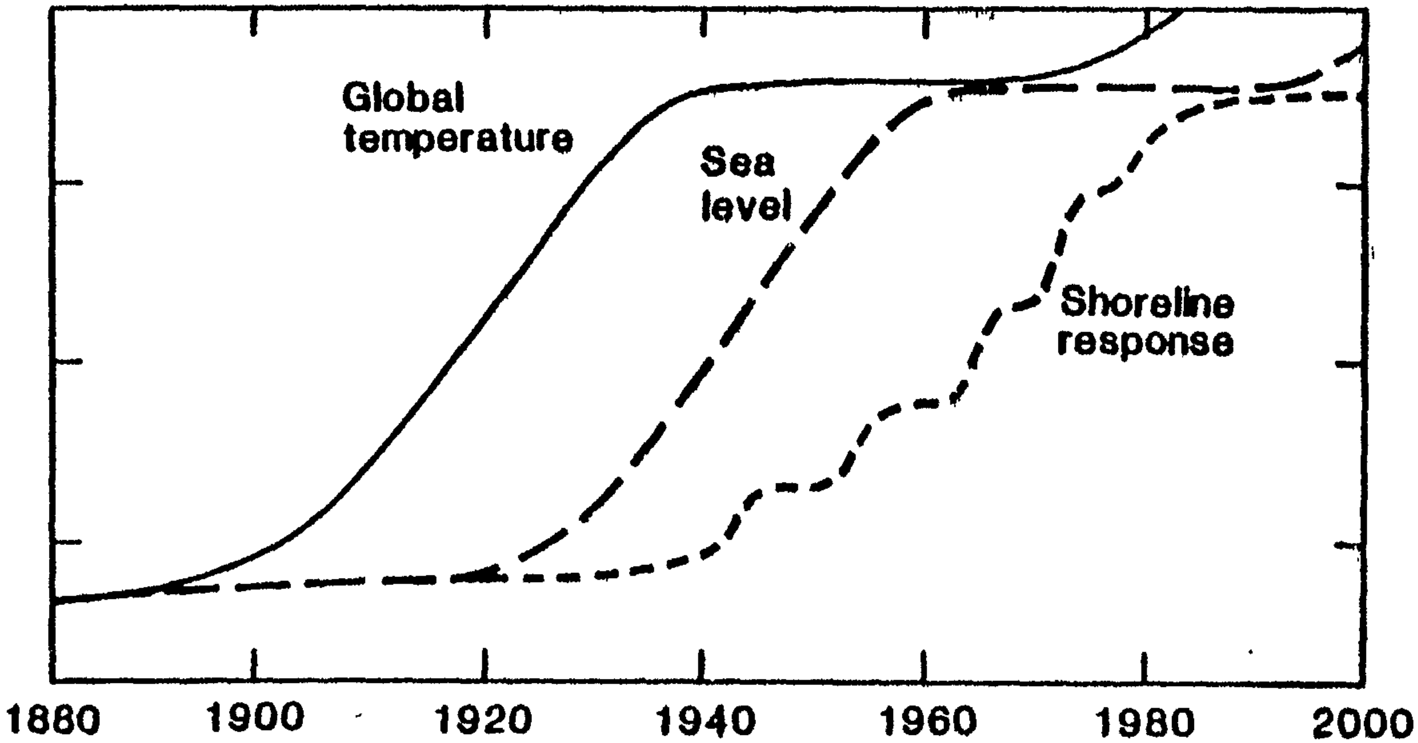
CONTRIBUTION TO RADIATIVE FORCING BY SECTOR: 2025 EMISSIONS

(Based on Global Warming Potentials For 100-Year Time Horizon)

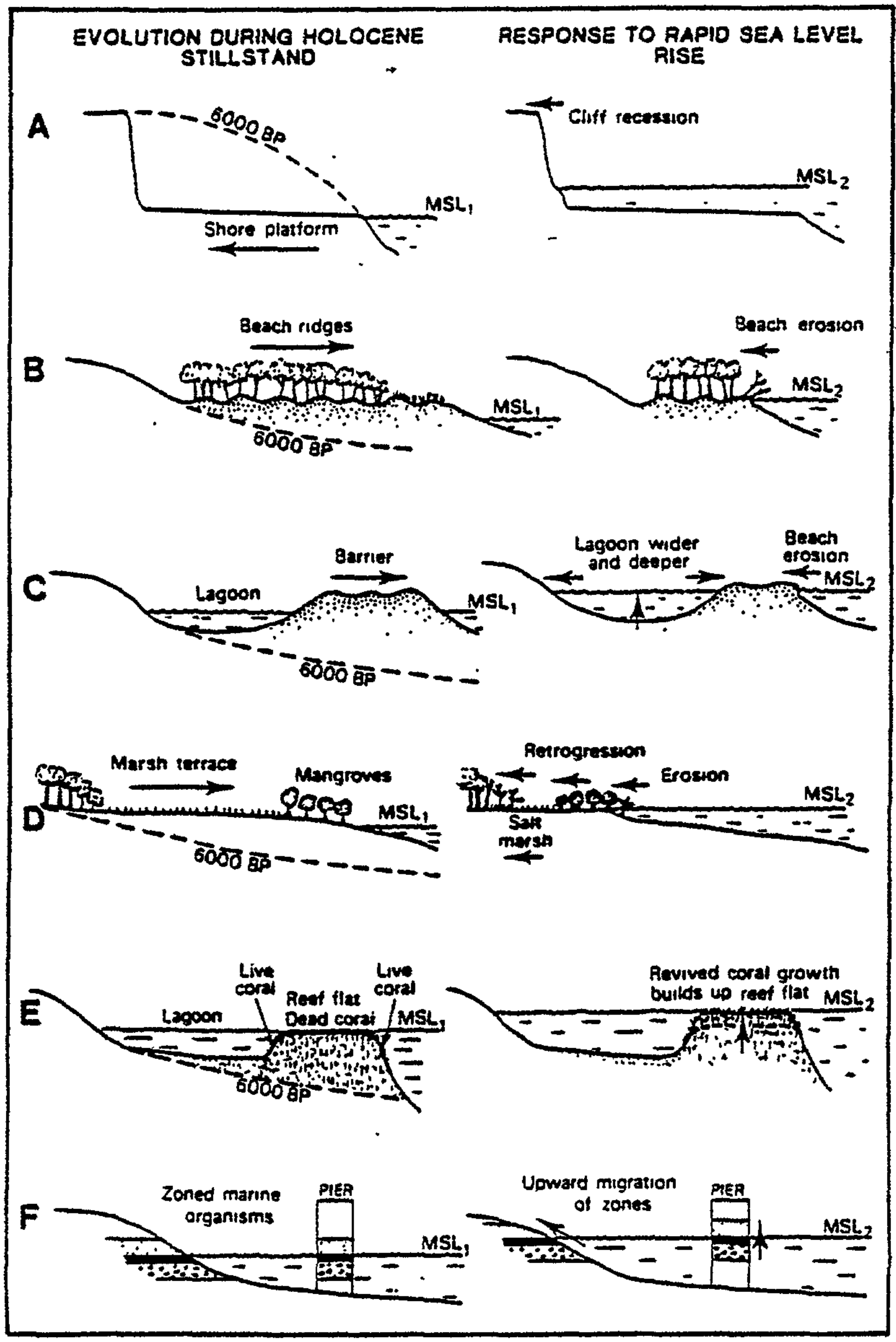




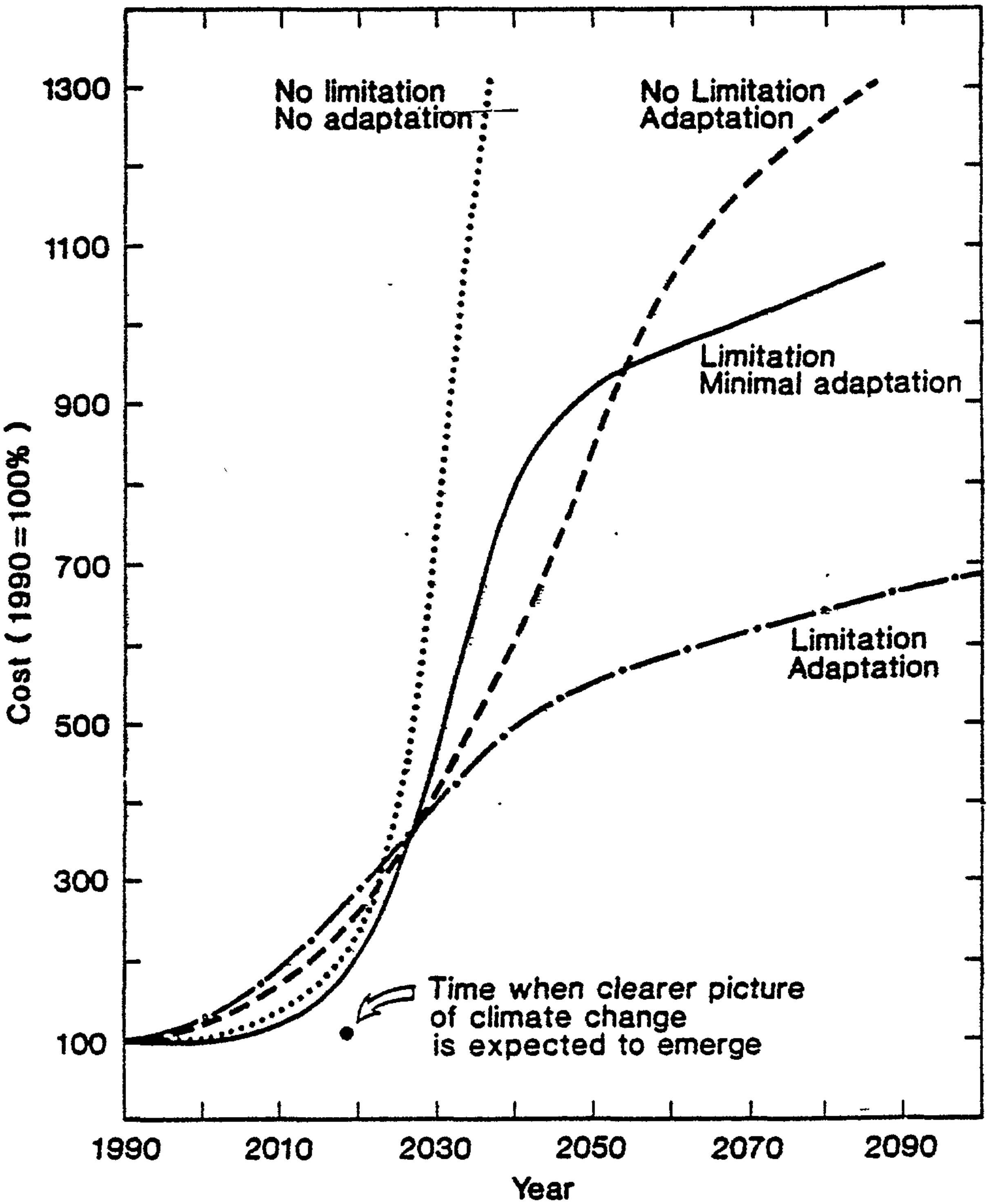
Source: Wigley (1987)



Schematic representation of the relationships between global warming(°C), sea-level rise (m) and shoreline response (m). The latter is a step function associated with major storms. (From G.I. Pearman (Ed.), Greenhouse, Planning for climate change, CSIRO, 1989).



Response of coastal features to a sea-level rise. (From G.I. Pearman (Ed.), Greenhouse, Planning for climate change, CSIRO, 1989).



Cost issues for management of a rising sea level. Very approximate relative costs are shown as percentages. No limitation: no additional actions on greenhouse emissions. Limitation: reduce emission by 2% per year. No adaptation: retreat from coastal damage. Minimal adaptation: ad hoc measures after disasters. Adaptation: selective coastal engineering measures. (From G.I. Pearman (Ed.), Greenhouse, Planning for climate change, CSIRO, 1989).

Future changes in global mean temperature and sea level

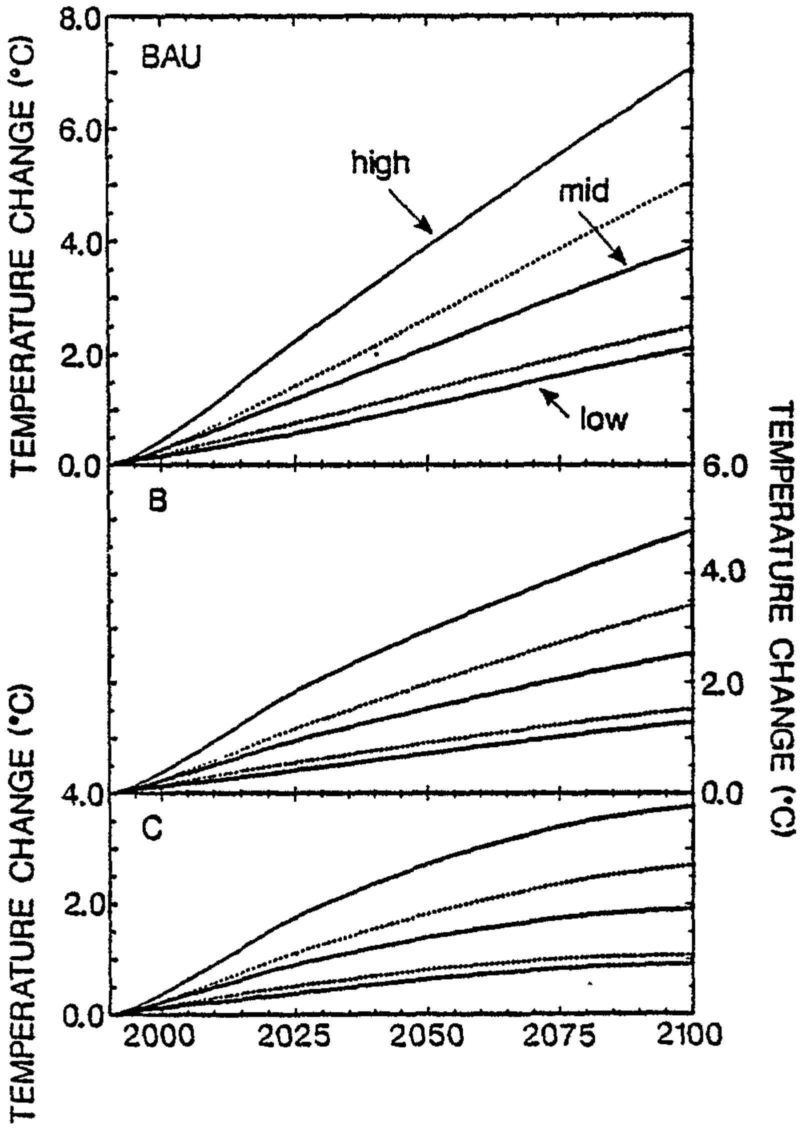


Fig. 7.8 Full range of projections of global mean temperature change under IPCC forcing scenarios BAU (top panel), B (centre) and C (bottom). The three full lines in each panel show low, mid and high estimates, based on the following model parameter values:

T.M.L. Wigley and S.C.B. Raper

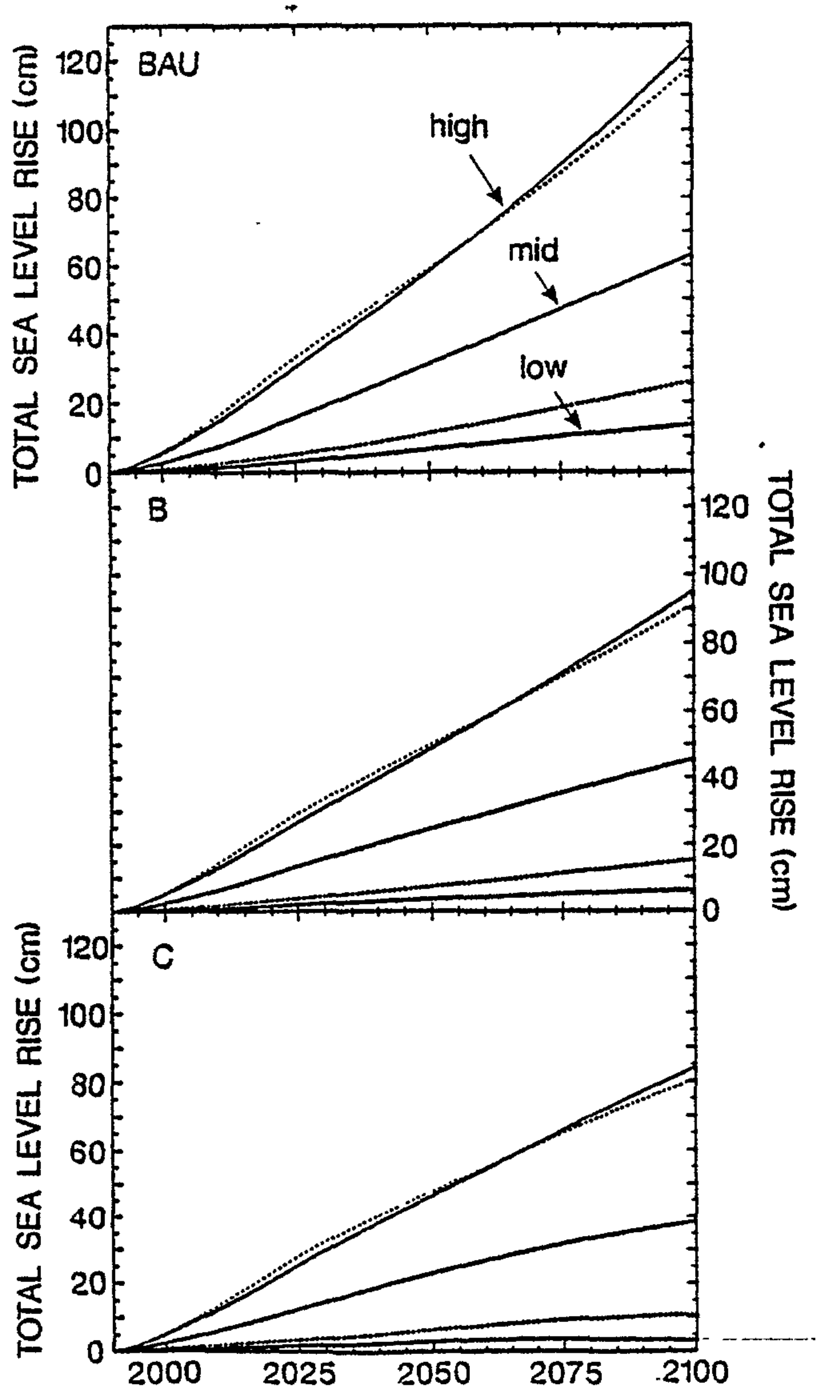
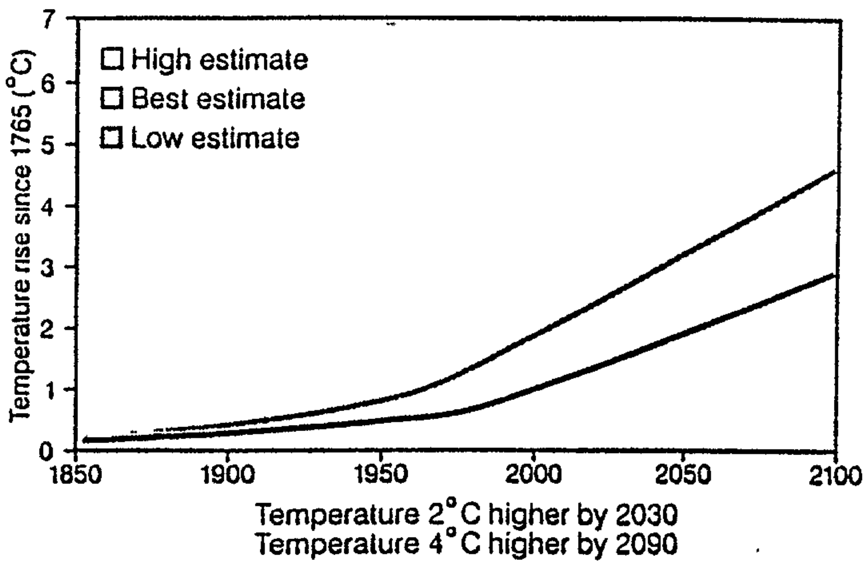
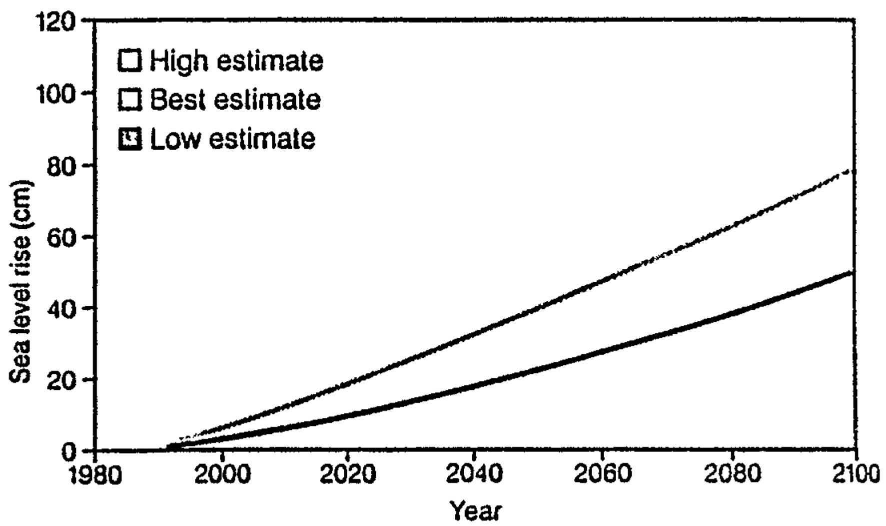


Fig. 7.9 Full range of projections of total global mean sea level rise under IPCC forcing scenarios BAU (top panel), B (centre) and C (bottom). The three full lines in each panel show low, mid and high estimates, with the two extremes based on parameter sets chosen to give extreme values of thermal expansion. The parameter values used are:



Temperature rise. IPCC Business as Usual Scenario



Sea Level rise. IPCC Business as Usual Scenario

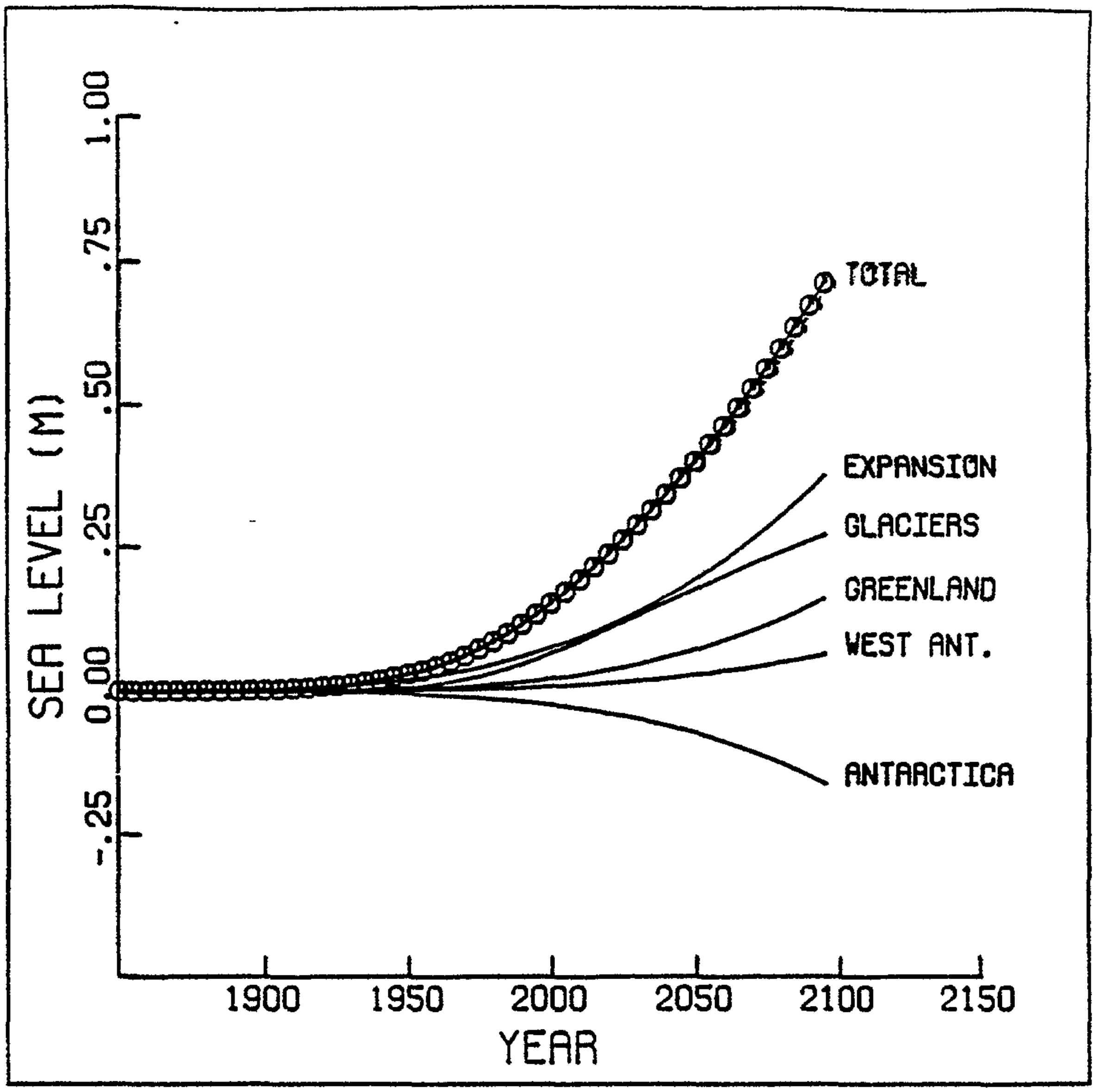
PROJECTED GLOBAL MEAN SEA LEVEL RISE

1985-2030 (CMS)

(from Raper et al., 1988)

GLOBAL MEAN SEA LEVEL RISE RESULTING FROM	LOW	BEST GUESS	HIGH
THERMAL EXPANSION	4	8 to 14	17
ALPINE GLACIERS	2	5 to 13	21
GREENLAND	1	1 to 2	3
ANTARCTICA*	-2	-3 to -1	3
	5	11 to 28	44

* Values chosen from analysis to maximise range


SEA LEVEL (M)
-.25
0.00
.25
.50
.75
1.00
1900
1950
2000
2050
2100
2150
YEAR
TOTAL
EXPANSION
GLACIERS
GREENLAND
WEST ANT.
ANTARCTICA

IMPACTS RESULTING FROM CLIMATIC CHANGES

FIRST ORDER IMPACTS

INCREASED AIR TEMPERATURE

INCREASED SEA SURFACE TEMPERATURE

CHANGES TO LOCAL CLIMATES AND WEATHER:

- CHANGED PATTERNS OF RAINFALL IN TIME AND SPACE;
- CHANGED PATTERNS OF WINDS IN TIME AND SPACE

IMPACTS RESULTING FROM CLIMATIC CHANGES

SECOND ORDER IMPACTS

CHANGES IN RELATIVE HUMIDITY

CHANGES IN RUN-OFF AND RIVER FLOW RATES

CHANGES IN SOILS

CHANGES IN LARGE SCALE COASTAL BIOME DISTRIBUTION

CHANGES IN COASTAL CURRENT AND WAVE REGIMES, AND STRATIFICATION/MIXING

CHANGES IN THE LOCATION AND/OR PERSISTENCE OF OCEANIC FRONTAL SYSTEMS

CHANGES IN SALINITY AND COASTAL WATER CHEMISTRY

CHANGES IN GEOGRAPHIC DISTRIBUTION, INTENSITY AND FREQUENCY OF STORMS

CHANGES IN PATTERNS OF COASTAL FLOODING AND OTHER EPISODIC EVENTS

CHANGES IN HUMAN COMFORT OF SPECIFIC LOCATIONS

IMPACTS RESULTING FROM CLIMATIC CHANGES

HIGHER ORDER IMPACTS

CHANGES IN RAINFALL AND TEMPERATURE WILL AFFECT RELATIVE HUMIDITY WHICH WILL ALTER EVAPO-TRANSPIRATION RATES HENCE AFFECTING:

- THE HYDROLOGICAL CYCLE AND LOCAL WATER BALANCE; WHICH WILL:
    - AFFECT VEGETATION DISTRIBUTION AND ABUNDANCE; HENCE AFFECTING:
        - ANIMAL DISTRIBUTION AND ABUNDANCE;
        - PRODUCTIVITY OF NATURAL AND AGRICULTURAL SYSTEMS;
        - SOIL DECOMPOSITION PROCESSES AND FERTILITY;
- HUMAN DRINKING WATER SUPPLIES; AND
- FRESHWATER MANAGEMENT PRACTICES;
- COASTAL WATER SALINITY AND MIXING; LEADING TO:
    - CHANGES IN COASTAL MARINE ECOSYSTEMS;
    - CHANGES TO FISHERIES PRODUCTIVITY AND MARICULTURE;

ALL OF WHICH WILL HAVE:

- SOCIAL AND ECONOMIC IMPACTS

IMPACTS RESULTING FROM SEA-LEVEL CHANGE

FIRST ORDER IMPACTS

INCREASED FREQUENCY OF FLOODING

INCREASED INLAND EXTENT OF FLOODING

REARRANGEMENT OF COASTAL UNCONSOLIDATED SEDIMENTS AND SOILS

INCREASED SOIL SALINITY IN AREAS PREVIOUSLY UNAFFECTED

CHANGED WAVE CLIMATES

ACCELERATED DUNE AND BEACH EROSION

UPWARD AND LANDWARD RETREAT OF THE BOUNDARY BETWEEN FRESHWATER AND BRACKISH WATERS

GREATER UPSTREAM INTRUSION OF SALTWATER WEDGES

CHANGES TO BANK AND WETLAND VEGETATION

CHANGES IN THE PHYSICAL LOCATION OF THE TERRESTRIAL-AQUATIC BOUNDARY

CHANGES IN COASTAL WATER CLARITY

CHANGES IN COASTAL WATER CIRCULATION PATTERNS, AND

CHANGES IN SEDIMENT SINK VOLUMES

IMPACTS RESULTING FROM SEA LEVEL CHANGE

SECOND ORDER IMPACT

CHANGES IN OFFSHORE BOTTOM PROFILES

CHANGES IN MARINE PRIMARY PRODUCTION, AND

CHANGES IN TERRESTRIAL (COASTAL) PRIMARY PRODUCTION

CHANGES IN SEDIMENT AND NUTRIENT FLUX RATES

IMPACTS RESULTING FROM SEA LEVEL CHANGE

HIGHER ORDER IMPACT

CHANGES IN BEACH PLAN FORM WILL ALTER:

- LOCAL CURRENT AND WAVE REGIMES; HENCE:
  - LOCAL PATTERNS OF EROSION AND DEPOSITION; AND
  - LOCAL DISTRIBUTION OF COASTAL SUBSTRATE TYPES; AND HENCE,
    - THE DISTRIBUTION PATTERNS OF BENTHIC ORGANISMS.
- SUSCEPTIBILITY OF THE COASTLINE TO WAVE ATTACK;
- CHANGE THE VULNERABILITY OF COASTAL AREAS TO EPISODIC FLOODING AND/OR SEASONAL OR PERMANENT INUNDATION; HENCE
  - AFFECTING CAPITAL INVESTMENT IN INFRASTRUCTURE; AND
  - SUITABILITY OF THE COASTLINE FOR HUMAN SETTLEMENT.

CHANGES IN MARINE PRIMARY PRODUCTION WILL AFFECT:

- ENERGY FLOW TO HIGHER TROPHIC LEVELS; HENCE
  - STANDING STOCKS OF HIGHER TROPHIC LEVELS; AND
  - OVERALL RATES OF SECONDARY PRODUCTION; AND ULTIMATELY
    - FINFISH AVAILABILITY FOR HUMAN CONSUMPTION.

SEA LEVEL CHANGE
HIGHER ORDER IMPACT (2)

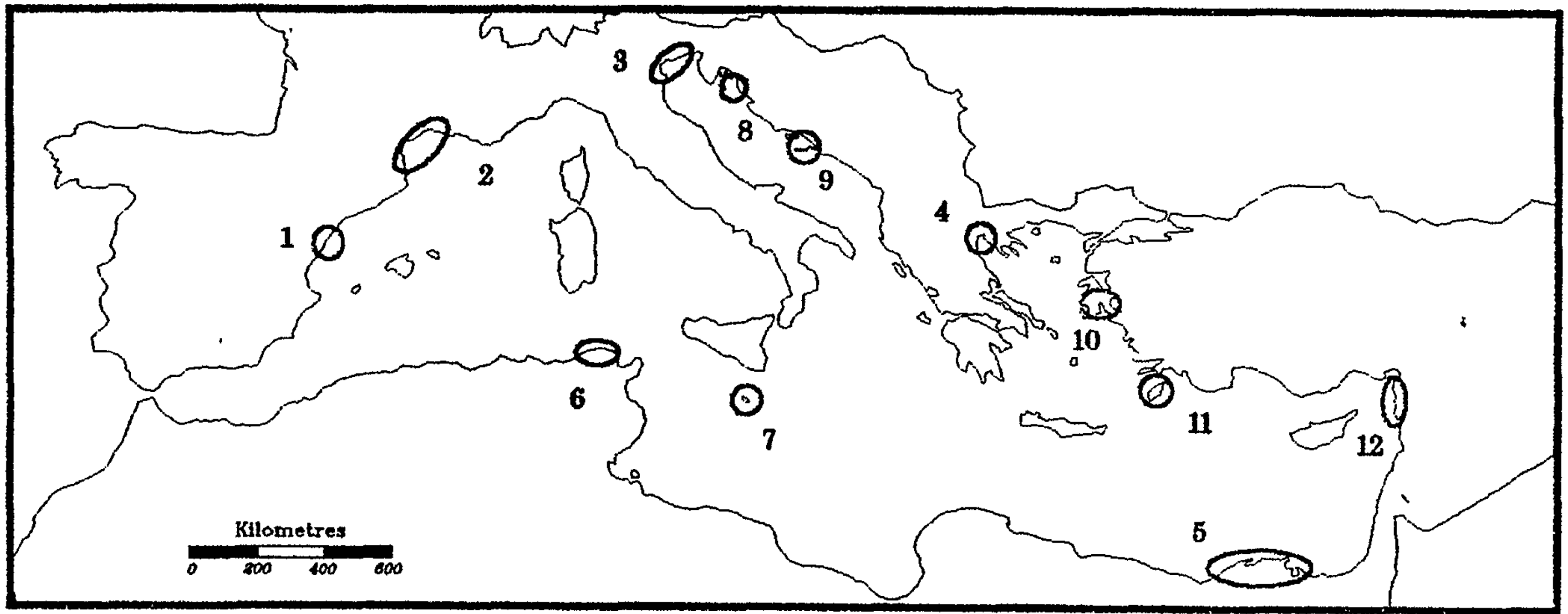
CHANGES IN COASTAL/TERRESTRIAL VEGETATION AND WETLANDS WILL:

- **ALTER THE DISTRIBUTION AND ABUNDANCE OF DEPENDENT ANIMALS;**
- **AFFECT ECONOMIC ACTIVITIES BY AFFECTING COMMERCIALLY IMPORTANT SPECIES SUCH AS PENAEID PRAWNS AND SHRIMP;**
- **ALTER THE FLUX OF SEDIMENTS AND NUTRIENTS INTO THE MARINE ENVIRONMENT;**
- **ALTER DISTRIBUTIONS OF HUMAN DISEASE VECTORS; HENCE,**
  - **CHANGING THE EPIDEMIOLOGY OF VECTOR BORNE DISEASES.**

CHANGES IN NUTRIENT LEVELS IN COASTAL WATERS WILL CHANGE MARINE BASED PRIMARY PRODUCTIVITY; AND

- **MAY CHANGE THE FREQUENCY OF HARMFUL ALGAL BLOOMS; WHICH MAY:**
  - **IMPACT FISH AND SHELLFISH RESOURCES; AND MAY THEREFORE:**
    - **AFFECT SUBSISTENCE AND COMMERCIAL ACTIVITIES IN HUMAN SOCIETIES.**

THE MEDITERRANEAN REGION
Location of Case Studies on Implications of Climatic Changes



Scale 1:18000000 Internal Code. CASESTUD UNEP/MEDU December 1992

<u>1987 – 1989</u>

1 EBRO DELTA
2 GULF OF LION/RHONE DELTA
3. PO DELTA/VENICE LAGOON
4. THERMAIKOS GULF
5. NILE DELTA
6. LAKES ICHKEUL/BIZERTE

<u>1990 – 1992</u>

7 MALTA ISLAND
8 CRES/LOSINJ ISLANDS
9. KASTELA BAY
10. IZMIR BAY
11. RHODES ISLAND
12. SYRIAN COAST

OVERVIEWS AND CASE STUDIES

THE OVERVIEWS AND CASE STUDIES WERE EXPECTED:

- TO EXAMINE THE POSSIBLE EFFECTS OF THE SEA LEVEL CHANGES ON THE COASTAL ECOSYSTEMS (DELTAS, ESTUARIES, WETLANDS, COASTAL PLAINS, CORAL REEFS, MANGROVES, LAGOONS, ETC.);

- TO EXAMINE THE POSSIBLE EFFECTS OF TEMPERATURE ELEVATIONS ON THE TERRESTRIAL AND AQUATIC ECOSYSTEMS, INCLUDING THE POSSIBLE EFFECTS ON ECONOMICALLY IMPORTANT SPECIES;

- TO EXAMINE THE POSSIBLE EFFECTS OF CLIMATIC, PHYSIOGRAPHIC AND ECOLOGICAL CHANGES ON THE SOCIO-ECONOMIC STRUCTURES AND ACTIVITIES; AND

- TO DETERMINE AREAS OR SYSTEMS WHICH APPEAR TO BE MOST VULNERABLE TO THE ABOVE CHANGES.

OBJECTIVES OF SITE SPECIFIC CASE STUDIES

OBJECTIVES OF THE CASE STUDY ARE:

- **TO IDENTIFY AND ASSESS POSSIBLE IMPLICATIONS OF EXPECTED CLIMATE CHANGE ON THE TERRESTRIAL, AQUATIC AND MARINE ECOSYSTEMS, POPULATIONS, LAND-USE AND SEA-USE PRACTICES AND OTHER HUMAN ACTIVITIES;**

- **TO DETERMINE AREAS OR SYSTEMS WHICH APPEAR TO BE MOST VULNERABLE TO THE EXPECTED CLIMATE CHANGE; AND**

- **TO IDENTIFY OPTIONS AND GIVE RECOMMENDATIONS FOR PLANNING AND MANAGEMENT OF COASTAL AREAS AND RESOURCES, AS WELL AS FOR PLANNING AND DESIGN OF MAJOR INFRASTRUCTURE AND OTHER SYSTEMS.**

OUTLINE OF THE SITE SPECIFIC STUDY

THE FOLLOWING OUTLINE FOR EACH STUDY IS USED, WITH POSSIBLE SLIGHT MODIFICATIONS DUE TO LOCAL SPECIFICITIES:

EXECUTIVE SUMMARY

1. INTRODUCTION

- 1.1. BACKGROUND
- 1.2. BASIC INFORMATION CONCERNING THE STUDY AREA
- 1.3. METHODOLOGY AND ASSUMPTIONS USED IN THE STUDY

2. IDENTIFICATION AND ASSESSMENT OF THE POSSIBLE CONSEQUENCES OF CLIMATE CHANGE

- 2.1. CLIMATE
- 2.2. LITHOSPHERE
- 2.3. HYDROSPHERE
- 2.4. ATMOSPHERE
- 2.5. NATURAL ECOSYSTEMS
  - 2.5.1. TERRESTRIAL
  - 2.5.2. FRESHWATER
  - 2.5.3. MARINE
- 2.6. MANAGED ECOSYSTEMS
  - 2.6.1. AGRICULTURE
  - 2.6.2. FISHERIES
  - 2.6.3. AQUACULTURE
  - 2.6.4. SYLVICULTURE
- 2.7. ENERGY AND INDUSTRY
- 2.8. TOURISM
- 2.9. TRANSPORT AND SERVICES
- 2.10. HEALTH AND SANITATION
- 2.11. POPULATION AND SETTLEMENT PATTERN

3. SYNTHESIS OF FINDINGS

- 3.1. PRESENT SITUATION
- 3.2. MAJOR EXPECTED CHANGES AND THEIR IMPACTS

4. RECOMMENDATIONS FOR ACTION

- 4.1. PREVENTIVE POLICIES AND MEASURES
- 4.2. ADAPTIVE POLICIES AND MEASURES

REFERENCES

GENERAL CONCLUSIONS AND RECOMMENDATIONS

According to a broad scientific consensus, increasing atmospheric concentrations of greenhouse gases resulting from human activities are expected to lead to changes in climate. These changes may have started already and their continuation may now be inevitable. The rise in global temperature and mean sea level are expected to be among the major consequences of the future climate change.

In spite of uncertainties surrounding the rate and magnitude of future climate changes, the scenarios developed by the Climatic Research Unit of the University of East Anglia (see Annex IV), seem a reasonable basis for the assessment of the possible impacts of climate changes on the natural and man-made systems of the case study areas. Nevertheless, work on improving the quality (precision) of area/site specific climate scenarios should continue in order to assist in the formulation of meaningful and effective policies and measures which are responsive to changes which may be specific for each site.

Another source of uncertainty stems from the presently limited capability for making predictions about the behaviour of natural and social systems under normal or stressed conditions, such as those which may be caused by changing climate conditions. Improving this capability should be considered as a matter of high priority, and should be achieved by:

- a more imaginative and creative use of existing data, for example more work on changes in extreme climate events;

- development of models and scenarios related to subjects such as future climate conditions, economic development, population dynamics, taking into account the possible non-linear responses of many systems and processes;

- building of necessary data bases and capabilities for use and interpretation of data; and

- target oriented research and monitoring in fields contributing to an improved understanding of the trends in key parameters and processes (e.g. temperature, sea level, extreme and episodic events, soil erosion and moisture), and to the development of new or improved models and scenarios relevant to climate changes.

The marine and terrestrial environments of the five study areas are heavily influenced by climate-driven events and processes in regions far removed from these areas (e.g. the hydrology of the North Adriatic drainage basin; the structure and movement of Levantine water masses; the cyclogenesis of the Mediterranean basin). Research and observation programmes should be intensified for a better understanding of the impact of these events and processes on the case study areas.

There are no reliable methodologies for the assessment of the risks and benefits which may be associated with climate changes; determination of the most vulnerable sites, systems or processes; or formulation of options for response policies and measures. On the basis of the experience gained through the eleven Mediterranean site-specific climate impact case studies, an attempt should be made to develop such methodologies and to test their applicability.

The impacts of non-climatic factors (e.g. population increases, present development plans) on the natural environment and the society in the study areas will, during the next several decades, most probably far exceed the direct impacts of greenhouse warming. Nevertheless, changes in climate conditions may contribute significantly to the continuous increase of society's vulnerability towards adverse environmental conditions and impair its sustainable development.

Many unprotected shorelines and low-lying regions are at present suffering from erosion and are experiencing periodic inundation during high sea level conditions (e.g. storms). Any increase in the mean sea-level, or in the frequency and intensity of episodic events affecting that level, would worsen the present situation. Highly site specific combination of protective and adaptive measures should be applied to avoid or mitigate the problems caused by erosion and inundation, with preference for soft, non-engineering solutions whenever they can be successfully applied.

The elevation of mean sea level would lead to increased seawater intrusion into the coastal aquifers and to a worsening of the difficulties, already present in the five study areas, with the supply of freshwater. Timely adoption and implementation of freshwater management policies and measures, based on realistic analyses and projections for freshwater demand, are an appropriate response to the expected climate change impacts on the aquifers of these areas.

The negative impact on natural vegetation and crops, as well as on the marine ecosystems in the study areas, is expected to be slight until the middle of the 21st century, except in areas where climatic or soil conditions are marginal. Forest areas would be adversely affected by the increased frequency of fires. Gradual latitudinal and altitudinal shifts in vegetation belts due to changes in precipitation and temperature might be experienced in some of the study areas. The positive economic impact of these shifts may be considerable, particularly if combined with modern agricultural practices (e.g. genetic engineering).

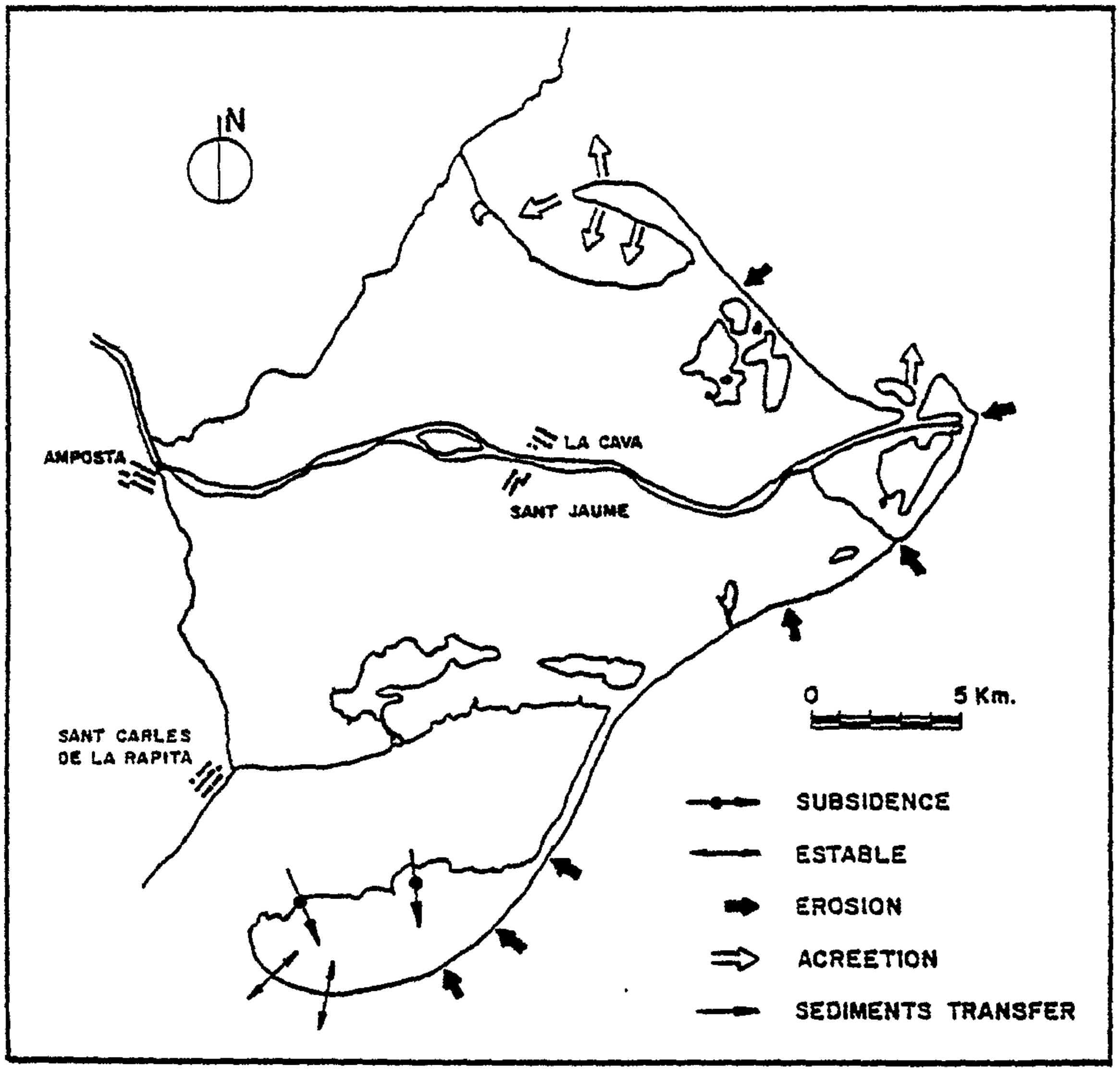
Until the end of the next century, the changes in climatic conditions are expected to have only a very limited impact on the distribution and dynamics of the human population in the study areas, which will remain strongly influenced by non climatic factors. In areas where the development of tourism is at present limited by temperature conditions, an increase in temperature would lead to a gradual extension of the tourist season, with concomitant problems and benefits.

By the middle of the next century, the impact on coastal settlements and construction (harbours, coastal roads, etc.) might be considerable, as most of them are only slightly above the present mean-sea level. Historic settlements and sites may require special, often quite expensive, protection measures, while the problems of other structures should be solved by their gradual transformation or transfer.

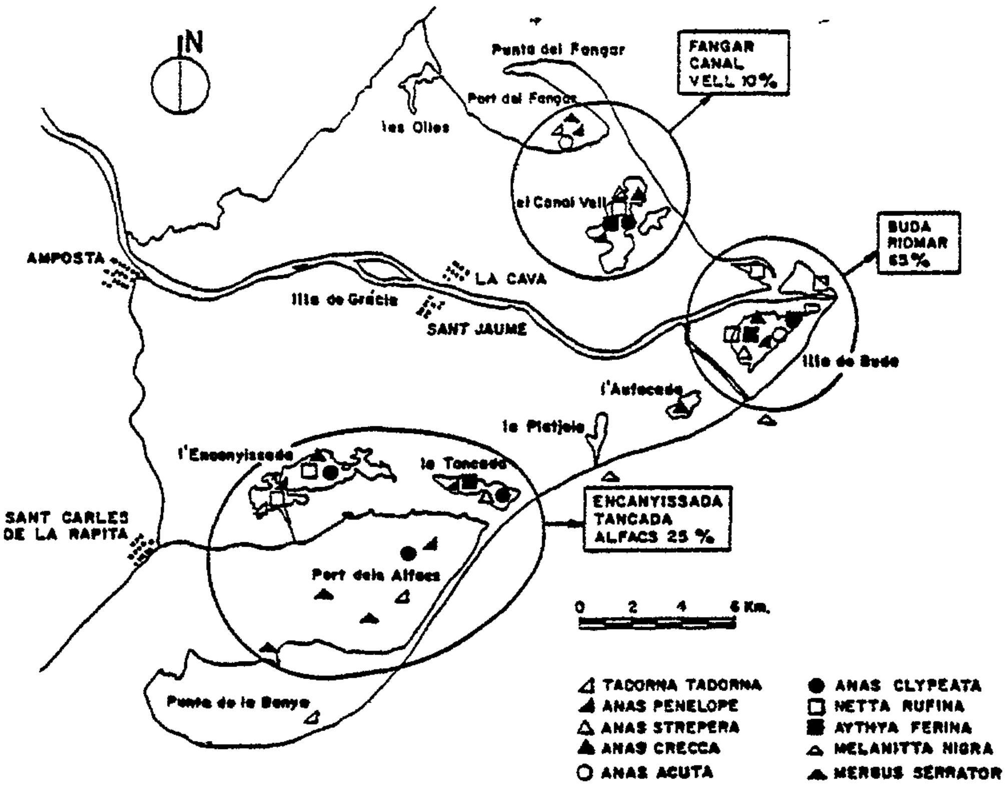
Sectorial approaches to the problems which may be associated with the impact of climate change will not lead to their long-term solution. The most promising general policy option to avoid or mitigate the eventual negative impact of expected climate changes is the broad application of integrated coastal zone planning and management which takes into account, among other factors, the requirements imposed by climate change.

Raising of the awareness of the general public about the problems which may be associated with expected climate changes is of great importance as it may facilitate the societal decision-making process and may generate the necessary public support for measures and expenditures which may be seen, by an uninformed public, as being unjustified.

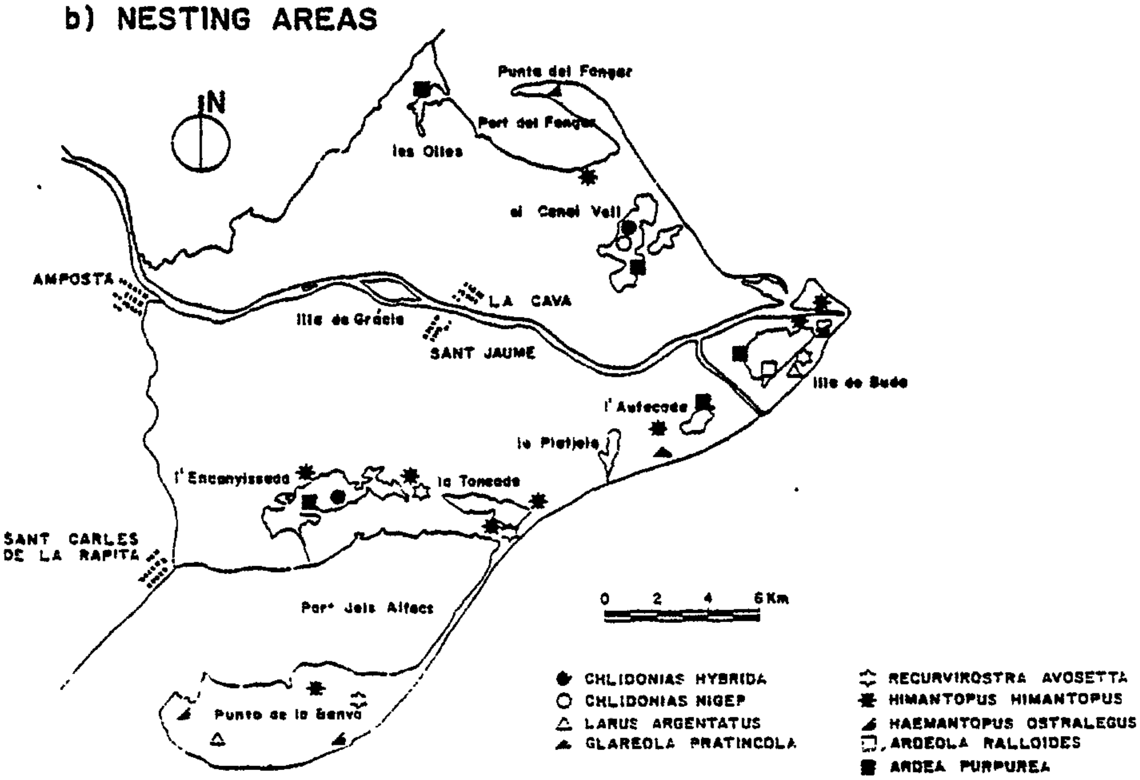
The conclusions and recommendations of the five case studies are primarily addressed to national managers and policy-makers, particularly those responsible for the administration and development of the geographic areas covered by the case studies. In order to ensure the full exposure of the main findings, conclusions and recommendations of these case studies, the convening of national seminars for the relevant policy-makers and managers, with the possible participation of media and public at large, are strongly recommended.

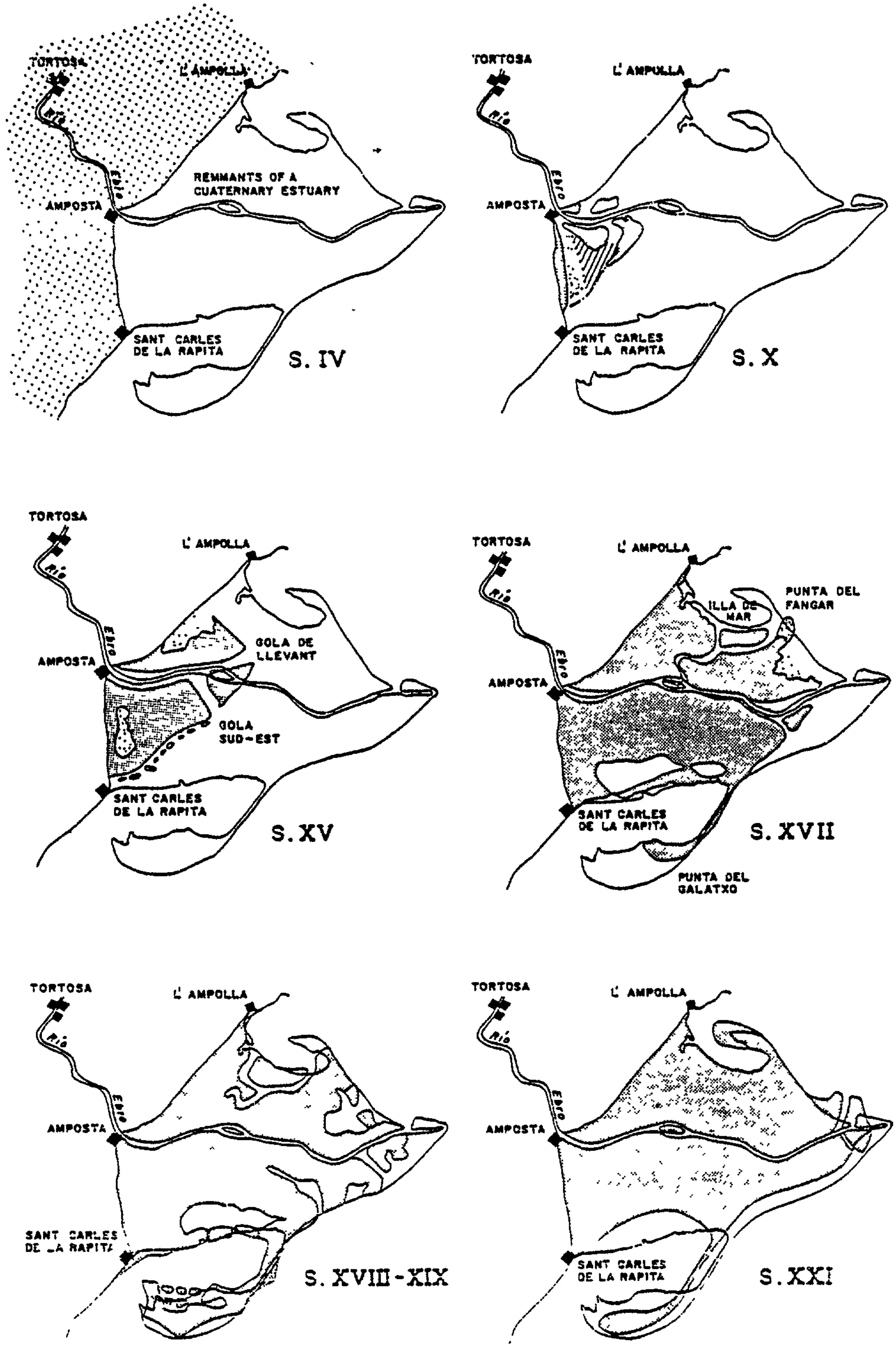

N
LA CAVA
AMPOSTA
SANT JAUME
SANT CARLES
DE LA RAPITA
0
5 Km.
SUBSIDENCE
ESTABLE
EROSION
ACREETION
SEDIMENTS TRANSFER

a) MAIN CONCENTRATION AREAS

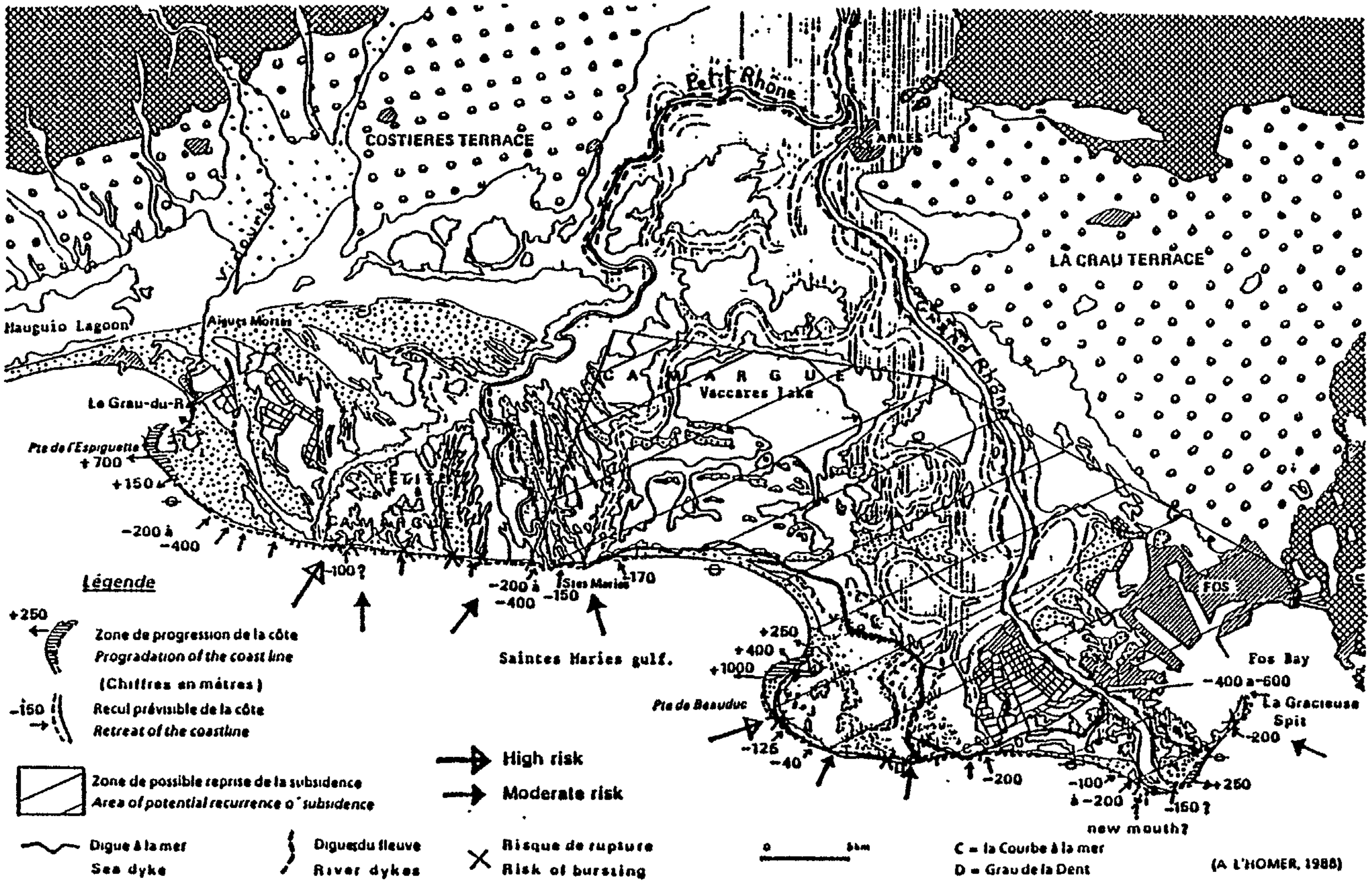


b) NESTING AREAS

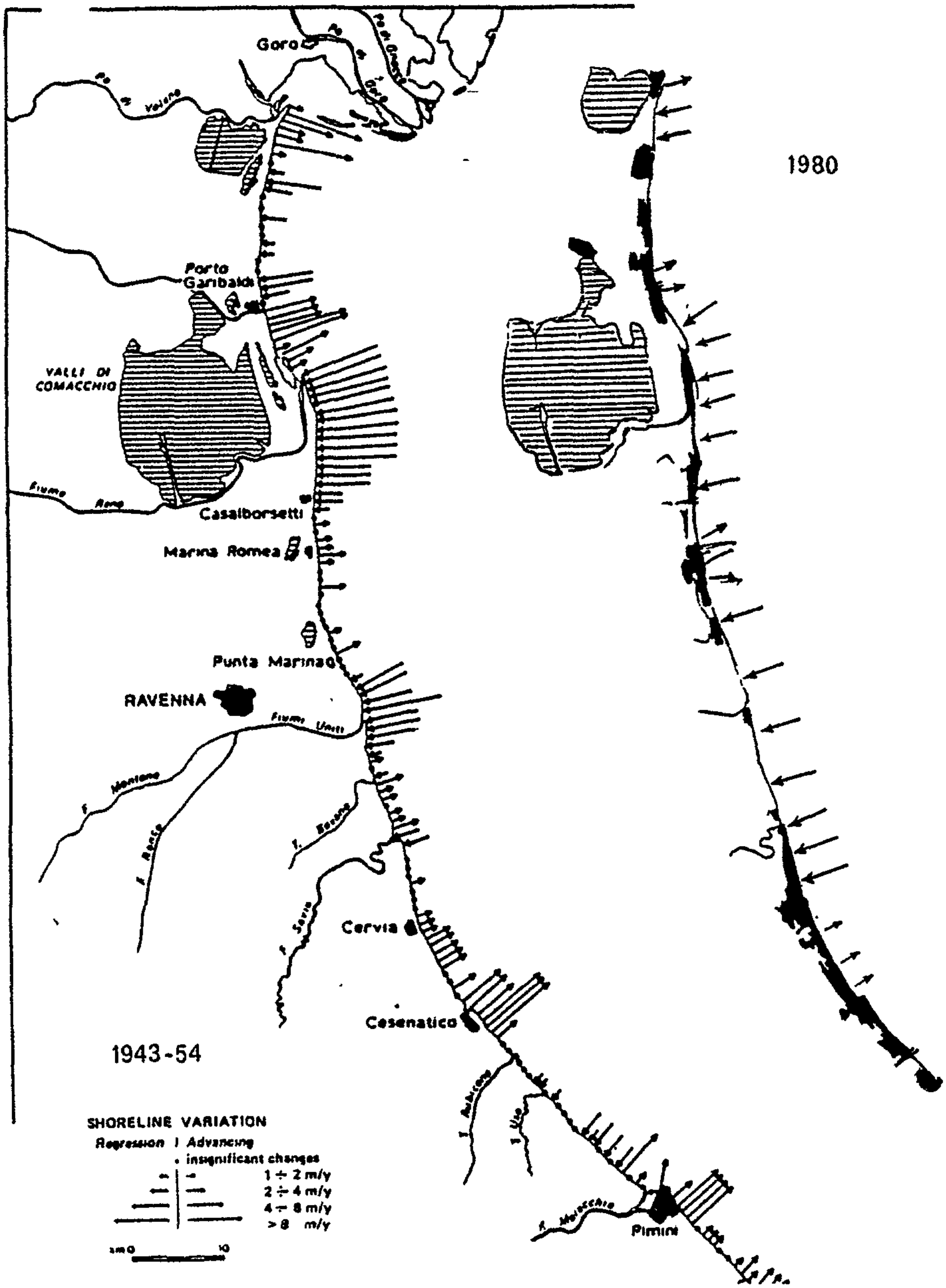



TORTOSA
L' AMPOLLA
Rio
Ebro
REMMANTS OF A
CUATERNARY ESTUARY
AMPOSTA
SANT CARLES
DE LA RAPITA
S. IV
S. X
GOLA DE
LLEVANT
GOLA
SUD-EST
S. XV
ILLA DE
MAR
PUNTA DEL
FANGAR
PUNTA DEL
GALATXO
S. XVII
S. XVIII-XIX
S. XXI

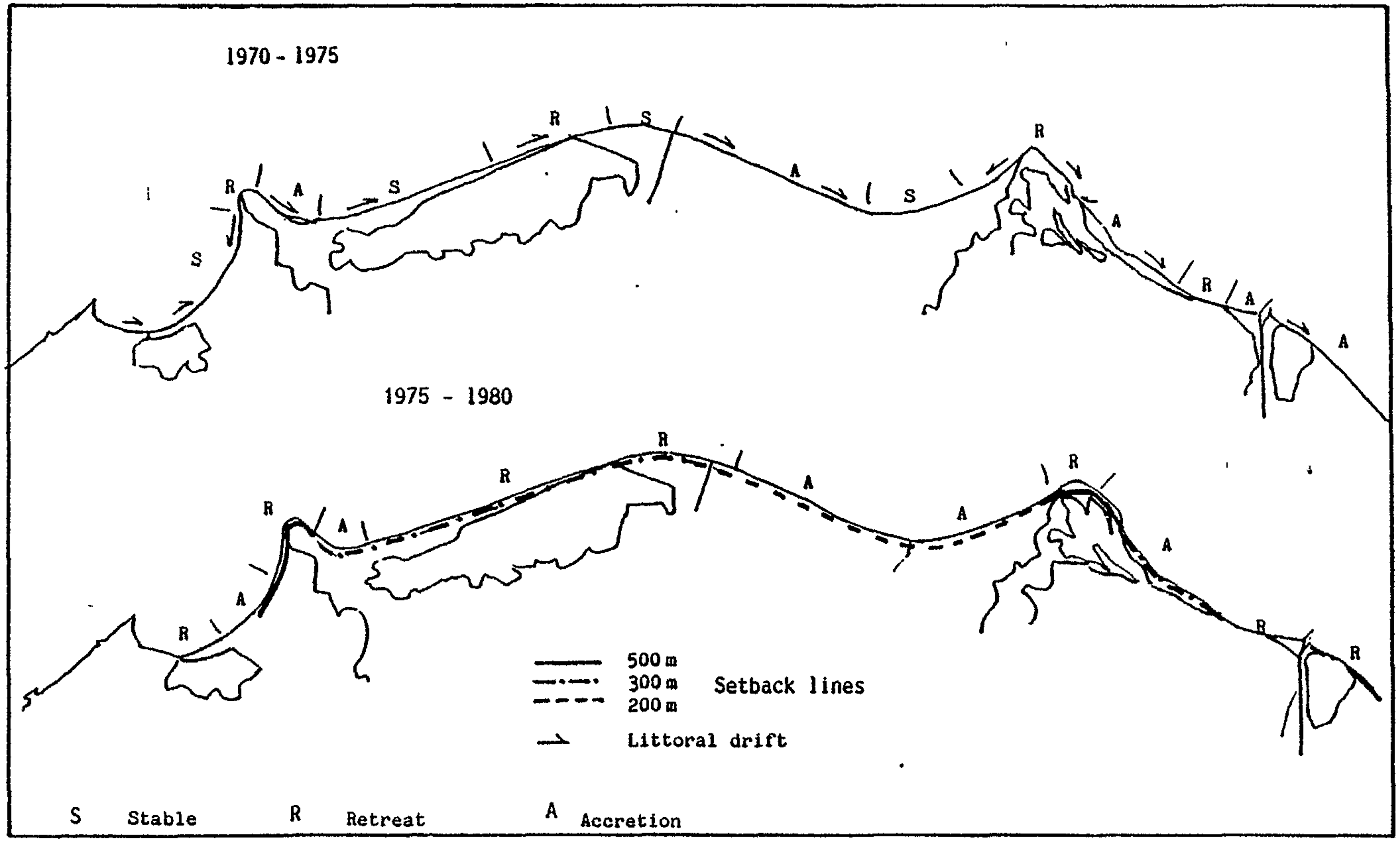
Projection du littoral à l'horizon 2025



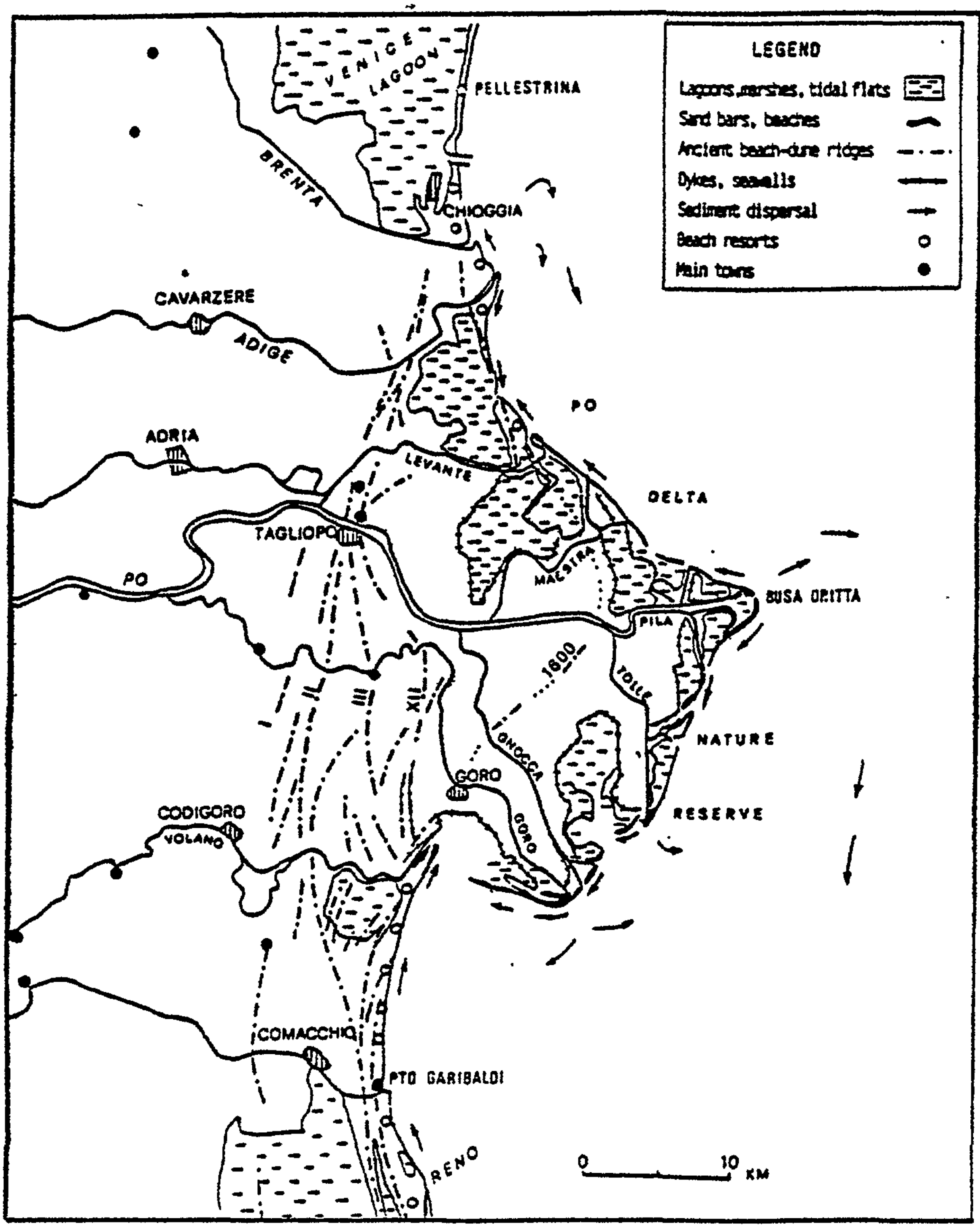
¹Les chiffres indiqués sur la figure tiennent compte des effets des aménagements récents en particulier de ceux effectués pour protéger le littoral de la Petite Camargue¹.

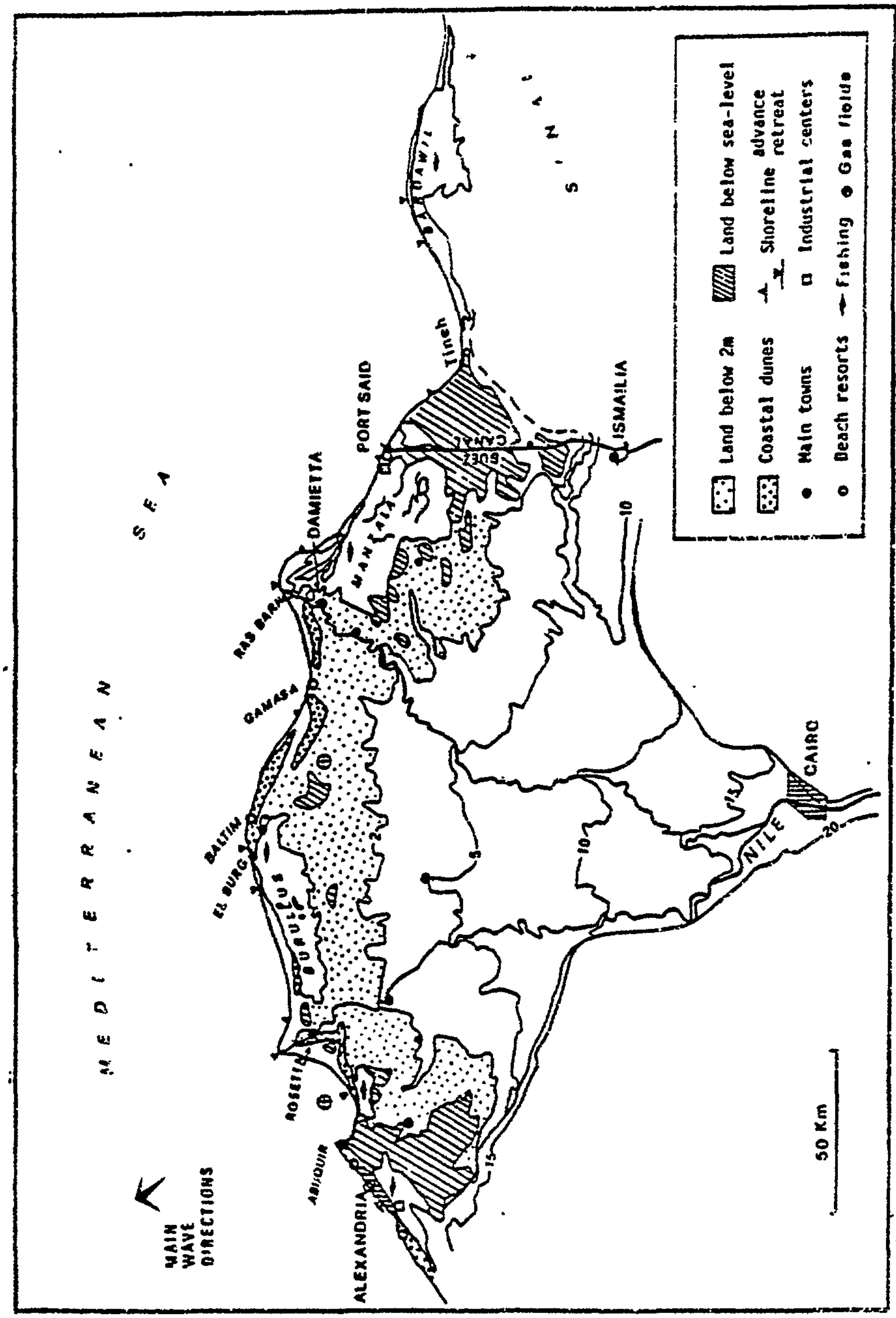


Summary of the state of erosion/accretion on the Romagna coast
(From Cencini et al 1979, CNR 1985)



Erosion-Accretion state of the Nile Delta shoreline. Top: from UNDP/UNESCO 1978; bottom, from Tetratech 1986 (based on Coastal Research Institute studies). Proposed setback lines, from Coastal Protection Master Plan.


LEGEND
Lagoons, marshes, tidal flats
Sand bars, beaches
Ancient beach-dune ridges
Dykes, seawalls
Sediment dispersal
Beach resorts
Main towns
VENICE LAGOON
PELLESTRINA
BRENTA
CHIOGGIA
CAVARZERE
ADIGE
PO
ADRIA
LEVANTE
DELTA
TAGLIOPO
PO
MAESTRA
BUSA DRITTA
PILA
1600
TOLLE
NATURE
GNOCCA
GORO
GORO
RESERVE
CODIGORO
VOLANO
COMACCHIO
PTO GARIBALDI
RENO
0
10 KM


MEDITERRANEAN SEA
SINAI
MAIN WAVE DIRECTIONS
ALEXANDRIA
ABUQUIR
ROSETTA
BURULLUS
EL BURG
BALTIM
GAMASA
RAS BARR
DAMIETTA
MANZALA
PORT SAID
Tineh
BARDAWIL
SUEZ CANAL
ISMAILIA
CAIRO
NILE
50 Km
Land below 2m
Land below sea-level
Coastal dunes
Shoreline advance retreat
Main towns
Industrial centers
Beach resorts
Fishing
Gas fields

ISLAND OF RHODES

a) A gradual increase in the rate of coastal erosion, mainly due to sea level rise is anticipated by the second half of the next century which will affect important coastal tourist areas, mainly in the northwest sector of the island.

> **ACTION: Coastal zone management (land-use, set-back zones for developing coastal zones of the Southern part) and readjustment of coastal building standards in terms of legislation with no social (public) compensation for erosion losses.**

b) A deterioration of water quality due to greater infiltration of sea water into the alluvial aquifer and increase of existing salinisation problems is expected by 2100.

> **ACTION: Water resource management and exploration for additional water resources, including construction of new dams and drilling of new boreholes into karstic aquifers.**

c) An increase in soil erosion will take place due to an increase in aridity caused by increased temperature and evapotranspiration, combined with changes in rainfall patterns and ecosystem status.

> **ACTION: Reforestation under scientific guidance and assistance.**

d) An increase of the maximum temperature by 2 to 3 ° C will modify the pattern of tourist arrivals. Nevertheless, the climatic scenarios indicate that even during the next century Rhodes will continue to constitute a fresher and milder spot in a warmer northeast Mediterranean.

> **ACTION: Study of the consequences of the changes to tourist season and services in relation to the islands economy and population.**

METHODOLOGY OF CONSTRUCTION OF SUB-GRID-SCALE TEMPERATURE AND PRECIPITATION SCENARIOS FOR MALTA REGION

A generalized computer programme that would be applicable throughout this geographically complex area, and could be used with meteorological records of variable length and density was required. After investigating a number of approaches to the problem, the procedure was adopted which is summarized below:

1. Data sets of monthly mean temperature and total precipitation have been compiled for the area surrounding the Mediterranean Basin. Where possible, each record should be complete for the period 1951-88. Any station with a record length less than 20 years in the period 1951-88 for over six months out of twelve was immediately discarded.

2. Then, for every valid station, the temperature and precipitation anomalies from the long-term (1951-88) mean were calculated. For this part of the work, which is the first step in the construction of the regression equations (the calibration stage), only the data for 1951-80 were used. The 1981-88 data were retained to test the performance of the regression models (the verification stage, see Final Report).

3. The individual station anomalies for temperature and precipitation are used to calculate regionally-averaged anomalies. The procedures described from here to the end of Point 6 are station-specific, and must be repeated for each station in the data set.

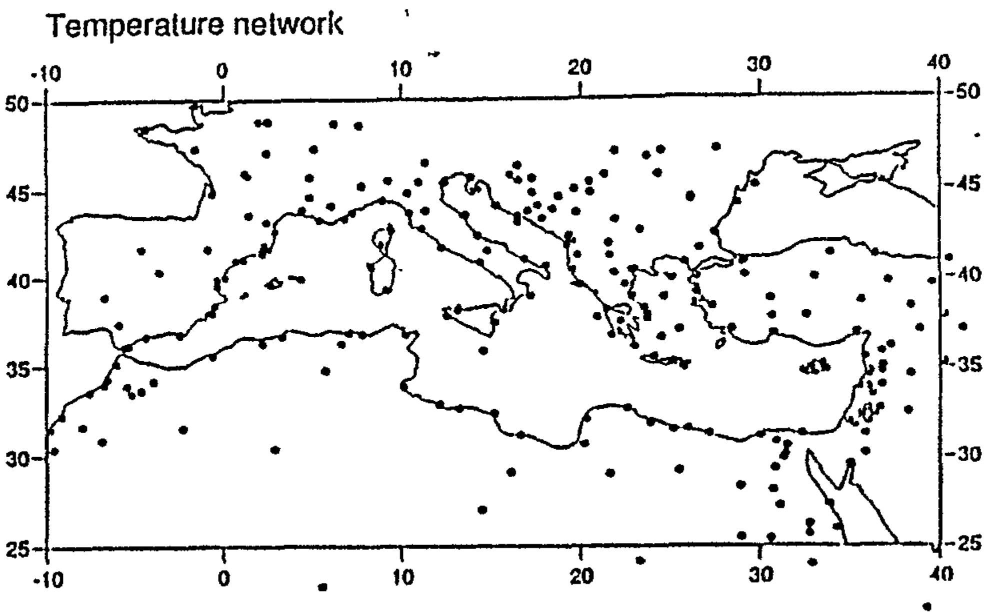
4. Regression analyses were performed using station temperature and precipitation anomalies as the predictants. These analyses were carried out on an annual and seasonal basis. The predictor variables are the regionally-averaged anomalies of temperature and precipitation.

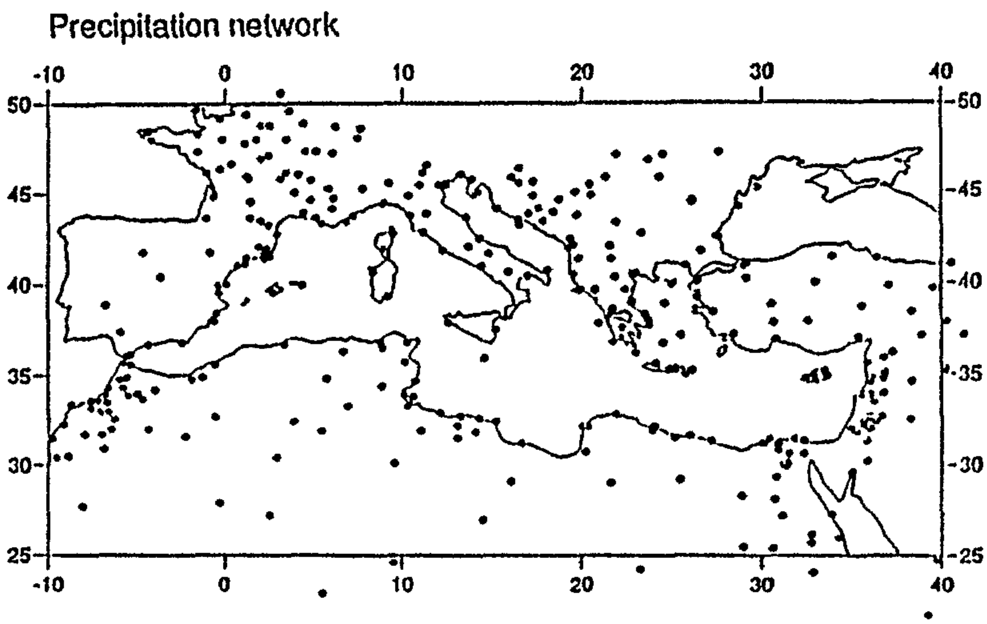
5. In order to determine the perturbation due to the greenhouse effect at each station, the results from GCMs were employed. It is assumed that a GCM grid-point temperature or precipitation value is equivalent to a regionally-averaged value derived from observational data. For each of the four GCMs (GFDL, GISS, OSU and UKMO), the perturbed run and control run grid-point temperature (t) and precipitation (p) values are interpolated to the station position.

   The values for "temperature anomaly" and "precipitation anomaly" for each GCM are then substituted in the regression equations to obtain a prediction for the station perturbation of temperature (°C) and precipitation (%) due to CO_2.

6. The predicted change in temperature and precipitation for each model is divided by the equilibrium (global mean) temperature change for that model. The results are then averaged across the four models to obtain a composite value.

7. The procedures from Points 3 to 6 is repeated for each station throughout the Mediterranean. The results can then be plotted and contoured to obtain a map of the expected patterns of temperature and precipitation change due to the greenhouse effect.





Network of temperature (above) and precipitation (below) measuring stations
(Palutikot et al., 1991)

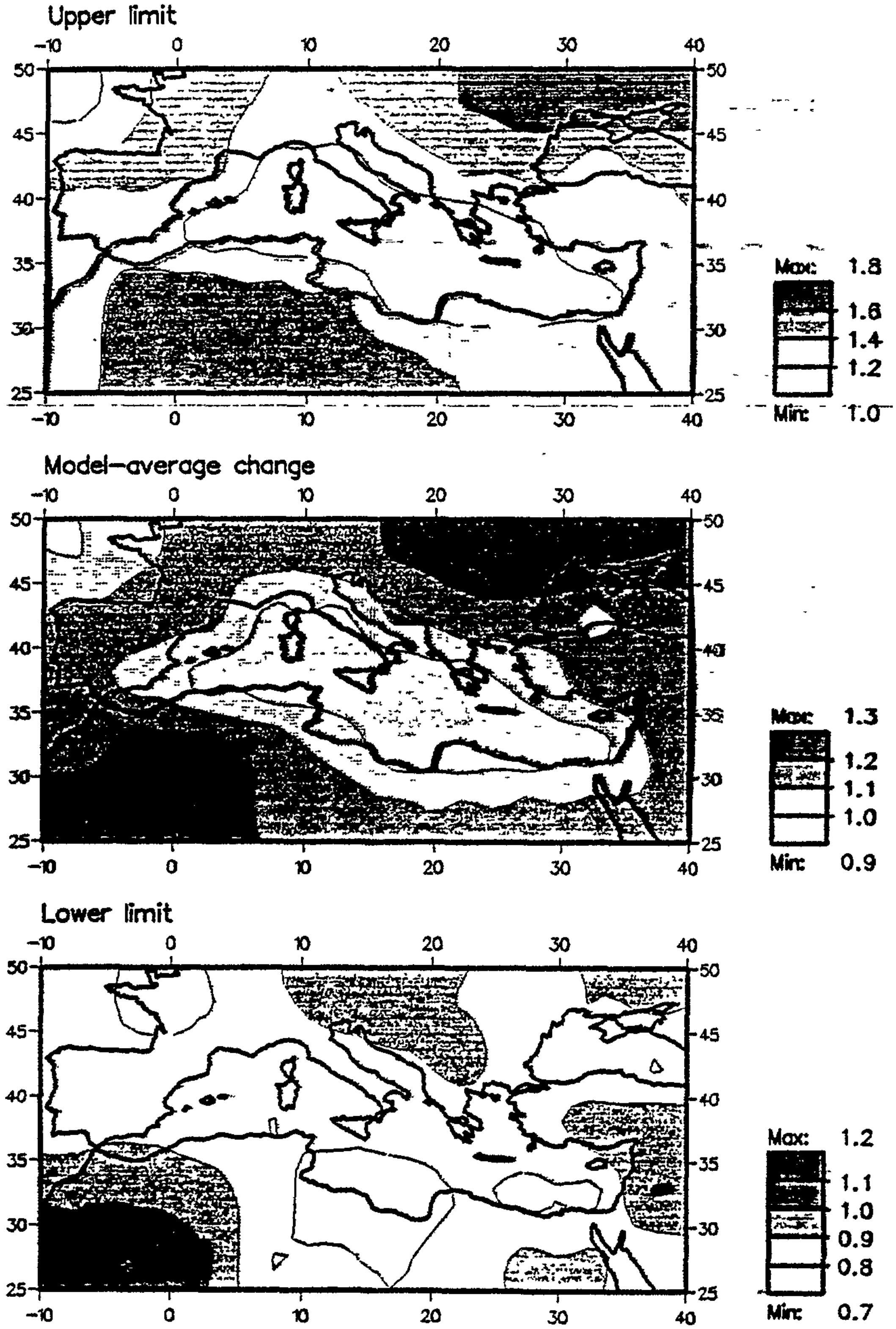


Fig. 3.1 Annual standardized model-average temperature change per ^{o}C global change, shown with the upper (above) and lower (below) 90% confidence limits (^{o}C)

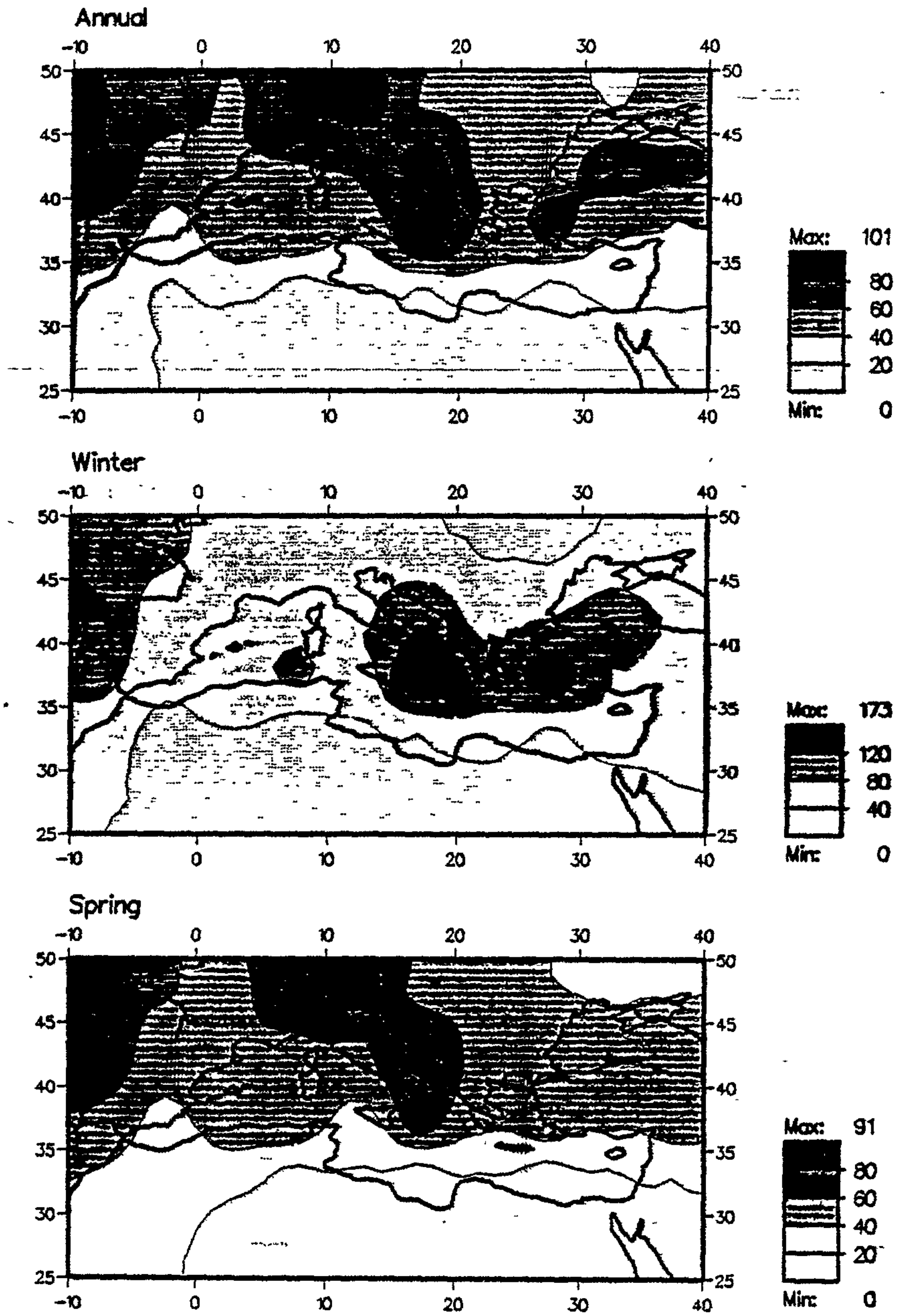


Fig. 2.8 Observed precipitation (mm/month)

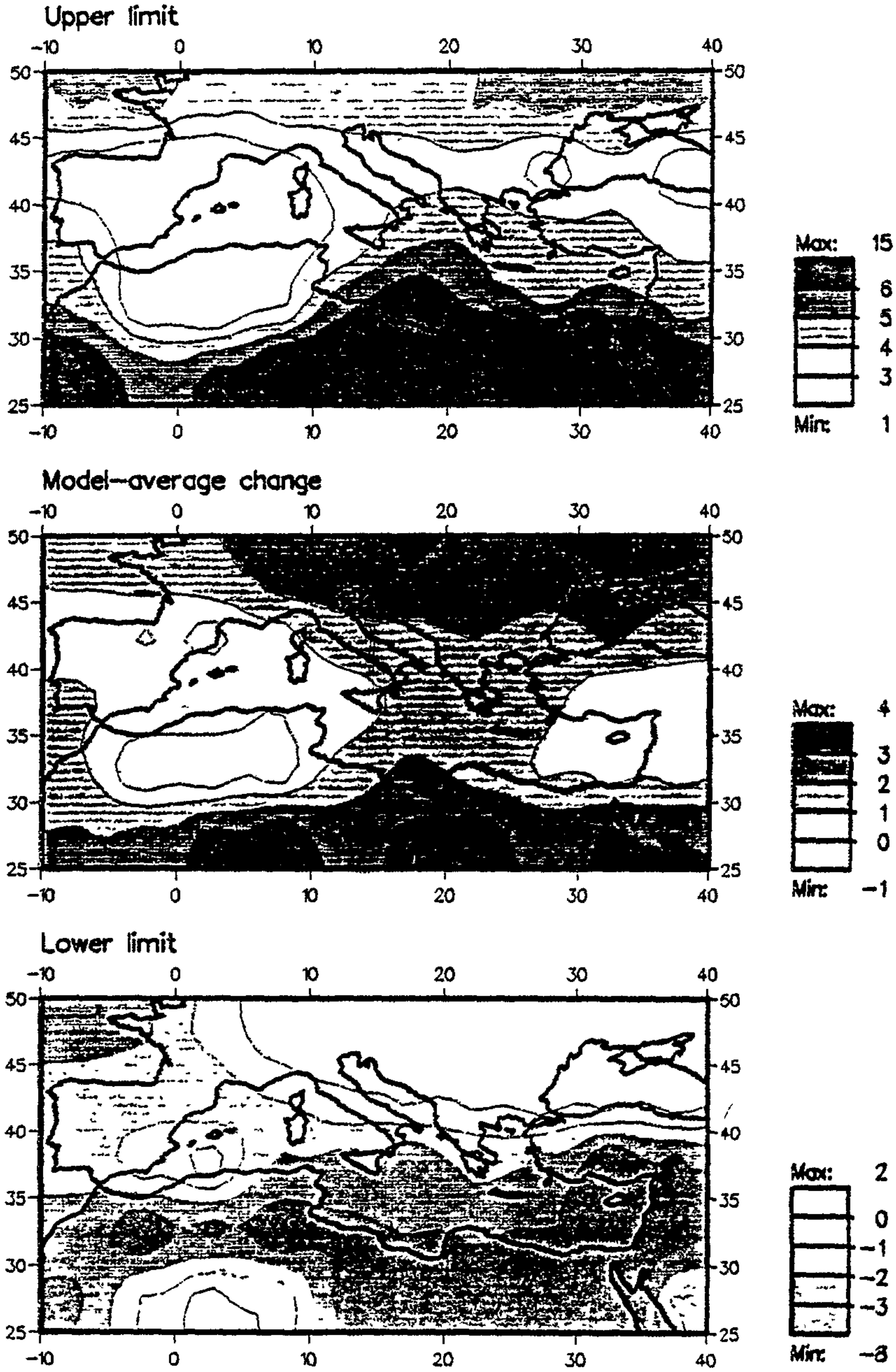


Fig. 3.6 Annual standardized model-average precipitation change per °C global change, shown with the upper (above) and lower (below) 90% confidence limits (mm)

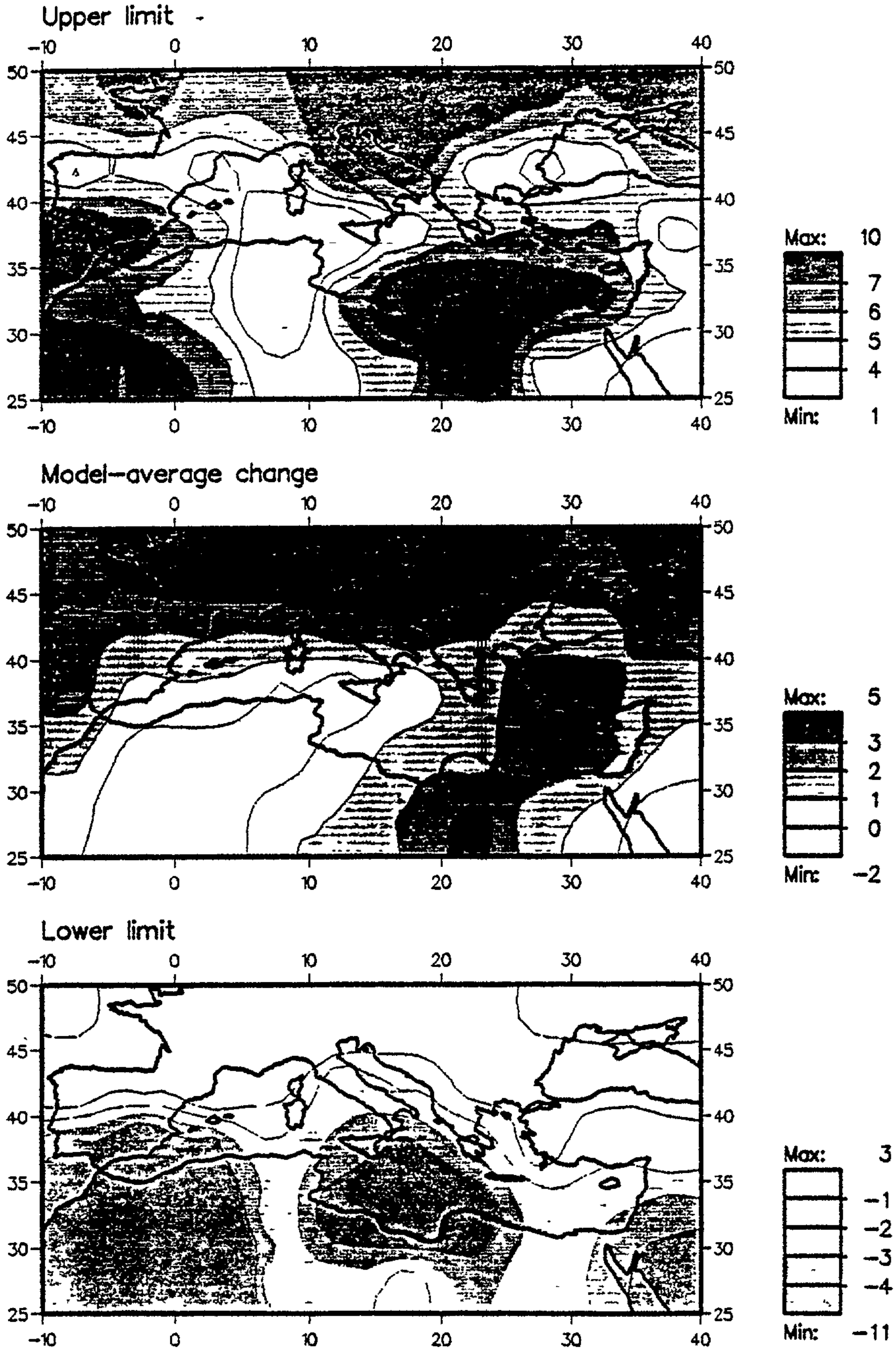
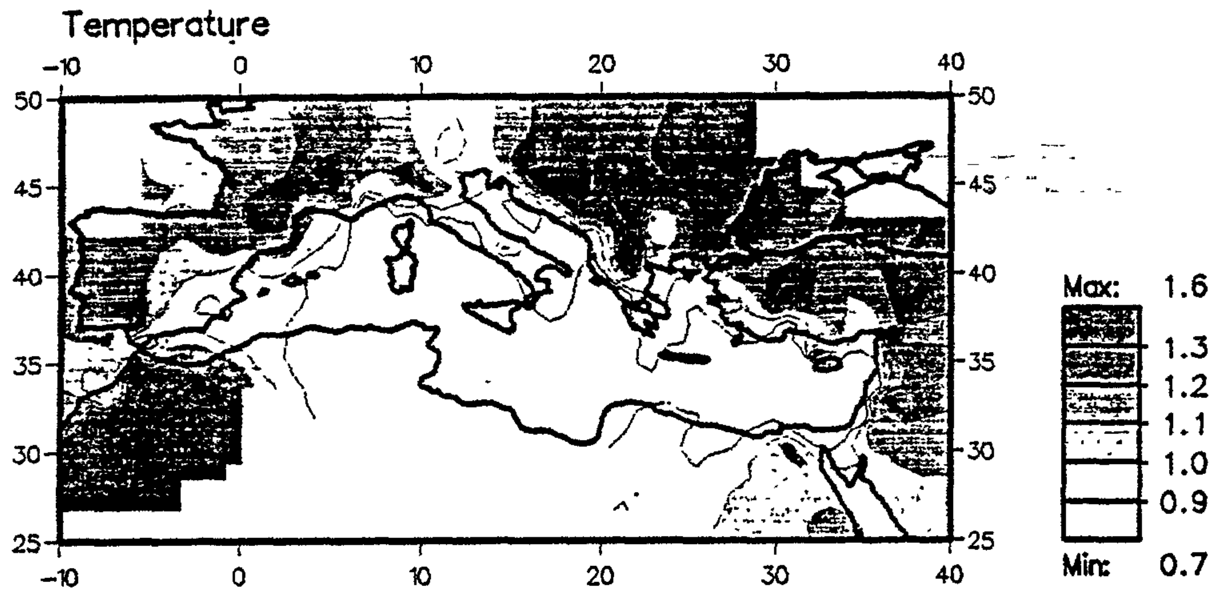


Fig. 3.7 Winter standardized model-average precipitation change per °C global change, shown with the upper (above) and lower (below) 90% confidence limits (mm)



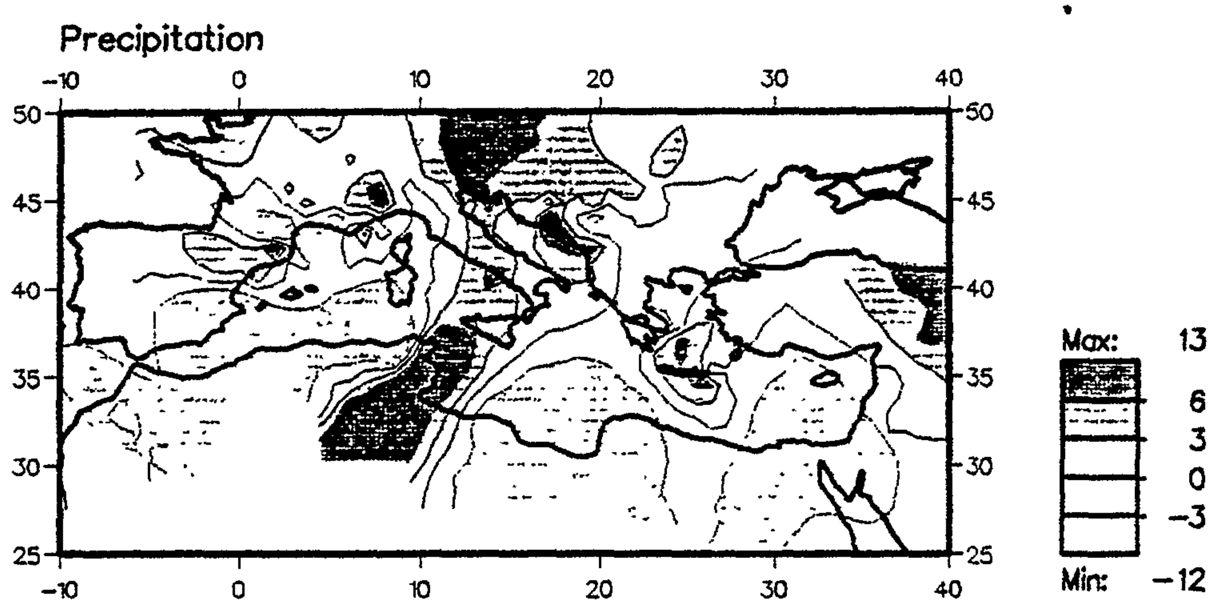
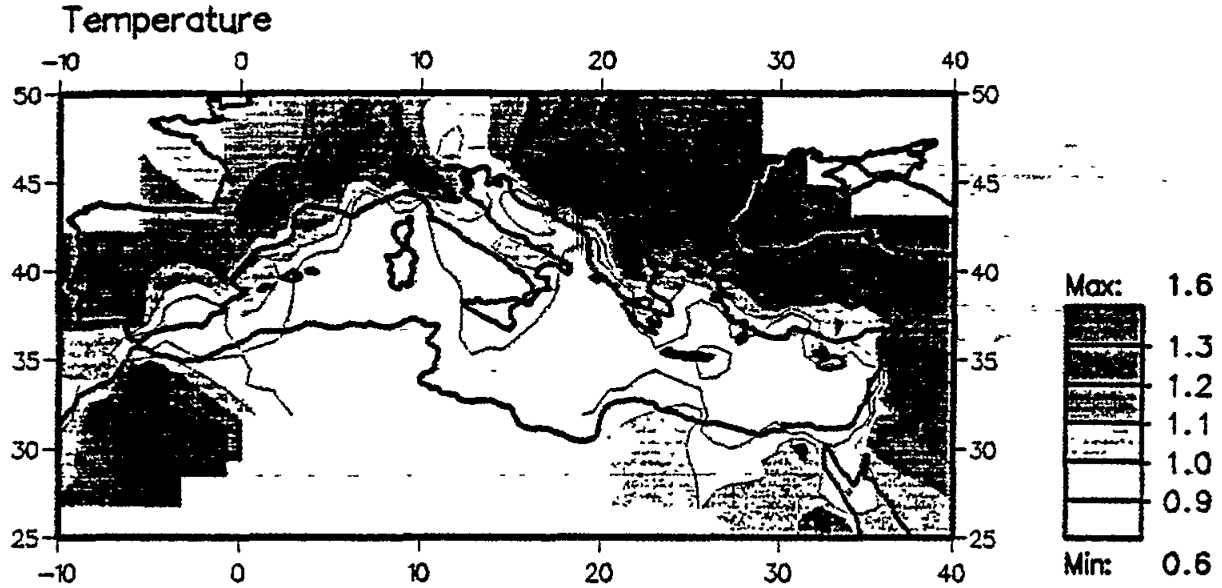


Fig. 4.27 Sub-grid scale scenarios of annual temperature (°C) and precipitation (mm) change per °C change in global-mean temperature



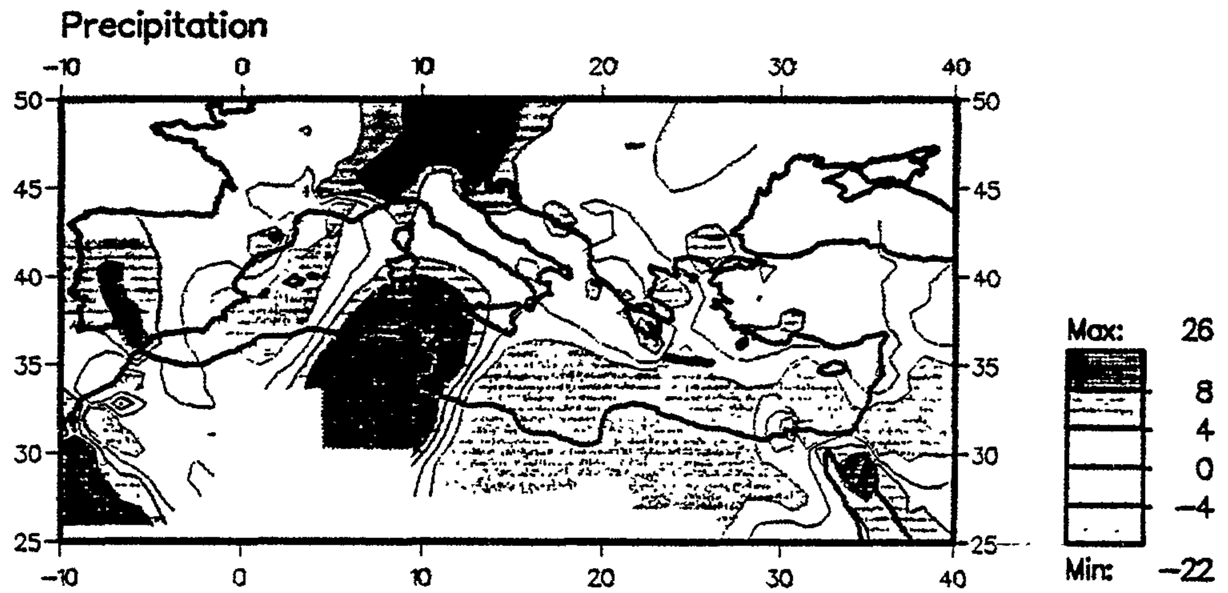
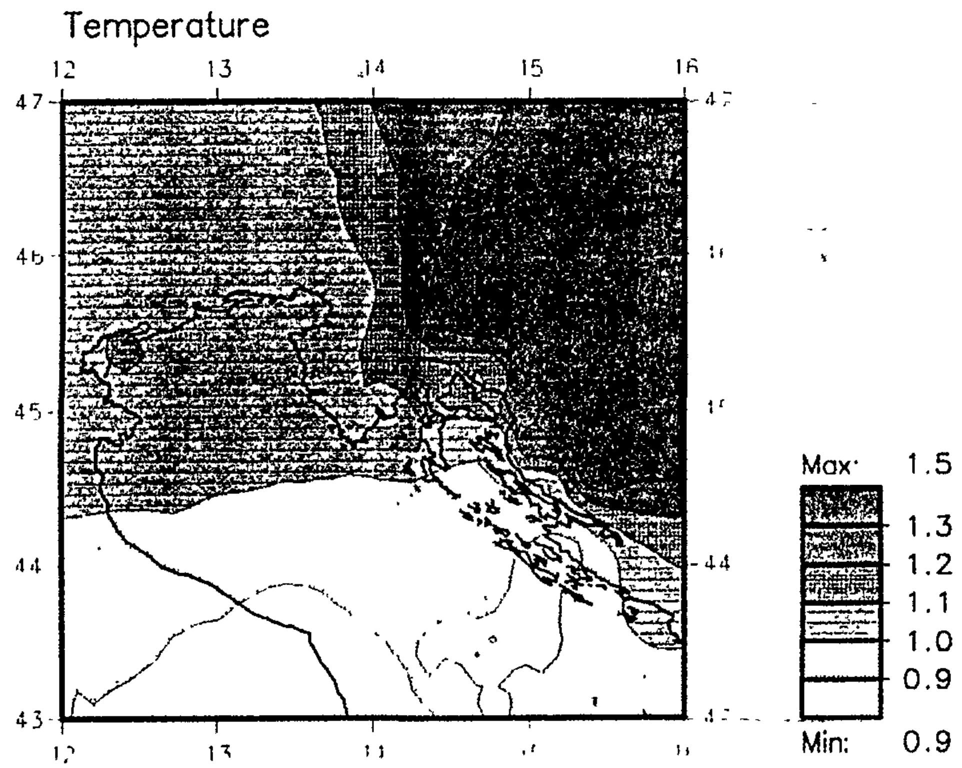
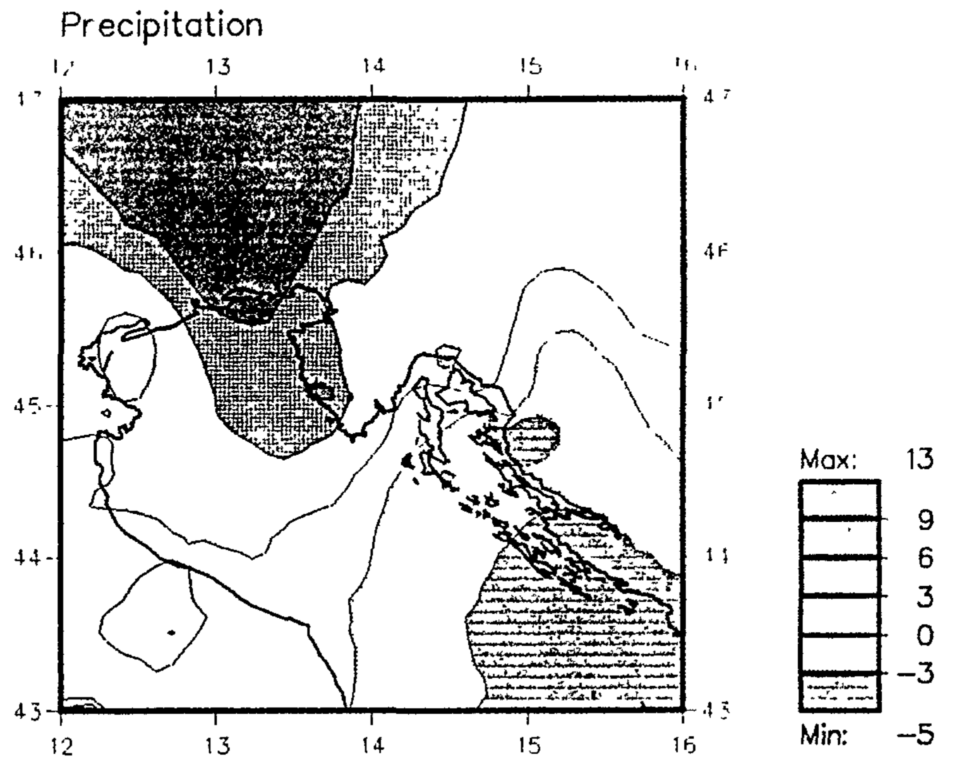
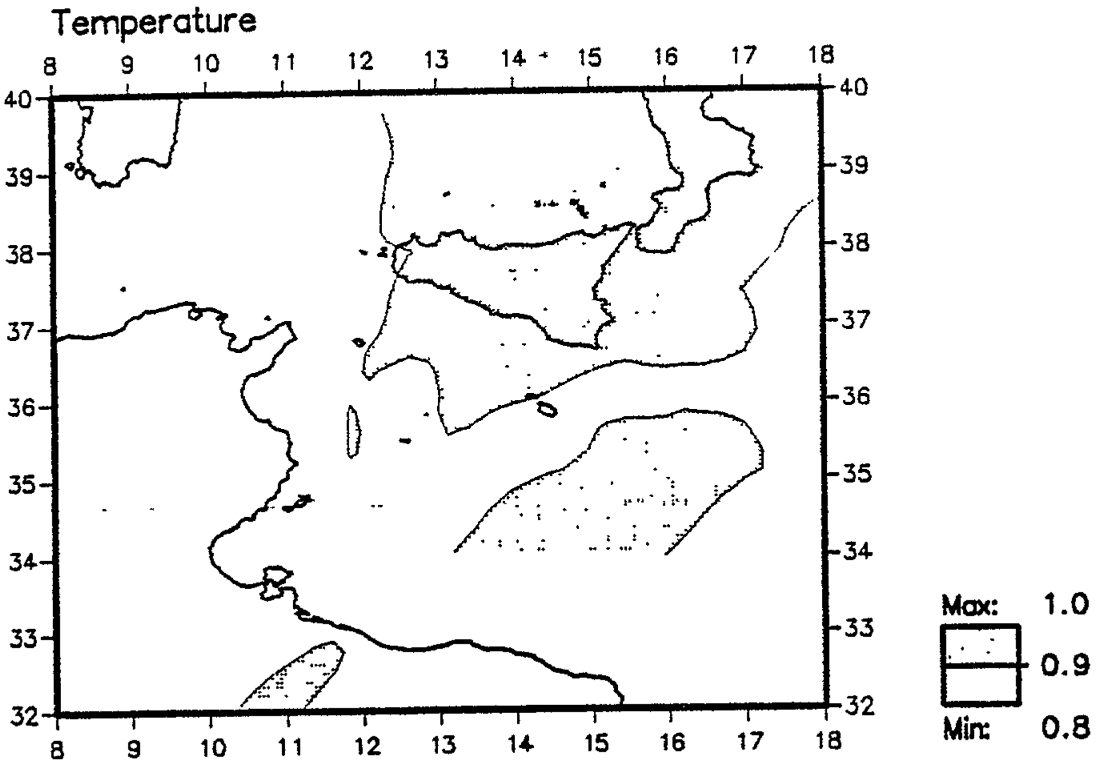
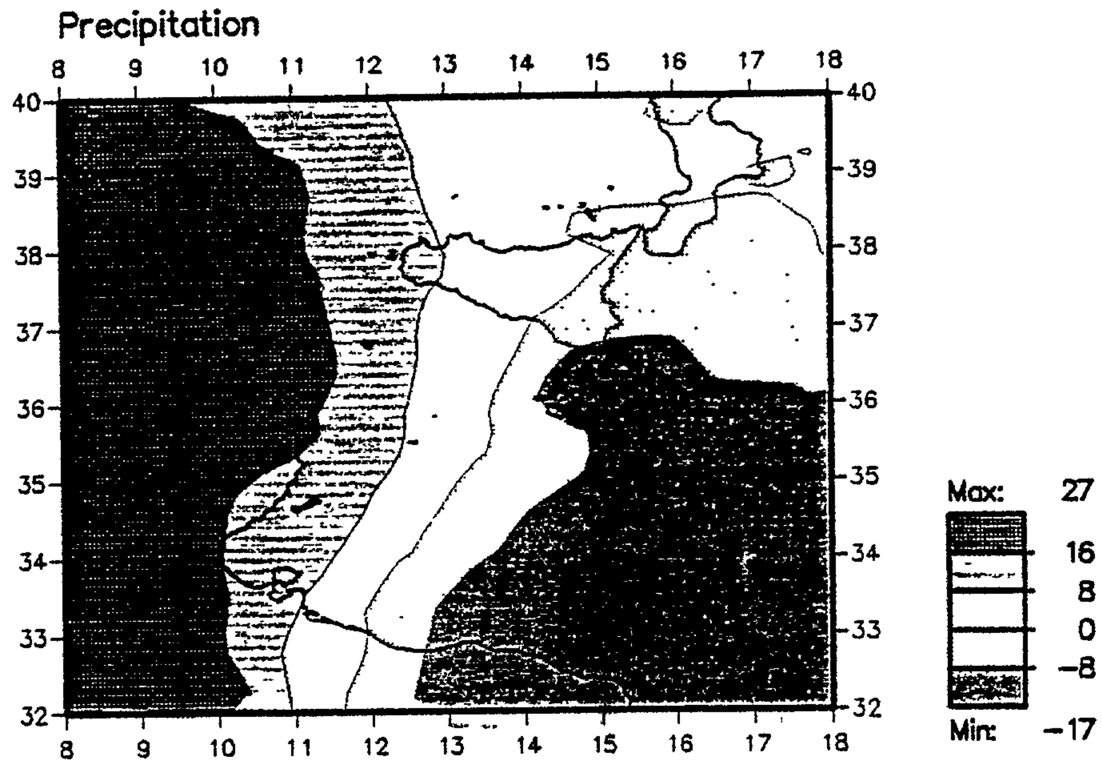


Fig. 4.28 Sub-grid scale scenarios of winter temperature (°C) and precipitation (mm) change per °C change in global-mean temperature


Temperature
12
13
14
15
16
47
46
45
44
43
Max: 1.5
1.3
1.2
1.1
1.0
0.9
Min: 0.9


Precipitation
13
14
15
45
44
43
12
13
14
15
16
Max: 13
9
6
3
0
−3
Min: −5


Temperature
8
9
10
11
12
13
14
15
16
17
18
40
39
38
37
36
35
34
33
32
Max: 1.0
0.9
Min: 0.8


Precipitation
8
9
10
11
12
13
14
15
16
17
18
40
39
38
37
36
35
34
33
32
Max: 27
16
8
0
−8
Min: −17

SCENARIOS	TIME HORIZON		
	2030**	2050	2100
Univ. East Anglia for Rhodes			
Temperature			
Annual	+ 0.7 to + 0.8°C		
Winter	+ 0.5 to + 0.8°C		
Spring	+ 0.6 to + 0.8°C	as for 2030	as for 2030
Summer	+ 1.0 to + 1.1°C		
Autumn	+ 0.7 to + 0.8°C		
Precipitation			
Annual	- 2 to 0 %		
Winter	0 to + 2%		
Spring	+ 4 to + 6%	as for 2030	as for 2030
Summer	+ 4 to + 12%		
Autumn	0 to + 2%		
Operative Scenario for Rhodes			
Temperature			
Annual	+ 1.3 to + 1.4°C	+ 1.6 to + 1.8°C	+ 2.5 to + 2.8°C
Winter	+ 0.9 to + 1.4°C	+ 1.1 to + 1.8°C	+ 1.8 to + 2.8°C
Spring	+ 1.1 to + 1.4°C	+ 1.4 to + 1.8°C	+ 2.1 to + 2.8°C
Summer	+ 1.8 to + 2.0°C	+ 2.3 to + 2.5°C	+ 3.5 to + 3.9°C
Autumn	+ 1.3 to + 1.4°C	+ 1.6 to + 1.8°C	+ 2.5 to + 2.8°C
Sea level*	+ 18 ± 12 cm	+ 38 ± 14 cm	+ 65 ± 35 cm
Precipitation			
Annual	- 3.5 to 0%	- 4.5 to 0%	- 7 to 0%
Winter	0 to + 3.6%	0 to + 4.5%	0 to + 7%
Spring	+ 7.2 to + 10.8%	+ 9 to + 13.5 %	+ 14 to + 21%
Summer	+ 7.2 to + 21.6%	+ 9 to + 27%	+ 14 to + 42%
Autumn	0 to + 3.6%	0 to + 4.5%	+ 0 to + 7%

* Where local sea level data clearly indicate a trend these values should be adjusted accordingly.

Scenarios of Climate Change for the Island of Rhodes

ANNEX IV

ACTIVITIES OF THE COASTAL AREA MANAGEMENT PROGRAMME (CAMP) FOR FUKA-MATROUH REGION

1. PROSPECTIVE ANALYSIS

1.1. Systemic and prospective analysis including Development/Environment scenarios

1.2. Implications of expected climatic changes in the coastal area of Fuka-Matrouh

2. INTEGRATED PLANNING AND MANAGEMENT PROGRAMME AND APPLICATION OF TOOLS AND TECHNIQUES FOR COASTAL ZONE MANAGEMENT (GIS, EIA, CARRYING CAPACITY)

2.1. Integrated planning and management study for the coastal area of Fuka-Matrouh

2.2. Training courses on the methodology of integrated planning and management in coastal areas

2.3. Training programme on GIS

3. LEGAL INSTRUMENTS AND INSTITUTIONAL STRUCTURES

3.1. Development of environmental legislation and institutional framework

3.2. Land-based Sources and Dumping protocols

3.3. Emergency Protocol and MARPOL Convention (contingency plan and port reception facilities)

3.4. Monitoring and research of marine environment

3.5. Specially Protected Areas Protocol and Historic Sites (protection and management of historic and natural sites)

4. SECTORIAL PLANNING (OPERATIONAL ACTIVITIES)

4.1. Development of environmentally sound tourism

4.1.1. Environmental Impact Assessment (EIA)
4.1.2. Carrying Capacity Assessment

4.2. Soil erosion and desertification

4.3. Water resources management study

ANNEX V

TEMPERATURE AND PRECIPITATION SCENARIOS FOR NORTHERN EGYPT

TEMPERATURE AND PRECIPITATION SCENARIOS FOR NORTHERN EGYPT

Report to the UNEP Co-ordinating Unit for the Mediterranean Action Plan

November 1993

CLIMATIC RESEARCH UNIT
School of Environmental Sciences
University of East Anglia
Norwich, NR4 7TJ
England

TEMPERATURE AND PRECIPITATION SCENARIOS FOR NORTHERN EGYPT

Report to the UNEP Co-ordinating Unit for the Mediterranean Action Plan

(in alphabetical order)
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School of Environmental Sciences
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November 1993

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SUMMARY

We have applied the methods developed by Kim et al. (1984) and Wigley et al. (1990) to construct high-resolution scenarios of climate change for northern Egypt. Regression equations were developed to predict station temperature and precipitation anomalies from regionally-averaged climate anomalies. We then substituted GCM perturbed-run minus control-run values of temperature and precipitation in the regression equations to obtain a prediction of the change due to the greenhouse effect at each station. The results were scaled by the equilibrium temperature of each of the four GCMs, and an average for the four models obtained. The procedure was repeated for every station in the data set, and the results contoured to produce a scenario for northern Egypt.

Annual and seasonal scenarios for both temperature and precipitation change were produced. The specific region of interest is the Egyptian coastline west of Alexandria. Here, for temperature, the annual change is indicated to be less than the global change i.e. in the range 0.7-0.8°C per °C global change. Broadly, the same pattern is seen in each season. Only in summer is the warming in the Fuka-Matrouh area shown to approach the global level (with changes in the region 0.9-1.1°C per °C global change.

The scenarios of precipitation indicate drier conditions at the annual level, with a change in rainfall in the range of -4-0% per °C global warming. This relatively small change is accounted for by decreases in winter and autumn, whereas conditions in spring and summer are shown to be wetter as a result of global warming.. In winter, the greatest change is seen in the west, towards the border with Libya, with a reduction in rainfall of over 10% per °C global warming. In autumn, the changes are between 0% and -14% per °C global warming. The increase in rainfall in spring is over 8% per oC global warming over the whole of the Egyptian coastline west of Alexandria. In summer, the increase is greatest in the west (over 8%), dropping to 0-4% per °C global warming close to Alexandria.

The problems associated with the construction of regional scenarios of climate change due to the enhanced greenhouse effect are discussed at length by Palutikof et al., 1992, in their report to UNEP on the construction of climate change scenarios for the whole Mediterranean region. The confidence that we can place in sub-grid-scale scenarios of precipitation is particularly low. These scenarios should be considered only as indicators of changes that might occur.

1. THE USE OF GCMS IN REGIONAL SCENARIO DEVELOPMENT

It is generally accepted that the results from General Circulation Models (GCMs) offer the best potential for the development of regional climate scenarios. They are the only source of detailed information on future climates which can extrapolate beyond the limit of conditions which have occurred in the past.

GCMs are complex, computer-based, three-dimensional models of the atmosphere which have been developed by climatologists from numerical meteorological forecasting models. The results used here are taken from GCM equilibrium response experiments. That is, the model is first run with a nominal "pre-industrial" atmospheric CO_2 concentration (the control run) and then rerun with doubled (or sometimes quadrupled) CO_2 (the perturbed run). In both, the models are allowed to reach equilibrium before the results are recorded.

The fact that the GCMs are run in equilibrium mode must in itself be regarded as a potential source of inaccuracy in model predictions. It can be argued that the predicted regional patterns of climate change will differ from those that will occur in a real, transient response world. Results are becoming available from transient response predictions, where the CO_2 concentration increases gradually through the perturbed run and where the oceans are modelled using ocean GCMs, and which therefore should provide a more realistic estimate (see Gates et al., 1992). These indicate that the large-scale patterns of change are similar to those obtained from comparable equilibrium experiments, scaled down by an appropriate factor. Differences do exist, largely because equilibrium model runs ignore important oceanic processes such as ocean current changes, differential thermal inertia effects between different parts of the oceans and between land and ocean, and changes in the oceanic thermohaline circulation. These differences are greatest in areas where the ocean thermal inertia is large, such as the North Atlantic and high southern latitudes (Mitchell et al., 1990). They are relatively small in most regions (and in the Mediterranean Basin in particular).

The four GCM experiments used to construct the scenarios are from the following research institutions: the U.K. Meteorological Office model (abbreviated here to UKMO; the model version used here is as described by Wilson and Mitchell (1987)); the Goddard Institute of Space Studies model (GISS; Hansen et al., 1984); the Geophysical Fluid Dynamics Laboratory model (GFDL; Wetherald and Manabe, 1986); the Oregon State University model (OSU; Schlesinger and Zhao, 1989). The models vary in the way in which they handle the physical equations describing atmospheric behaviour. UKMO, GISS and OSU solve these in grid-point form whereas GFDL uses a spectral method. All models have a realistic land/ocean distribution and orography (within the constraints of model resolution); all have predicted sea ice and snow; clouds are calculated in each atmospheric layer in all models.

One problem with the application of GCMs to the study of climate impacts is the coarse resolution of the model grid. The grid scale of the four models listed above ranges from 4° latitude x 5° longitude (OSU) to 7.83° latitude x 10° longitude (GISS). GCMs, therefore, have a spatial resolution of several hundreds of kilometres, which is inadequate for many regional climate change studies, especially in areas of high relief. We present here a set of high resolution scenarios for northern Egypt, based on the statistical relationship between grid-point GCM data and observations from surface meteorological stations.

2. CONSTRUCTION OF SUB-GRID-SCALE SCENARIOS

Kim et al. (1984) looked at the statistical relationship between local and large-scale regionally-averaged values of two meteorological variables: temperature and precipitation. They then used these relationships, developed using principal component analysis techniques, to look at the response of local temperature and precipitation to the predicted change at GCM grid points. The area of study was Oregon State. Although the paper contains certain statistical flaws, the underlying idea of relating local and large-scale data statistically is sound. The method of Kim et al. has been extended and refined by Wigley et al. (1990) and by Wilks (1989).

The methods of Kim et al. and Wigley et al. have been modified for application in the Mediterranean region. In the model validation exercise carried out for the Mediterranean region by Palutikof et al. (1992), it was established that no single GCM can be identified as being always the best at simulating current climate. This being the case, there is little merit in presenting scenarios based on only one model. Presentation of scenarios for each of the four models avoids the issue, since the task of deciding which model is 'best', and/or of synthesizing the information to obtain a best estimate, is left to the impact analyst. We have therefore combined the information from the four models into a single scenario for each variable, according to the method described below.

The problem with scenario construction based on a number of models is that the results may be biassed by the different equilibrium responses of the individual models. The global warming due to $2xCO_2$ for the four GCMs ranges between 2.8°C for the OSU model and 5.2°C for the UKMO model run. We would therefore expect that the warming indicated by the UKMO GCM for the Mediterranean Basin will be greater than that suggested by the OSU model, even though the sensitivity of the region to climate change when compared to the global sensitivity might be the same. The individual model perturbations have therefore been standardized by the equilibrium (global annual) temperature change for that model, prior to the calculation of the four-model average.

We required a generalized computer program that would be applicable throughout this geographically complex area, and could be used with meteorological records of variable length and density. After investigating a number of approaches to the problem, we adopted the procedure summarized below.

1. Data sets of monthly mean temperature and total precipitation have been compiled for the area surrounding the Mediterranean Basin. Stations used in this study of northern Egypt are listed in Appendix 1. Where possible, each record should be complete for the period 1951-88. Any station with a record length less than 20 years in the period 1951-88 for over six months out of twelve was immediately discarded.

2. Then, for every valid station, the temperature and precipitation anomalies from the long-term (1951-88) mean were calculated. For this part of the work, which is the first step in the construction of the regression equations (the calibration stage), only the data for 1951-80 were used. The 1981-88 data were retained to test the performance of the regression models (the verification stage, see Palutikof et al., 1992). For the calculation of the temperature anomaly At_{ij}, the simple difference was used:

$$At_{ij} = t_{ij} - T_j$$

where t_{ij} is the mean temperature of month j in year i, and T_j is the long-term mean for month j. The precipitation anomaly Ap_{ij} was expressed as a ratio of the long-term mean:

$$Ap_{ij} = (p_{ij} - P_j)/P_j$$

where p_{ij} is the monthly total precipitation in month j of year i, and P_j is the long-term mean for that month. If P_j is less than 1mm, then this equation is modified to:

$$Ap_{ij} = (p_{ij} - P_j)/1.0$$

3. The individual station anomalies are used to calculate regionally-averaged anomalies. The procedures described from here to the end of Point 6 are station-specific, and must be repeated for each station in the data set.

A 5° latitude x 5° longitude square is centred over the station for which regression equations are to be developed (the predicted station). All the stations which fall within this square are used to calculate the regional averages. If the number of stations is less than three, for temperature, or four, for precipitation, the procedure is halted. For temperature, the anomalies from all stations in the 5° x 5° square are averaged month-by-month to produce an area-average time series. For precipitation, the substantial degree of spatial variability makes it advisable to area-weight the station anomalies before calculating the regional mean for each month. To do this, the 5° x 5° region is divided into 20 x 20 smaller squares. The precipitation anomaly value assigned to a particular square is that of the station nearest to it (with the restriction that the distance separating a square from its nearest station should be no greater than 1° - where the distance is greater the square is ignored). The area average is then the mean of the values in the 400 (or fewer, if any fail the minimum distance criterion) squares. This method is similar to the standard Thiessen polygon method.

4. Regression analyses were performed using station temperature and precipitation anomalies as the predictands. These analyses were carried out on an annual and seasonal basis: winter (December, January, February), spring (March, April, May), summer (June, July, August) and autumn (September, October and November). By considering the monthly values as separate observations within each season, we were able to extend the number of observations and so preserve a high number of degrees of freedom. The predictor variables are the regionally-averaged anomalies of temperature and precipitation.

5. In order to determine the perturbation due to the greenhouse effect at each station, the results from GCMs were employed. It is assumed that a GCM grid-point temperature or precipitation value is equivalent to a regionally-averaged value derived from observational data. For each of the four GCMs (GFDL, GISS, OSU and UKMO), the perturbed run and control run grid-point temperature (t) and precipitation (p) values are interpolated to the station position. Then, we obtain, for temperature:

$$Atm_i = t_i(2 \times CO_2) - t_i(1 \times CO_2)$$

where Atm is the perturbation due to CO_2 or the 'temperature anomaly' for model i and, for precipitation:

$$Ptm_i = [p_i(2 \times CO_2) - p_i(1 \times CO_2)] \times 100/p_i(1 \times CO_2)$$

where Ptm is the standardized perturbation due to CO_2, or the 'precipitation anomaly'.

The values for Atm and Ptm for each GCM are then substituted in the regression equations to obtain a prediction for the station perturbation of temperature (°C) and precipitation (%) due to CO_2.

6. The predicted change in temperature and precipitation for each model is divided by the equilibrium (global mean) temperature change for that model. The results are then averaged across the four models to obtain a composite value.

7. The procedures from Points 3 to 6 is repeated for each station throughout the Mediterranean. The results can then be plotted and contoured to obtain a map of the expected patterns of temperature and precipitation change due to the greenhouse effect.

In order to arrive at this procedure, a rigorous investigation of the validity of the method has been carried out. In particular, we have looked at:

- the use of other predictor variables in the regression equations
- performance and verification of the regression equations
- autocorrelation in the data
- multicollinearity in the predictor variables.

These aspects are discussed in detail by Palutikof et al. (1992).

3. CLIMATE CHANGE SCENARIOS FOR NORTHERN EGYPT

The sub-grid-scale scenarios, constructed according to the method outline in Section 2, are shown in Figs. 1-5. The temperature perturbations are presented as the model average change, in degrees Celsius, per °C global annual change. The precipitation perturbations are shown as the percentage change for each 1°C global annual change. This procedure is described in greater detail, and the approach justified, in Section 2.

The scenarios are presented as the regional change in a particular climate variable to be expected in response to a 1°C change in mean global temperature. As such, they do not provide any information on when such changes might be expected to occur. However, such information can be extracted from scenarios presented in this form. The results from four transient response GCMs presented in IPCC92 (Gates et al., 1992) show a constant rate of warming in the later decades of around 0.3°C per decade. This is in line with the findings of IPCC90, based on the 'business-as-usual' CO_2 forcing scenario and an energy balance atmospheric model coupled to an upwelling-diffusion ocean model (Bretherton et al., 1990). Although the impossibility of placing calendar dates on this figure must be emphasized, it suggests that a 1°C temperature change may be achieved in a period of around thirty years.

It should be noted that the figure of 0.3°C per decade does not take into account possible opposing anthropogenic influences, in particular the forcing from sulphate aerosols and stratospheric ozone depletion. Wigley and Raper (1992) made temperature projections based on IPCC92 emissions scenario IS92a (Leggett et al., 1992), taking into account the ozone-depletion feedback and best-guess sulphate aerosol effects. They used their upwelling-diffusion energy-balance climate model (as used in IPCC90, see above) and found the warming between 1990 and 2100 to be in the range 1.7-3.8°C.

The results from these time-dependent experiments can be combined with the scenarios of the magnitude of change presented in this report, and superimposed on a baseline (present-day) climatology in order to arrive at a scenario of climate for a particular future time. A recent example of the application of this approach to the development of 'snapshot' scenarios for Europe is the ESCAPE project (CRU, 1992). This approach requires that the spatial pattern of the enhanced greenhouse signal remains constant with time, but the available model evidence suggests that this is a reasonable assumption to make (Mitchell et al., 1990; Gates et al., 1992).

Annual scenarios of climate change

The scenarios for changes at the annual level are shown in Fig. 1. The temperature change along the coast west of Alexandria (the region of interest) is indicated to be less than the global change i.e. in the range 0.7-0.8°C per °C global change. The scenario of precipitation indicates drier conditions at the annual level, with a change in rainfall in the range of -4% to 0% per °C global warming.

Seasonal scenarios of climate change

The seasonal changes in temperature in the Fuka-Matrouh area, as predicted by the four GCMs, broadly reflect the changes which are seen at the annual level. Only in the summer months of June, July and August (Fig. 4) does the temperature change approach the global level, with suggested increases of between 0.9°C and 1.1°C per °C global change shown along the north-western coast of Egypt. In the winter months of December, January and February (Fig. 2) the predicted increases of temperature are 0.7-0.8°C per°C global change i.e. less than the global change. The smallest amount of warming in the study region is found in the spring season (Fig. 3), of between 0.6°C and 0.8°C per °C global warming. In autumn (Fig. 5), the warming is between 0.7°C and 0.9°C in the Fuka-Matrouh region.

The annual change of around -4 to 0% per °C global change in precipitation is made up of increased rainfall in the spring and summer seasons (lower maps, Figs. 3 and 4), and drier conditions in winter and autumn (lower maps, Figs. 2 and 5). In winter, the suggested reduction in precipitation along the coast west of Alexandria is between 0% and 22% per °C global change, with a gradient from east to west of increasing aridity. In spring, an increase of more than 8% is indicated for virtually the whole of the area of interest. Summer conditions are also shown to be wetter as a result of the enhanced greenhouse effect, with increases of between 0% and 8% per °C global change, with the greatest increase in the west of the coastal region. In autumn, the suggested changes are again negative, with a reduction of between 0% and 14% per °C global change. The greatest changes in this season are seen close to Alexandria.

Fig. 1 Regional climate scenarios for northern Egypt: annual. Upper map shows change in temperature (°C per °C global change) and the lower map shows change in precipitation (% per °C global change).

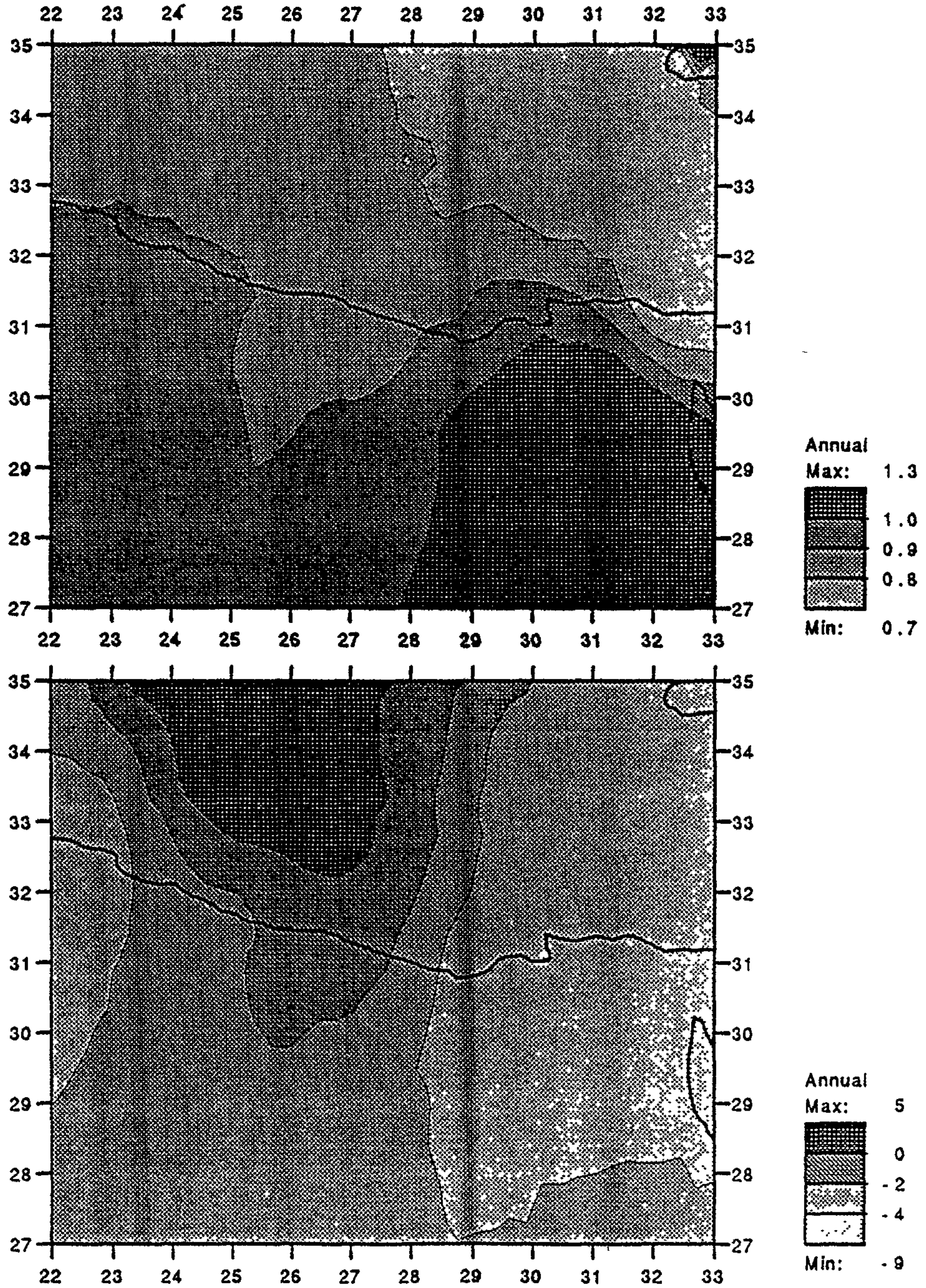


Fig. 2 Regional climate scenarios for northern Egypt: winter. Upper map shows change in temperature(°C per °C global change) and the lower map shows change in precipitation % per °C global change).

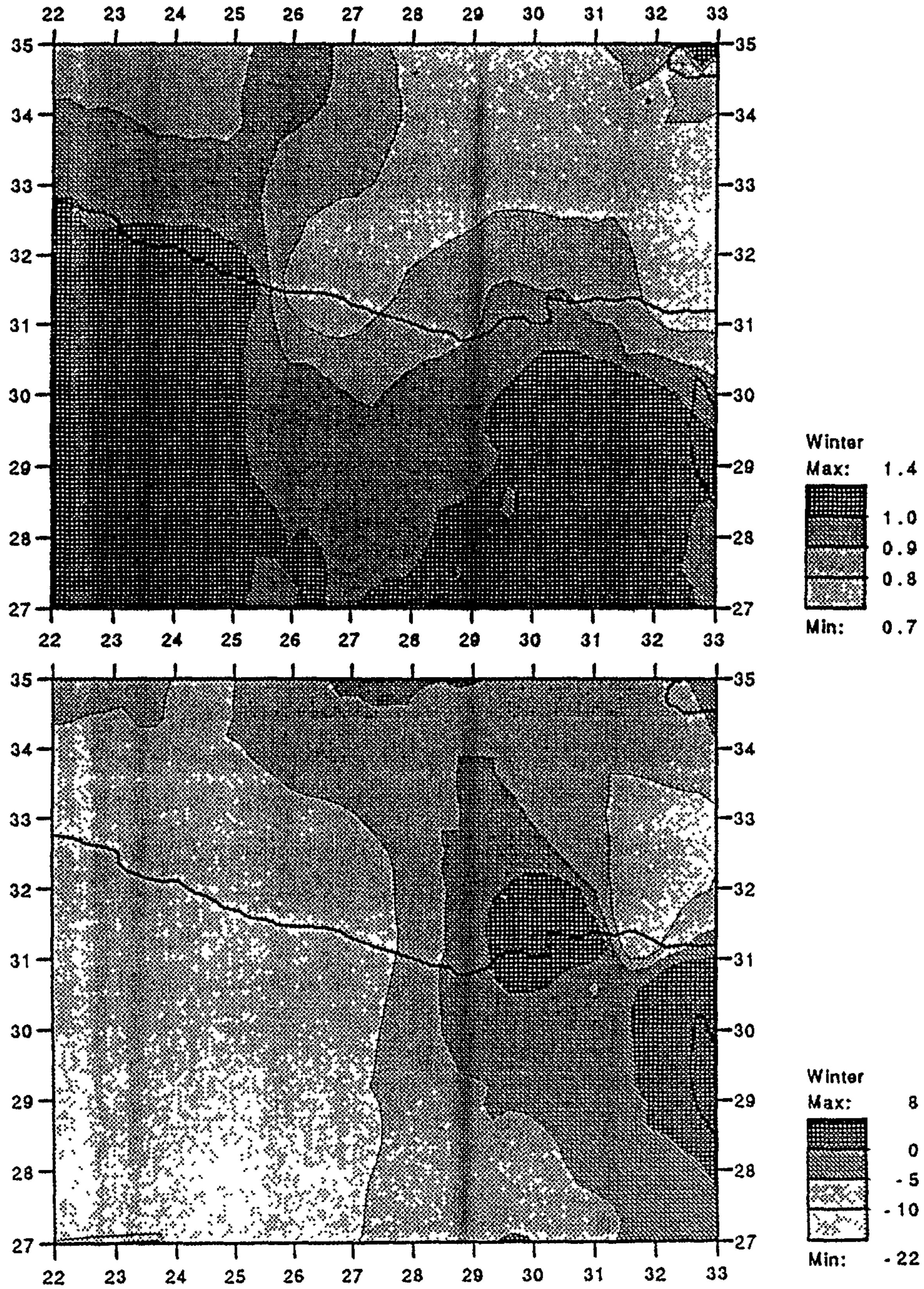


Fig. 3 Regional climate scenarios for northern Egypt: spring. Upper map shows change in temperature(°C per °C global change) and the lower map shows change in precipitation (% per °C global change).

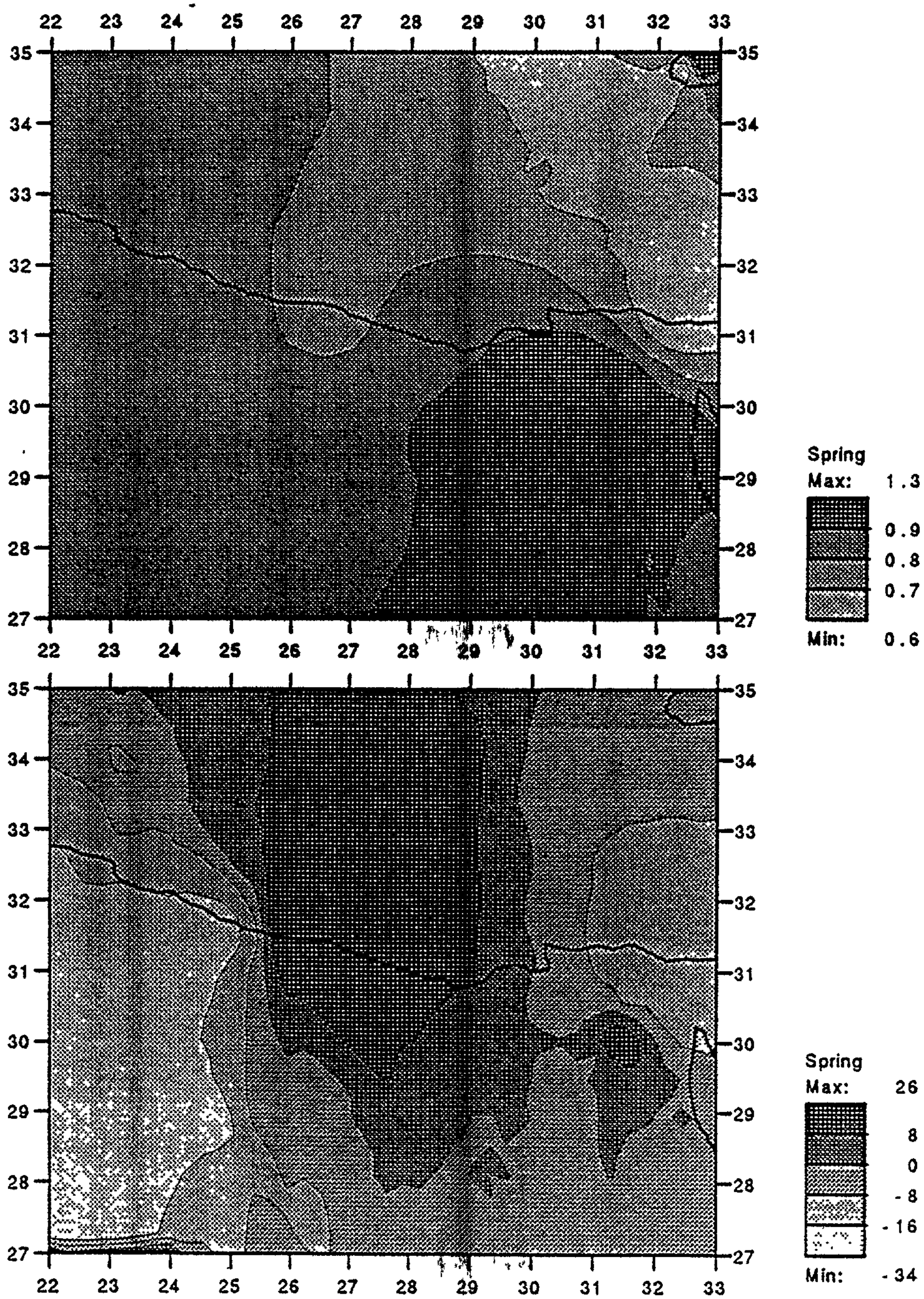
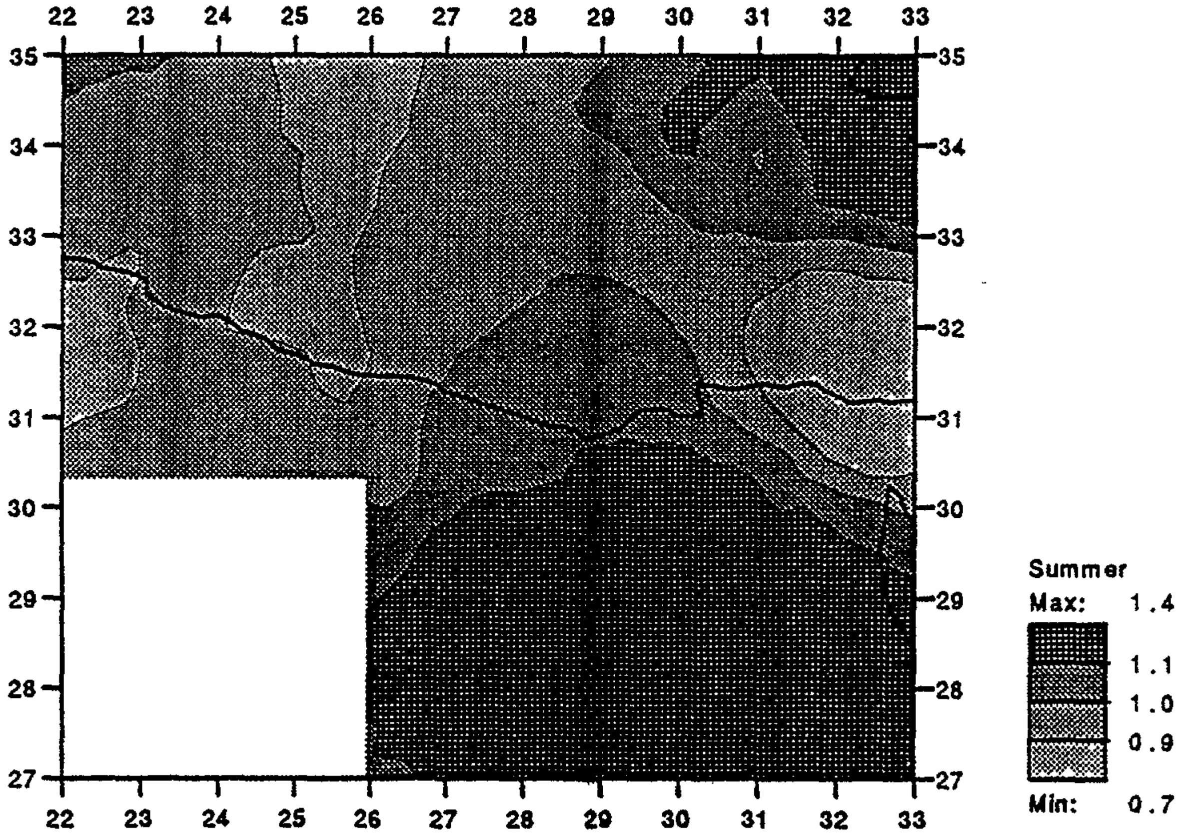


Fig. 4 Regional climate scenarios for northern Egypt: summer. Upper map shows change in temperature(°C per °C global change) and the lower map shows change in precipitation (% per °C global change).



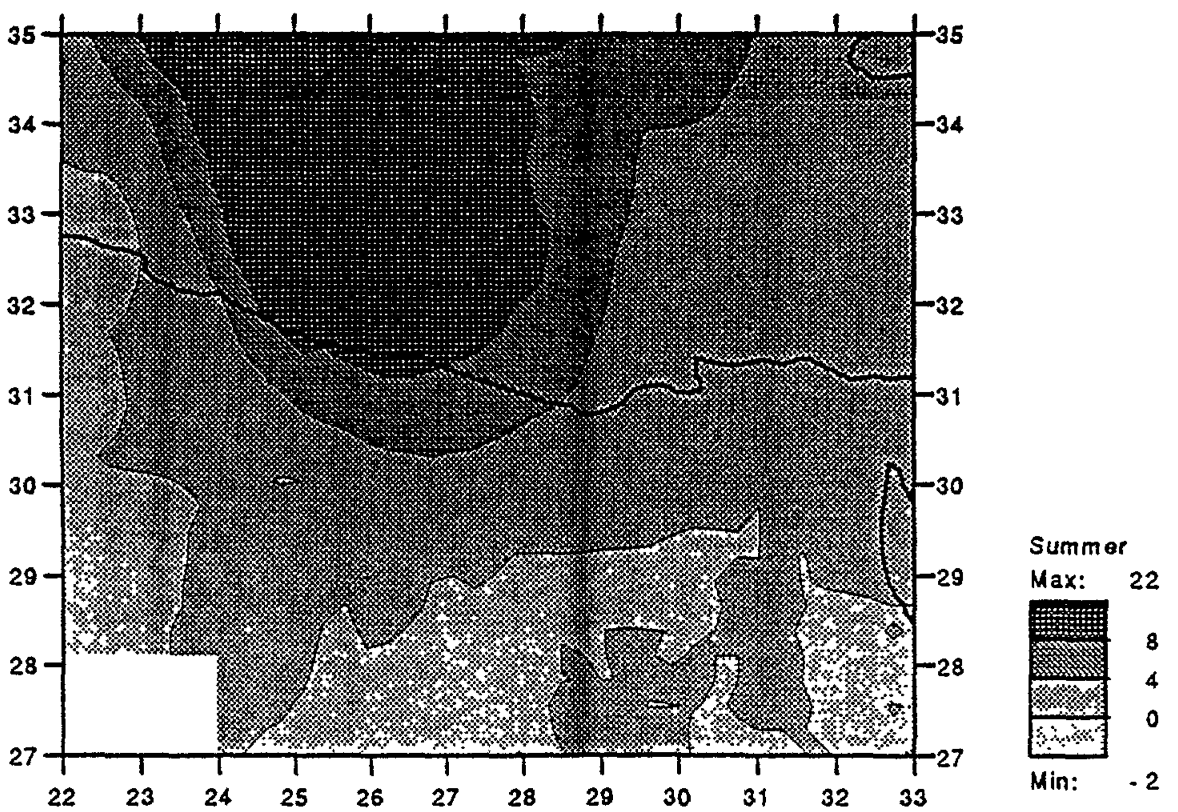
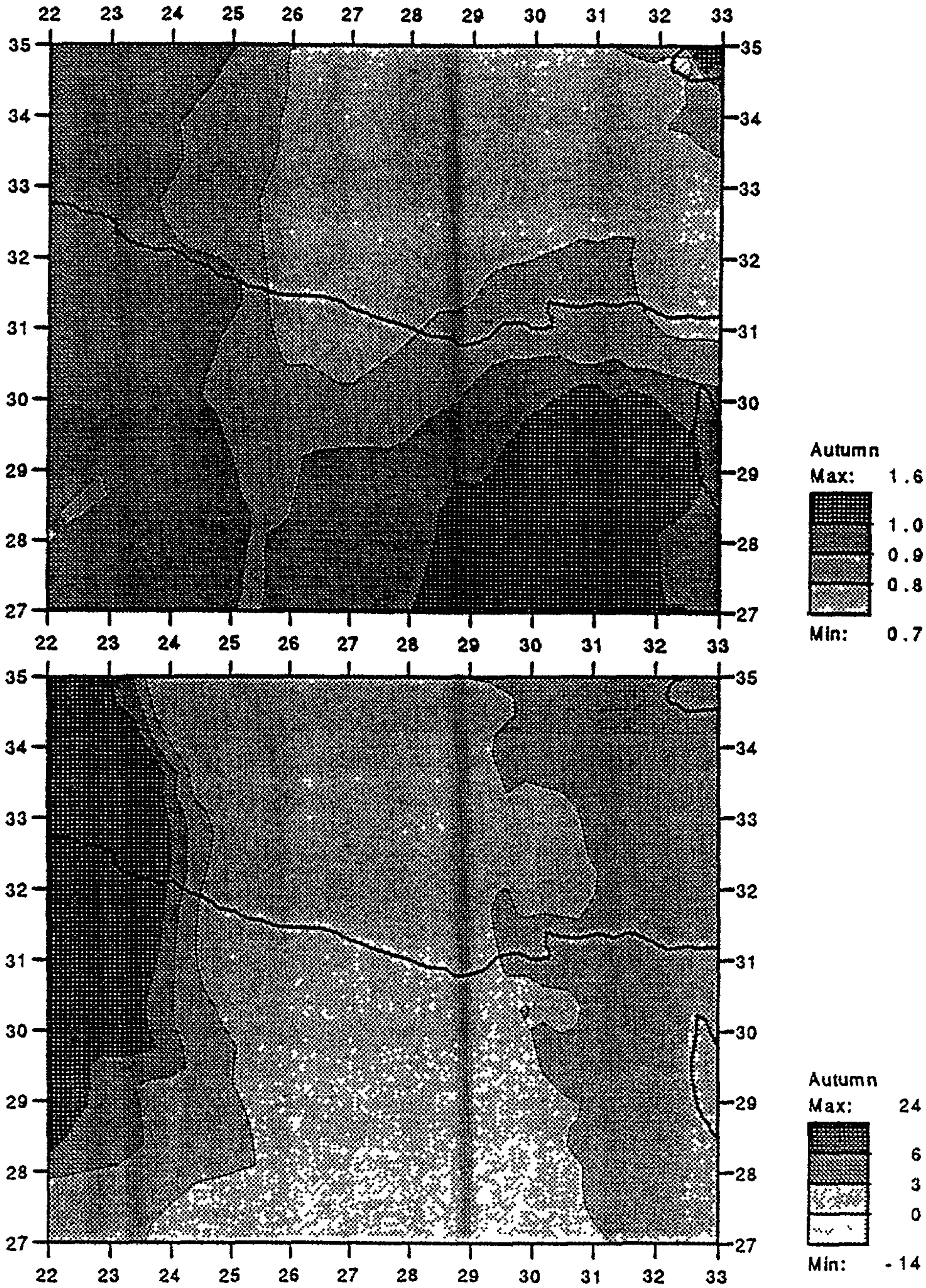


Fig. 5 Regional climate scenarios for northern Egypt: autumn. Upper map shows change in temperature(°C per °C global change) and the lower map shows change in precipitation (% per °C global change).



4. CONCLUSIONS

We have applied the methods developed by Kim et al. (1984) and Wigley et al. (1990) to the problem of constructing sub-grid-scale climate change scenarios for northern Egypt. Regression equations were developed to predict station temperature and precipitation anomalies from regionally-averaged climate anomalies. We proceeded to substitute GCM perturbed-run minus control-run values of temperature and precipitation in the regression equations to obtain a prediction of the change due to the greenhouse effect at each station. The results were scaled by the equilibrium global temperature change of each of the four GCMs, and an average change per °C global change obtained, calculated from the results for the four models. The procedure was repeated for every station in the data set, and the results contoured to produce scenarios for northern Egypt.

Annual and seasonal scenarios for both temperature and precipitation change were produced. The specific region of interest is the Egyptian coastline west of Alexandria. Here, for temperature, the annual change is indicated to be less than the global change i.e. in the range 0.7-0.8°C per °C global change. Broadly, the same pattern is seen in each season. Only in summer does the warming in the Fuka-Matrouh area approach the global level (with changes in the region 0.9-1.1°C per °C global change.

The scenarios of precipitation indicate drier conditions at the annual level, with a change in rainfall in the range of -4 to 0% per °C global warming. This relatively small change is accounted for by decreases in winter and autumn, whereas conditions in spring and summer are shown to be wetter as a result of global warming. In winter, the greatest change is seen in the west, towards the border with Libya, with a reduction in rainfall of over 10% per °C global warming. In autumn, the changes are between 0% and -14% per °C global warming. The increase in rainfall in spring is over 8% per °C global warming over the whole of the Egyptian coastline west of Alexandria. In summer, the increase is greatest in the west (over 8%), dropping to 0 to 4% per °C global warming close to Alexandria.

The problems associated with the construction of regional scenarios of climate change due to the enhanced greenhouse effect are discussed at length by Palutikof et al. (1992), in their report to UNEP on the construction of climate change scenarios for the whole Mediterranean region. The confidence that we can place in sub-grid-scale scenarios of precipitation is particularly low. These scenarios should be considered only as indicators of changes that might occur.

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APPENDIX 1

STATIONS USED IN SCENARIO CONSTRUCTION FOR NORTHERN EGYPT

Note that not all these stations will necessarily be used in the final scenario construction. They must first fulfill the criteria for acceptance laid down in Section 2 of this report, and by Palutikof et al. (1992).

CYPRUS

	Station	E	N	HT	PRN	TEM	P%	T%
1.	PAPHOS	32.4	34.8	10	1951-1989	1951-1989	100	100
2.	PRODHROMOS	32.8	35.0	1380	1967-1989	1959-1989	96	99
3.	LIMASSOL	33.0	34.7	10	1951-1989	1951-1989	100	98
4.	NICOSIA	33.4	35.2	160	1951-1989	1951-1989	100	100
5.	LARNACA	33.6	34.9	3	1951-1989	1951-1989	100	97

EGYPT

	Station	E	N	HT	PRN	TEM	P%	T%
6.	SALLOUM	25.2	31.5	6	1951-1987	1951-1987	99	89
7.	SIDI-BARANI	26.0	31.6	23	1951-1987	1951-1987	100	99
8.	MERSA-MATRUH	27.2	31.3	30	1951-1988	1951-1987	99	97
9.	NOUZHA	30.0	31.2	7	1951-1987	1951-1987	100	56
10.	ROSETTA	30.4	31.4	3	1951-1987	-	74	0
11.	DAMIETTA	31.8	31.4	5	1951-1987	-	99	0
12.	PORT-SAID	32.3	31.3	6	1951-1987	1951-1987	99	98
13.	SAKHA	30.9	31.1	-999	1951-1987	-	96	0
14.	TANTA	30.9	30.8	8	1961-1986	1951-1986	100	100
15.	ZAGAZIG	31.5	30.6	13	1961-1986	1951-1986	100	100
16.	CAIRO	31.4	30.1	74	1951-1988	1951-1986	99	83
17.	GIZA	31.2	30.0	22	1951-1986	1975-1986	100	100
18.	HELWAN	31.3	29.9	141	1951-1988	1951-1986	99	96
19.	FAYOUM	30.8	29.3	23	1961-1986	1951-1986	100	100
20.	MINYA	30.7	28.1	40	1951-1987	1951-1986	100	100
21.	ASSUIT	31.1	27.2	70	1951-1986	1951-1986	100	100
22.	QENA	32.7	26.2	74	1951-1986	1951-1986	100	100
23.	LUXOR	32.7	25.7	88	1951-1986	1951-1986	99	100
24.	ASSWAN	32.8	24.0	194	1951-1988	1951-1986	95	100
25.	SIWA	25.5	29.2	14	1951-1987	1951-1986	100	100
26.	BAHARIA	28.9	28.3	130	1951-1986	1951-1986	100	99
27.	DAKHLA	29.0	25.5	112	1951-1988	1951-1986	96	99
28.	KHARGA	30.6	25.4	73	1951-1986	1951-1986	100	100
29.	ISMAILIA	32.3	30.6	12	1951-1986	1951-1986	64	42
30.	TOR	33.6	28.2	3	1955-1986	1956-1986	48	41
31.	HURGHADA	33.8	27.3	3	1951-1986	1951-1986	99	100
32.	KOSSEIR	34.2	26.0	-999	1955-1986	1961-1986	100	99

GREECE

	Station	E	N	HT	PRN	TEM	P%	T%
33.	KERKYRA	19.9	39.6	2	1955-1987	1951-1988	100	96
34.	YANENA	20.7	39.6	-999	1956-1987	-	100	0
35.	AGRINION	21.7	38.6	47	1956-1987	-	99	0
36.	ARAXOS	21.4	38.2	23	1955-1987	1951-1970	100	100
37.	ZAKYNTHOS	20.9	37.8	8	1956-1982	1951-1982	89	79
38.	LARISSA	22.4	39.6	74	1955-1987	1951-1987	100	100
39.	AGXIALO	22.8	39.0	-999	1956-1987	1956-1987	100	100
40.	TRIPOLIS	22.2	37.6	660	1957-1987	1957-1987	100	100
41.	KALAMATA	22.1	37.0	5	1951-1989	1951-1988	92	95
42.	METHONI	21.7	36.8	34	1951-1987	1951-1987	100	99
43.	TANAGRA	23.5	38.3	-999	1957-1986	1957-1986	99	99
44.	ATHENS	23.7	38.0	107	1951-1986	1951-1988	100	97
45.	HELLENIKON	23.7	37.9	10	1951-1989	1951-1987	97	100
46.	KYTUIRA	23.0	36.2	-999	1955-1987	1955-1987	100	100
47.	SKYROS	24.6	38.9	5	1955-1987	1955-1987	100	100
48.	MILOS	24.5	36.7	-999	1955-1987	1955-1987	99	99
49.	MITILIA	26.4	39.2	-999	1955-1987	1955-1987	100	100
50.	NAXOS	25.5	37.1	9	1955-1987	1955-1987	100	100
51.	SOUDA	24.1	35.6	161	1958-1986	1958-1986	97	97
52.	ANOGIA	24.9	35.3	-999	1951-1985	-	96	0
53.	HIRAKLION	25.2	35.3	48	1955-1986	1951-1988	100	97
54.	IERPETRA	25.8	35.0	-999	1956-1987	1956-1987	99	99
55.	SITIA	26.1	35.2	28	1951-1985	-	87	0
56.	KARPATHOS	27.2	35.5	20	1971-1988	1971-1988	95	95
57.	RHODES	28.1	36.4	12	1955-1988	1955-1988	99	100

ISRAEL

	Station	E	N	HT	PRN	TEM	P%	T%
58.	LOD	34.9	32.0	49	1951-1989	1951-1988	93	100
59.	JERUSALEM	35.2	31.8	809	1951-1989	1951-1980	97	100
60.	EILAT	35.0	29.5	11	1951-1989	1951-1988	86	99

ITALY

	Station	E	N	HT	PRN	TEM	P%	T%
61.	CROTONE	17.1	39.0	155	-	1961-1985	0	100

JORDAN

	Station	E	N	HT	PRN	TEM	P%	T%
62.	IRBID	35.9	32.6	585	1955-1989	1955-1989	100	98
63.	AMMAN	36.0	32.0	771	1951-1989	1951-1989	100	100
64.	DEIR-ALLA	35.6	32.2	-224	1952-1989	1952-1989	98	98
65.	MAAN	35.8	30.2	1069	1960-1989	1960-1989	100	100
66.	WADI-YABIS	35.6	32.4	-200	1960-1989	1960-1989	95	98
67.	MAFRAQ	36.3	32.4	686	1960-1989	1960-1989	100	100
68.	ER-RABBAH	35.8	31.3	920	1960-1989	1961-1989	100	94
69.	AQABA	35.0	29.6	51	1960-1989	1960-1989	100	100
70.	JORDAN-UNIV	35.9	32.0	980	1960-1989	1961-1989	100	89

LEBANON

Station	E	N	HT	PRN	TEM	P%	T%
71. BEIRUT	35.5	33.9	24	1951-1985	1951-1985	80	84
72. RAYACK	36.0	33.9	921	1951-1984	1951-1985	76	80
73. TRIPOLI	36.0	34.6	10	1951-1982	1951-1980	77	76

LIBYA

Station	E	N	HT	PRN	TEM	P%	T%
74. BENINA	20.3	32.1	132	1951-1989	1951-1988	85	88
75. BENGHAZI	20.0	32.1	10	1951-1973	-	100	0
76. AGEDABIA	20.2	30.7	-999	1951-1988	1954-1988	99	58
77. SHAHAT	21.9	32.8	625	1951-1988	-	98	0
78. DERNA	22.6	32.7	9	1951-1988	1951-1988	31	56
79. TOBRUQ	24.0	32.1	14	1951-1973	-	100	0
80. ADEM	23.9	31.9	155	1951-1988	1951-1975	96	93
81. GIALO	21.6	29.0	62	1951-1988	1964-1988	98	86
82. KUFRA	23.3	24.2	382	1951-1989	1951-1988	86	79

SAUDI ARABIA

Station	E	N	HT	PRN	TEM	P%	T%
83. TABUK	36.6	28.4	774	1966-1989	1966-1989	59	48
84. WEJH	36.5	26.2	8	1966-1989	1966-1989	60	50

SYRIA

Station	E	N	HT	PRN	TEM	P%	T%
85. ALEPPO	37.2	36.2	393	1951-1989	1952-1988	97	99
86. LATTAKIA	35.8	35.6	9	1952-1989	1952-1988	90	94
87. DAMASCUS	36.2	33.5	724	1951-1989	1951-1988	97	99
88. SAFITA	36.1	34.8	-999	1959-1988	1959-1988	100	100
89. IDLEB	36.7	35.9	-999	1955-1988	1957-1988	100	100
90. HAMA	36.8	35.1	-999	1955-1988	1956-1988	100	100
91. HOMUS	36.7	34.8	-999	1955-1988	1955-1988	100	100
92. NABEK	36.7	34.0	-999	1955-1988	1959-1988	100	100
93. SUEIDA	36.6	32.7	-999	1958-1988	1958-1988	100	100
94. TELSHEHAB	36.0	32.7	-999	1958-1988	1958-1988	100	100

TURKEY

Station	E	N	HT	PRN	TEM	P%	T%
95. IZMIR	27.3	38.4	25	1929-1989	1929-1988	97	98
96. MUGLA	28.4	37.2	646	1951-1989	1951-1988	94	96
97. AFYON	30.5	38.8	1034	1951-1989	1951-1988	97	98
98. ISPARTA	30.6	37.8	1043	1951-1989	1951-1988	97	98
99. ANTALYA	30.7	36.9	43	1929-1989	1930-1988	97	98
0. ANKARA	32.9	40.0	894	1926-1989	1926-1988	98	98
1. KONYA	32.5	37.9	1022	1951-1989	1951-1988	93	98
2. KAYSERI	35.5	38.7	1070	1951-1982	1951-1988	97	91

3. ADANA	35.3	37.0	66	1929-1985	1929-1985	96	97
4. SIVAS	37.0	39.8	1285	1929-1989	1930-1980	98	100

E - latitude
N - longitude
HT - height above sea level (m)
PRN - length of precipitation record
TEM - length of temperature record
P% - percentage of precipitation record present
T% - percentage of temperature record present

ANNEX VI

OPERATIVE SCENARIOS FOR TEMPERATURE, PRECIPITATION AND SEA-LEVEL RISE FOR TIME-HORIZONS 2030 AND 2100 TO BE USED BY THE TASK TEAM

Temperature change

IPCC92 (page 17) gives a warming of 0.3° C per decade for IPCC90 Scenario A. However, this figure does not include the effects of sulphates and stratospheric ozone depletion. These effects are incorporated by Wigley and Raper (1992). They give a warming of 2.5° C between 1990 and 2100, which works out at 0.23° C per decade, for IPCC92 Scenario IS92a. There appear to be some problems with their carbon cycle model, which are currently being rectified. Changes to the carbon cycle model appear to lower the rate of global warming. This is interesting, since the warming rates given by Wigley and Raper (1992) are already lower than those of IPCC92. In a paper by Wigley (in press) it would appear that the quoted warming between 1990 and 2100 will be 2.25° C as opposed to 2.5° C over the same period in Wigley and Raper (1992). However, Wigley (in press) figure should not be used since it could well undergo further modification prior to publication.

This leaves a certain dilemma: whether to use the IPCC92 figure, which omits the effects of sulphates and stratospheric ozone depletion, or whether to use the Wigley and Raper (1992) figure, where it might be a problem with the carbon cycle model. On balance, and because the problem with the carbon cycle model is unlikely to become widely known, Wigley and Raper (1992) figure should be used.

On this basis, global warming figures are as follows:

1990-2100 2.5° C
1990-2030 0.9° C.

This assumes the changes are linear which, particularly in the case of IS92a, is reasonable (see upper diagram of Fig. 5, Wigley and Raper (1992)).

Sea level change

IPCC92 (page 17) gives a figure of 2 to 4 cm/decade, but this is due only to oceanic thermal expansion (which admittedly is expected to be the largest contributor). Wigley and Raper (1992) incorporate land-based ice sheets and small glaciers also. They arrive at a figure of 48 cm increase between 1990 and 2100, based on IS92a. When scaled linearly, this gives a figure of +17 cm between 1990 and 2030. However, linear scaling is less valid in the case of sea level change (see lower diagram in Fig. 5, Wigley and Raper (1992)). A figure of +16 cm appears more appropriate.

The best-guess figures, based on Wigley and Raper (1992) appear to be:

1990-2100 +48 cm
1990-2030 +16 cm.

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UEA Scenarios for the Fuka-Matrouh Region

These are based on inspection of the maps, looking particularly at the area along the coast of NW Egypt between 27° and 28° E. *The changes given below are per 1° C global warming.*

Annual	Temperature Precipitation	0.8 to 0.9° C 0 to -4%
Winter	Temperature Precipitation	0.7 to 0.9° C -5 to -22° C
Spring	Temperature Precipitation	0.7 to 0.9° C +8 to +26%
Summer	Temperature Precipitation	1.0 to 1.1° C not applicable - rainfall is non-existent in summer
Autumn	Temperature Precipitation	0.7 to 0.8° C 0 to -14%

OPERATIVE SCENARIOS FOR TIME HORIZONS 2030 AND 2100

		Time horizon	
		2030	2100
Annual	Temperature Precipitation	0.7 to 0.8° C 0 to -4 %	2.0 to 2.3° C 0 to -10 %
Winter	Temperature Precipitation	0.6 to 0.8° C -5 to -20 %	1.8 to 2.3° C -13 to -55 %
Spring	Temperature Precipitation	0.6 to 0.8° C 7 to 23 %	1.8 to 2.3° C +20 to +65 %
Summer	Temperature Precipitation	0.9 to 1.0° C not applicable	2.5 to 2.8° C not applicable
Autumn	Temperature Precipitation	0.6 to 0.7° C 0 to -13 %	1.8 to 2.0° C 0 to 35 %
Sea level change		+ 16 cm	+ 48 cm

ANNEX VII

BASIC INFORMATION ON THE FUKA-MATROUH COASTAL REGION

Location

The project area (Fuka-Matrouh) is located between latitude 25,26 - longitude 27,28. it covers 5600 km^2 and it goes around 80 km from Marsa Matrouh eastward to Fuka and 70 km southward to the limits of the desert.

This area is part of the North-West Coastal Zone that goes from Alexandria in the East to Sallum in the west and the project area is served by different highways:

- the North Africa international highway;
- rail road from Alexandria to Sallum;
- one-way road, 15 km south of the international highway from Sallum to Alexandria- Cairo highway on the 70 km mark south of Alexandria;
- several exit roads to serve communities south and north of the international highways.

Population

Around 40,000 is the total population of the project area. 15 to 20% are coming from outside the area, the rest are native belonging to 22 different tribes.

The main tribes are Ali el-Abyad, Ali el-Ahmar, el-Senna, Kataan and Gemeat. The average family size is 10. Most of them are working in the agriculture and extensive livestock through 17 local cooperatives which serve 4854 members. The population density is higher in the western area of the project and decreases southward because of the limited natural resources.

Topography

The area is divided into three main zones:

- the coastal zone which includes coastal plains consisting of narrow strips (1-3.5 km) of sand dunes and depression, this area is mainly olive and fig planted. South of this area from 3.5-6 km consists of plains desiccated by 45 wadis;

- the northern plateau of the strip of 10-13 km. This zone is gently sloped with shallow wadis and alluvial deposits;

- the southern plateau goes to 50 km to the south and is characterized by sand dunes, depressions and rocky soils.

Natural resources

<u>Water resources</u>

Rainfall water is the main source. The annual average rainfall is around 140 mm most of it falling during the winter time (mid-October to mid-March). It decreases southward. This water is harvested through cisterns, dykes to be used for agricultural and animal and human use purposes. Some limited underground water is exploited in some locations like Fuka, Burbeta and Ras el-Hekma.

Soil resources

The soil can be classified into:

- coastal sand dunes;
- limestone;
- sandy limestone;
- silty limestone.

The total area is around 500,000 feddans:

- 12,000 feddans orchards;
- 15,000 feddans of field crops;
- 10,000 rangeland.

Plant production

Olive, fig and almond trees are planted in the wadis deltas where the soil is deep, besides the cultivation of cereals (barely and wheat) during the winter and rainfed field crops. Trees are irrigated during the first two years. The natural vegetative cover is considered the main source for animal (sheep, goats and camels) grazing which is the main income of the bedouins.

Climate

The climate is Mediterranean:

- annual average rainfall:	140 mm
- average wind speed:	14 km/hr (mainly from the North-West)
- maximum temperature:	35 ° C
- minimum temperature:	5 ° C
- relative humidity:	Max 90%, Min 60%.

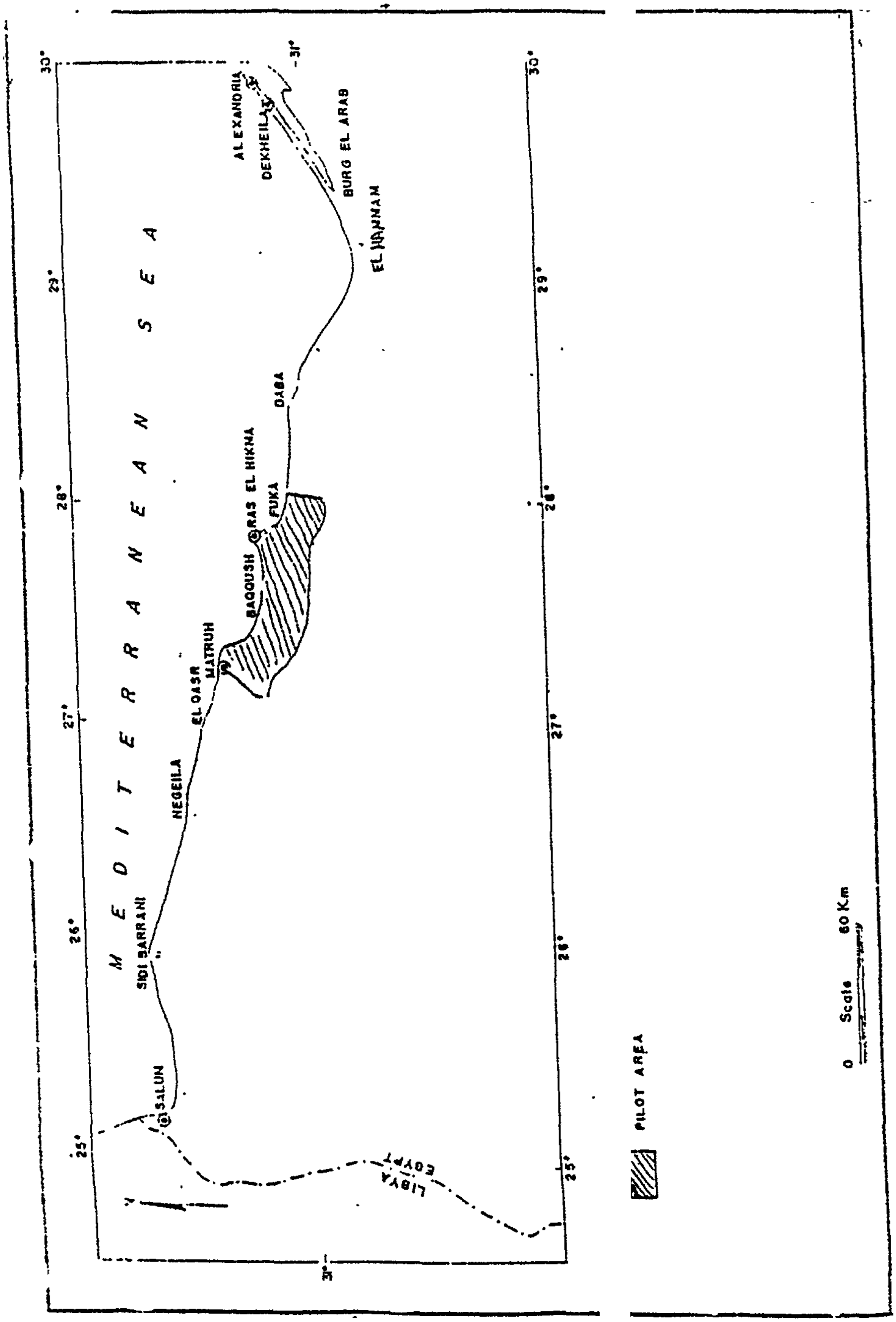
Infrastructure

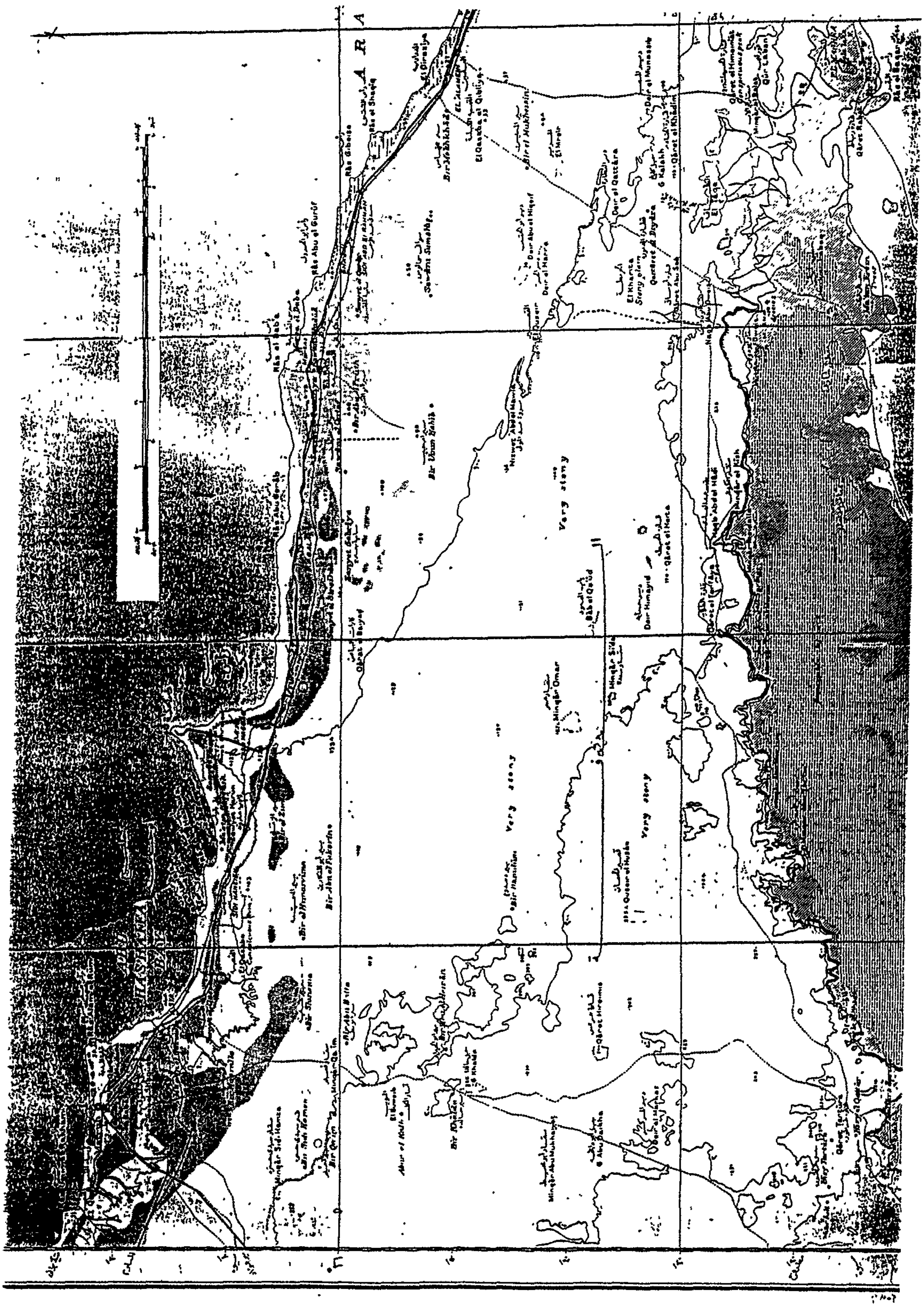
The North-West Coastal Development Authority with the aid of WFP has implemented the following activities in the project area:

- 2749 cisterns with the capacity of 778,382 m^3 to collect rain water for domestic use and irrigation of 6768 feddans;
- 397 Sawani (underground water) to irrigate 99 feddans;
- 1960 linear meters of galeries (underground water) to irrigate 196 feddans;
- 432 cemented dykes of 53,448 m^3 to collect water in the cultivated areas to irrigate 1188 feddans or orchards;
- 22 earth dykes of 321,184 m^3 to irrigate 2361 feddans;
- 2692 stone dykes of 218,807 m^3 to irrigate 4862 feddans of orchards;
- 608 houses for bedouins to settle;
- 80 animal sheds;
- plantation of 8390 feddans of fruit trees;
- improvement and development of 3140 feddans of rangelands;
- plantation of trees along 7 km of road;
- construction of several centres (7 schools, 3 dispensaries, 1 women activities centre, 7 local bureaus for cooperatives, local storage rooms for cooperatives);
- training of 448 girls in the domain of sewing, knitting, hand crafts activities.

ANNEX VIII

MAPS OF THE STUDY AREA





ANNEX IX

OBJECTIVES, ASSUMPTIONS AND OUTPUTS OF THE CLIMATIC CHANGES STUDY

OBJECTIVES

Long-term objective:

sound environmental management and planning of land use and the use of resources in the coastal region of Fuka-Matrouh in the conditions of climate change.

Short term objectives:

- to identify and assess possible implications of expected climatic changes on the terrestrial, aquatic and marine ecosystems, populations, land-use and sea-use practices and other human activities;
- to determine areas or systems which appear to be most vulnerable to the expected climatic changes;
- to give recommendations for planning and management of coastal areas and resources, as well as for planning and design of major infrastructure and other systems;
- to provide an input into other projects and developments relevant to the subject of the study.

The findings should serve for:

- development strategies for the coastal region of Fuka-Matrouh in the changed climate conditions;
- further work on coastal zone management studies in the frame of UNEP/MAP;
- information for the public, economists, policy and decision makers.

ASSUMPTIONS

For the specific purpose of the study two time horizons will be considered (years 2030 and 2100), and the following will be taken into account:

- the best available information, knowledge and insights into the problems relevant to the coastal region of Fuka-Matrouh including major projects, planned or under consideration;

- warming figures of 0.9° C (1990-2030) and 2.5° C (1990-2100) and sea level change of + 16 cm (1990-2030) and + 48 cm (1990-2100) (see Annex VI);

- the results of the University of East Anglia's "Temperature and Precipitation Scenarios for Northern Egypt" (1993).

OUTPUTS

- identified impacts of predicted climatic changes and sea level rise;

- an assessment of the magnitude and implications of the identified impacts;

- proposed policies and measures to mitigate or avoid the predictable consequences of expected climatic change;

- development strategies for Fuka-Matrouh region in the changed climate conditions.

ANNEX X

OUTLINE OF THE REPORT

ANNEX XI

WORKPLAN AND TIMETABLE *

- Nomination of the Co-ordinator of the Task Team	January 1993
- Establishment of the Task Team	June 1993
- First (preparatory) meeting of the Task Team	November 1993
- Collection of data and relevant documentation	November 1993-May 1994
- Analysis and evaluation of data and documentation collected	June 1994
- Presentation of the preliminary analysis at the second meeting of the Task Team	end of June 1994
- Finalization of the draft report	September 1994
- Presentation of the final draft of the report at the third meeting of the Task Team	October 1994
- Finalization and publication of the report and presentation to the national and local authorities	December 1994

* In addition to the formal meetings of the Task Team it is envisaged that the core members will meet frequently between meetings of the full Team. The Co-ordinator of the Task Team will keep the external members informed of progress on a regular basis, by providing them with materials produced by the Core members of the Task Team.

ANNEX XII

REPORTS AND PUBLICATIONS OF THE QASR RURAL DEVELOPMENT PROJECT

Title	Author	Date	Language	Remarks
Pre-development stage (data compilation) conservation and development of renewable resources for agriculture	Desert Research Centre	May 1987	English	
Baseline survey - El Qasr 1986, part 1	Dr H.D. Mueller-Mahn	1988	English	
El Qasr project - Agriculture baseline survey, women	I. Roushdy Hammady	1988	English	
Water budget and water supply for the regional agricultural development in El Qasr area	Ergenzinger	Feb-July 1989	English	
Programme for soil and water conservation, mission report	W. Wiertmann	16.07.89-22.07.89	English	Translated
Implementation of soil and water conservation measures, final mission report	W. Wiertmann	13.10.89-04.11.90	English	
Installation report, meteorological hydrological monitoring system	T. Vetter	05.09.89-22.12.89	English	
Progress report for Qasr rural development project on hydrological meteorological measuring network	T. Vetter	03.03.90-04 04.90	English	
Designing a monitoring and evaluation system M & E SYS, version number 1	Dr M. Nasr Eng.S. Shaban	October 1989	English	
An economic study of some different rainfed desert farming systems of El Qasr area at Marsa Matrouh	Dr M. Nasr	June 1990	English/Arabic	
Report on the installation of clicom and the training course in Marsa Matrouh	Arno Belau	Sept. 1989	English	Translated
Consultant report on animal health improvement through basic animal health care	Dr F. Schenkel	May 1989	English	
Study on marketing, tourism and handcraft	Dr W. Warmbier	Dec. 1988	English	
A literature review of research and management programmes of the North Western coastal desert North Egypt	Prof. M. Ayyad Dr S Eldarier Dr Boshra Salem	Feb. 1990	English	Draft
Study on the non-agricultural activities in El-Qasr region Matrouh governorate	Prof. S. El-Zogby Dr Abdel Rehim Dr Gala El-Mallah Dr M. El-Ezabi Dr M. Kamel	1990	Arabic/English	Draft
The bedouin groups, a social environmental study. The model of the study is Wadi Al-Mestagima	H. Abdel Kader	1990	Arabic/English	Draft
Qasr rural development project regional development plan Phase 1 Phase 2 Phase 3	H. El Miniaw F. Mark Sanna Tobah	May-Oct 90 Dec. 1990 July 1991	English/Arabic	Final Final Draft Draft
The tribal group, a social and environmental study	H. Abdel Kader	1990	English/Arabic	Draft

Title	Author	Date	Language	Remarks
Rangeland observations	Prof. M. Ayyad	April 1991	English	Interm. report
Water well logging, geophysical report	CGG	August 1991	English	
Resistivity survey	CGG	June 1991	English	
Report of progress evaluation mission	GTZ mission	Sept. 1990	Germ./English	
Study (remote sensing) (range land)	DRC		English Arabic	pre-inform.
Mission report on landuse planning and environmental monitoring QRDP	T. Vetter	Nov. 1990- Feb. 1991	English	
Conservation and development of agriculture resources in El Qasr region	Dr M Bartels Dr F. Kebschull	June 1987	German	
Progress report No. 1	F. Hayer	October 1988	German	
Progress report No. 2	F. Hayer	April 1989	German	
Progress report No 3	F. Hayer	Feb. 1989	German	
Progress report No 4	M. Bartels	August 1990	German	
Progress report No. 5	H. Regner	April 1991	German	
Progress report No. 6	P. Klemann	July 1991	German	
Land use planning for the area of QRDP	M. Bartels	January 1991	English	
Meteorological report: - from June 1990 to Dec. 1990 - from June 1991 to Dec. 1991	T.A. Gafaar	April 1991	English	
QRDP Monitoring and evaluation data	T.A. Gafaar		English	
Monitoring report about El Qasr rural development project, March 1990	F. Hayer	Feb. 1989	English/Arabic	
Report about a business trip	F. Hayer	October 1990	German	
Project Planning Seminar	QRDP	July 1990	English	
Basic animal health care system workshop	QRDP	Nov. 1990	English	
M & E data and results	S. Moustafa	July 1991	English	
Thematic Atlas Western Matrouh Area (5 maps)	M. Bartels	Jan. 1991	German	
Progress report on El Qasr rural development project	Desert Research Centre	1990		
Estimation of development costs for the area of the QRDP Marsa-Matrouh	QRDP	1993		