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MEDITERRANEAN ACTION PLAN

First Meeting of the Task Team on
Implications of Climatic Changes on Malta

Msida, 11-12 November 1991

**REPORT
OF THE FIRST MEETING OF THE TASK TEAM ON IMPLICATIONS
OF CLIMATIC CHANGES ON MALTA**

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BACKGROUND

The greenhouse effect is among man's potentially most pressing long-term environmental problem, one which presents major scientific challenges which span a wide range of disciplines. Changes in global climate between now and the middle of the 21st century are likely to be dominated by the influence of global warming due to increasing concentrations of carbon dioxide and other "greenhouse gases" in the atmosphere. These greenhouse gases individually and collectively change the radiative balance of the atmosphere, trapping more heat near the earth's surface and causing a rise in global-mean surface air temperature and as a consequence substantial global warming is virtually certain.

In spite of uncertainties surrounding predicted climatic changes, greenhouse gases seem to have accumulated in the magnitude of the atmosphere to such a level that the changes may have started already and their continuation may now be inevitable.

The Second World Climate Conference (Geneva, 29 October-7 November 1990) concluded that without actions to reduce emissions, global warming is predicted to reach 2 to 5 degrees C over the next century, a rate of change unprecedented in the past 10,000 years. The warming is expected to be accompanied by a sea level rise of 65 cm \pm 35 cm by the end of the next century. There remain uncertainties in predictions, particularly in regard to the timing, magnitude and regional patterns of climatic change, as well as in the numerous secondary effects of this warming and sea level rise.

In view of the importance of this issue, the Oceans and Coastal Areas programme Activity Centre (OCA/PAC) of the United Nations Environment Programme (UNEP) in co-operation with several intergovernmental and non-governmental organisations, launched, co-ordinated and financially supported a number of activities designed to contribute to an assessment of the potential impacts of climatic changes and to the identification of suitable policy options and response measures which may mitigate the negative consequences of the expected impacts.

As part of these efforts, Task Teams on the implications of climatic changes were established in 1987 for six regions covered by the regional seas programme (Mediterranean, Wider Caribbean, South Pacific, East Asian Seas and South East Pacific regions) with the initial objective of preparing reviews of expected climatic changes on coastal and marine ecosystems, as well as on the socio-economic structures and activities within their respective regions. Three additional Task Teams were established later, two in 1989 (for the West and Central African region and for the East African region) and one in 1990 (for the Kuwait Action Plan region). The establishment of Task Teams for the Black Sea and for the Red Sea is under consideration.

In the framework of the activities of the Mediterranean Task Team six site specific case studies were prepared (deltas of the rivers Ebro, Rhone, Po and Nile, and for Thermaikos Gulf and Ichkeul/Bizerte lakes) in the period from 1987 to 1989. Since 1990 second generation site specific case studies (Island of Rhodes; Kastela Bay; Syrian coast; Izmir Bay; Malta; Cres/Losinj islands) have been and are being developed.

REPORT OF THE MEETING

Opening of the meeting - Agenda item 1

The meeting was opened by His Excellency Professor G. de Marco, Deputy Prime Minister of Malta and Minister for Foreign Affairs and Justice who welcomed the participants on behalf of the Government of Malta and expressed his Governments' appreciation of the support of 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 Malta. He continued by referring to the prominent role that Malta had and continues to play in international affairs relating to the development of the

United Nations Convention on the Law of the Sea, the environmental protection of extra-territorial spaces, the current international debate surrounding the issue of climatic change, and the significance which Malta attaches to the current negotiations for an international convention on climate which characterizes this change as the common concern of mankind. In conclusion, he expressed his hope that the meeting would be productive and that the report when produced would provide guidance to the Government on alternative responses to the potential impacts of climatic change and sea level rise. The Minister referred to the need to find a new role for the United Nations Trusteeship Council: that might include holding in trust on behalf of humanity the environment, extra-terrestrial spaces, the climate and the rights of future generations. Professor G. de Marco's address is appended as Annex 1 to this report.

Dr L. Jeftic, Senior Marine Scientist in the Co-ordinating Unit for the Mediterranean Action Plan (MAP) on behalf of Dr M. K. Tolba, Executive Director of UNEP, expressed his appreciation of the Deputy Prime Minister's opening the meeting and thanked the Government of Malta for hosting 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 Malta would be successful.

The meeting was held at the University of Malta, meeting's participants and Task Team members are listed in Annex II to this report.

Election of Officers - Agenda Item 2

The meeting unanimously elected H.E. Professor D. Attard, Ambassador and Co-ordinator of the Task Team as Chairman, and Dr J. Pernetta as Rapporteur of the meeting. Dr L. Jeftic acted as technical secretary of the meeting.

Adoption of the Agenda - Agenda Item 3

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

Overview of the implications of climatic changes - Agenda Item 4

Dr L. Jeftic gave an overview of the current consensus views concerning the greenhouse effect; past and predicted changes in the temperature and sea level; as well as the possible implications of climatic changes (Annex IV). 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.

In the discussion which followed this presentation, Major J. Mifsud provided the meeting with the results of an analysis of historical meteorological data for Malta which indicate increasing maximum temperatures, decreasing minimum temperatures and decrease in total precipitation during this century. These data are presented graphically in Annex V of this report.

Dr L. Jeftic informed the meeting that the Climate Research Unit of the University of East Anglia is working on a set of regional scenarios of climatic changes for the Mediterranean region and had agreed to provide sub-regional scenarios in support of case studies. As part of this work a sub-regional scenario shall be provided in support of the Malta study by the end of 1991. Dr L. Jeftic offered to put Major J. Mifsud in direct touch with the Climate Research Unit in order to ensure that data referred to in the preceding paragraph are taken into account in the preparation of the sub-regional scenario for Malta.

Implications of expected climatic changes on Malta - agenda item 5

Project outline - Agenda Item 5.1.

Dr L. Jeftic presented basic information on Malta (Annex VI to this report) and gave a detailed presentation of the objectives, assumptions, outputs (Annex VII) and the proposed outline of the final report of the project. After discussion the outline for the final report was adopted as appearing in Annex VIII of this report.

General Workplan and timetable - Agenda Item 5.2.

The proposed general workplan and timetable for the project as prepared by the secretariat was discussed and adopted with the amendment that the national presentation of the final report should occur later than originally planned, preferably around October/November 1992. The final agreed workplan and timetable appear in Annex IX of this report.

Detailed workplan for each Task Team member - Agenda Item 5.3.

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

Adoption of the report - Agenda Item 6

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 7

In his closing remarks, Dr L. Jeftic expressed satisfaction for the results of the meeting and the constructive spirit in which it was conducted. He also thanked the participants, Chairman and Rapporteur and the Government and University of Malta for technical and logistic assistance and their warm hospitality.

An exchange of courtesies followed after which the Chairman closed the meeting on 12th November 1991.

ANNEX I

OPENING STATEMENT BY PROFESSOR GUIDO DE MARCO DEPUTY PRIME MINISTER AND MINISTER OF FOREIGN AFFAIRS AND JUSTICE

This is just a short note of welcome to express my deep appreciation for your presence here in Malta. I do not intend to take much of your time as I understand it is already rather short for the important task which you are going to accomplish during these two days.

It is a great pleasure for me to welcome you today to our country, to be able to express my deep appreciation for the support which the United Nations Environment Programme has always given to Malta.

The study which you are going to undertake is of fundamental importance, as it is an expression of co-ordination which was rather lacking in the past and which has prompted Malta to take the initiative at the 43rd United Nations General Assembly to propose a resolution entitled: "Climate Change as Common Concern of mankind".

In its resolution Malta expressed its concern about the inadequate, political consideration which was being given to the phenomenon of climate change, and therefore had felt the need to define it, as a common concern of mankind, because an appropriate conservation strategy cannot be restricted by political boundaries but should have as its primary objective the common good of mankind.

Whilst congratulating the numerous scientific bodies within and outside the U.N. system for their formidable work, Malta had insisted that a comprehensive and effective global strategy was indispensable in order to conserve climate in the interest of mankind - a strategy which required the co-ordination of resources between scientists and policy makers alike. It was clear to us that no progress could be made unless there was more scientific cooperation among states, coupled with a political determination to take protective measures.

The Intergovernmental Panel on Climate Change established under the World Meteorological Organisation and the United Nations Environment Programme, composed of over 300 leading scientists from over 50 states is a remarkable case in point. Not only have the Panel's deliberations helped to establish a consensus on a series of authoritative scientific statements but its report provides basic and essential information to the Intergovernmental Negotiating Committee entrusted by the General Assembly with the task of formulating a framework convention on Climate Change by the Earth Summit, next June.

As current international law is inadequate to provide effective protection to the global climate, its development in this field depends to a large extent on the results of scientific assessments. Without such scientific research, legislation would fail to provide the effective measures required to conserve climate in the interests of mankind, particularly when it comes to the special circumstances and particular characteristics of the various regions of the world.

UNEP's Regional Seas Programme to study the probable impact of climate change in the Mediterranean, therefore represents the realisation of Malta's work within the International Community. Being an intrinsic part of the Mediterranean, Malta would doubtlessly benefit immensely from the scientific results of such a Programme and particularly from this meeting. I am sure that your final report would serve as an essential set of guidelines upon which my government together with Maltese experts would be able to formulate the required response strategies and policy to meet with the adverse effects of Climate Change in Malta.

We consider climate change a matter of common concern to humanity. We have voiced this concern with that sense of responsibility which avoids the sensational.

Climate change is an important aspect of the environmental problem, which requires the commitment of all members of the United Nations.

We have suggested at New York and elsewhere that in addition to its role under the Charter, a new concept should be given to the Trusteeship Council: that to hold in trust not only territories aspiring to independence, but also hold in trust for humanity, its common heritage and its common concerns: the environment, the protection of the extra territorial zones, and of the resources of the sea and of the sea-bed, the climate and the rights of future generations.

These we hold in trust for humanity and the Trusteeship Council can hold this function.

We intend promoting further this notion with the meeting at Rio in mind.

The Government of Malta is contemplating advancing with others this proposal to make of the Trusteeship Council, a World Council for the Environment, giving it that role of trust and vigilance for future generations.

11th November, 1991

ANNEX II

LIST OF PARTICIPANTS AND TASK TEAM MEMBERS

CORE MEMBERS OF THE TASK TEAM

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* Unable to attend

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ANNEX III

AGENDA

1. Opening of the meeting
2. Election of officers
3. Adoption of the agenda
4. Overview of greenhouse effect and its implications
5. Implications of expected climatic changes on Malta
 - 5.1. Project outline
 - 5.2. General workplan and timetable
 - 5.3. Detailed workplan for each Task Team member
6. Adoption of the report
7. Closure of the meeting

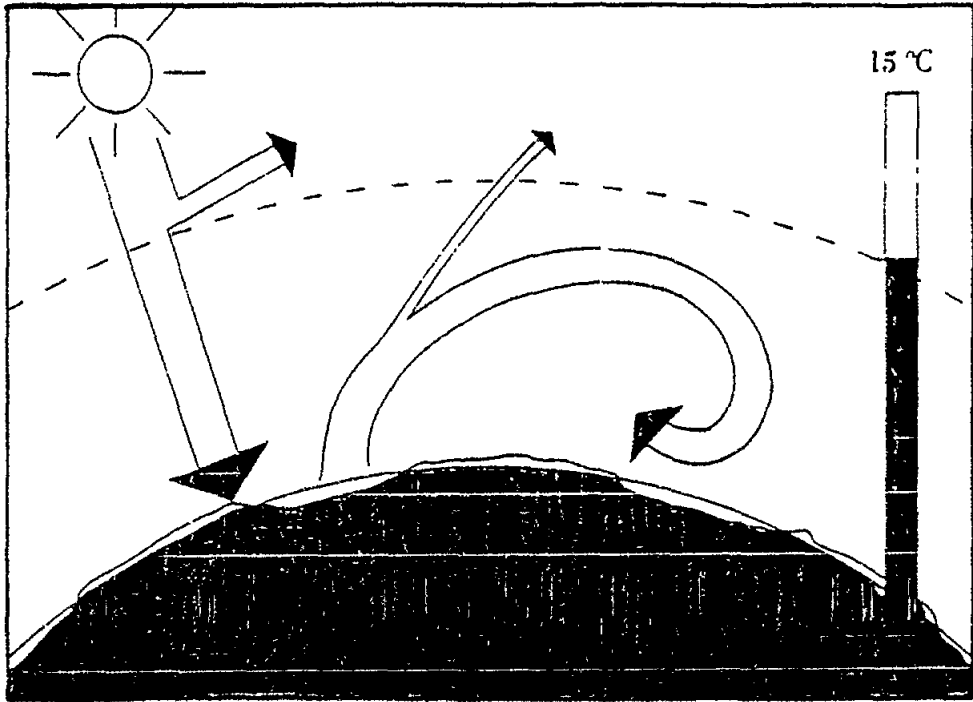
ANNEX IV

OVERVIEW OF THE GREENHOUSE EFFECT AND ITS IMPLICATIONS

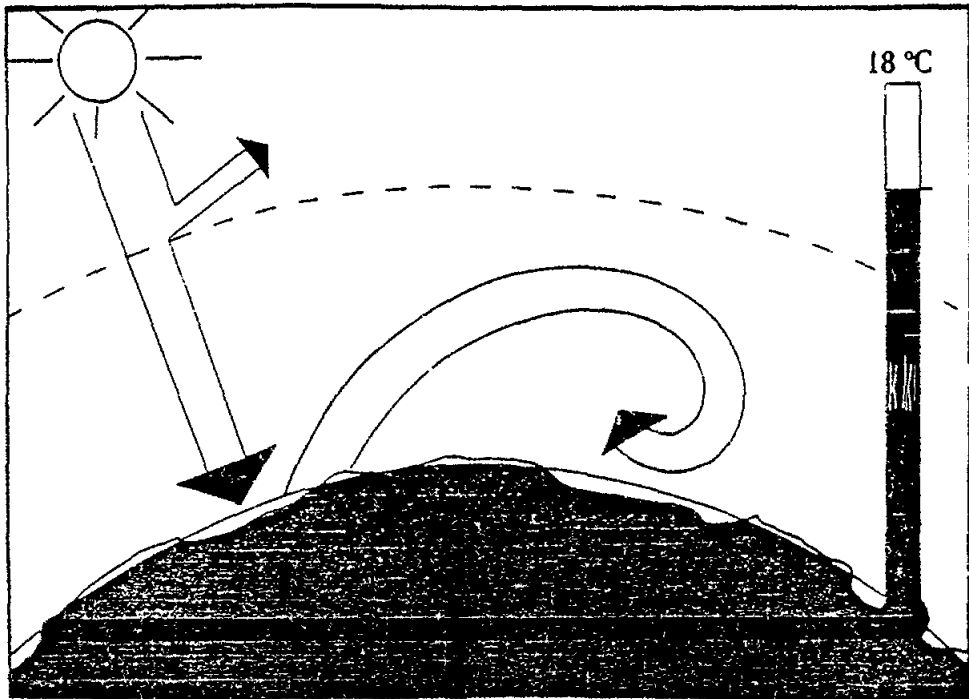
This Annex contains copies of transparencies reviewing:

- the basics of the greenhouse effect;
- past and predicted changes in temperatures and sea level;
- 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;
- possible implications of climatic changes;
- activities organised by the Oceans and Coastal Areas Programme Activity Centre (OCA/PAC) of UNEP and MAP concerned with studying the implications of climatic changes in coastal areas;
- work carried out by the Mediterranean Task Team on climatic changes and its results;

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.

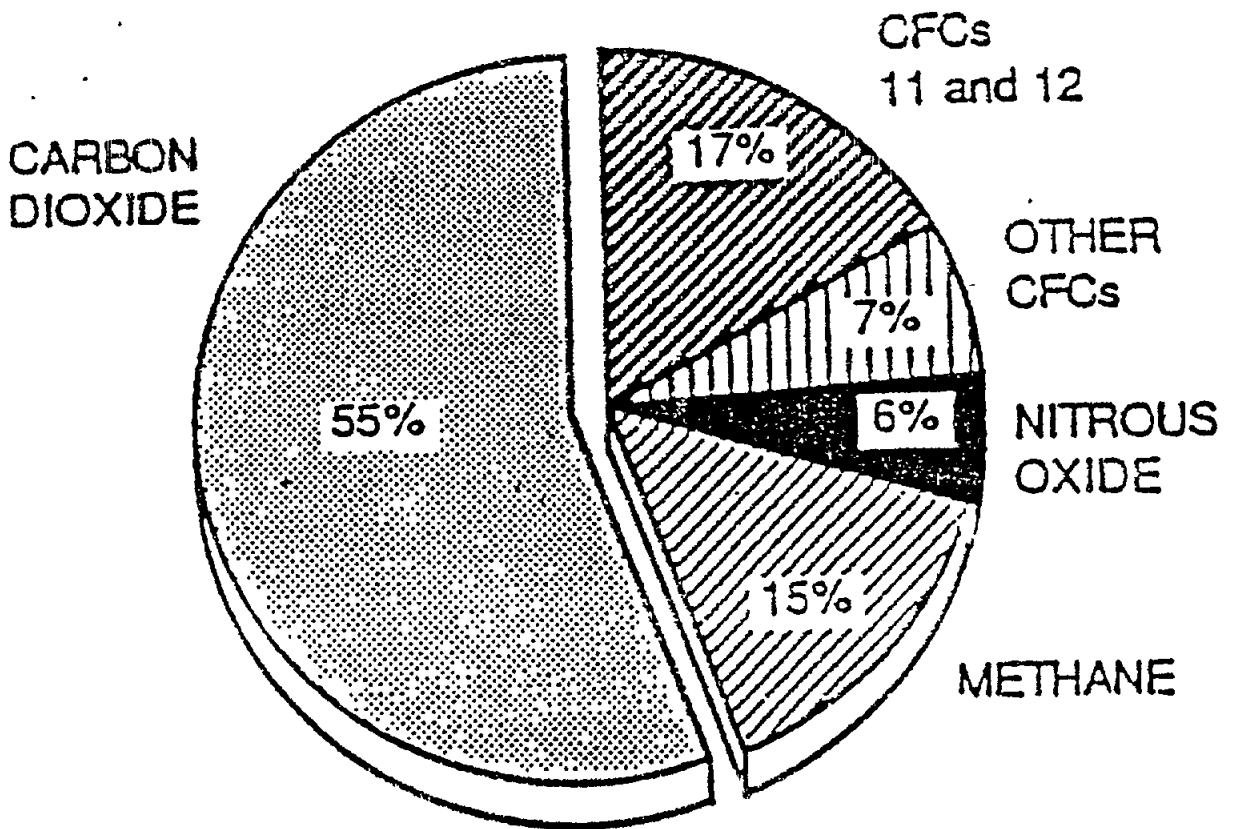


GREENHOUSE EFFECT AT PRESENT



GREENHOUSE EFFECT IN THE FUTURE

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



SUMMARY OF KEY GREENHOUSE GASES AFFECTED BY HUMAN ACTIVITIES

	Carbon Dioxide	Methane	CFC-11	CFC-12	Nitrous Oxide
Atmospheric concentration	ppmv	ppmv	pptv	pptv	ppbv
Pre-industrial (1750-1800)	280	0.8	0	0	288
Present day (1990)	353	1.72	280	484	310
Current rate of change per year	1.8 (0.5%)	0.015 (0.9%)	9.5 (4%)	17 (4%)	0.8 (0.25%)
Atmospheric lifetime (years)	(50-200)†	10	65	130	150

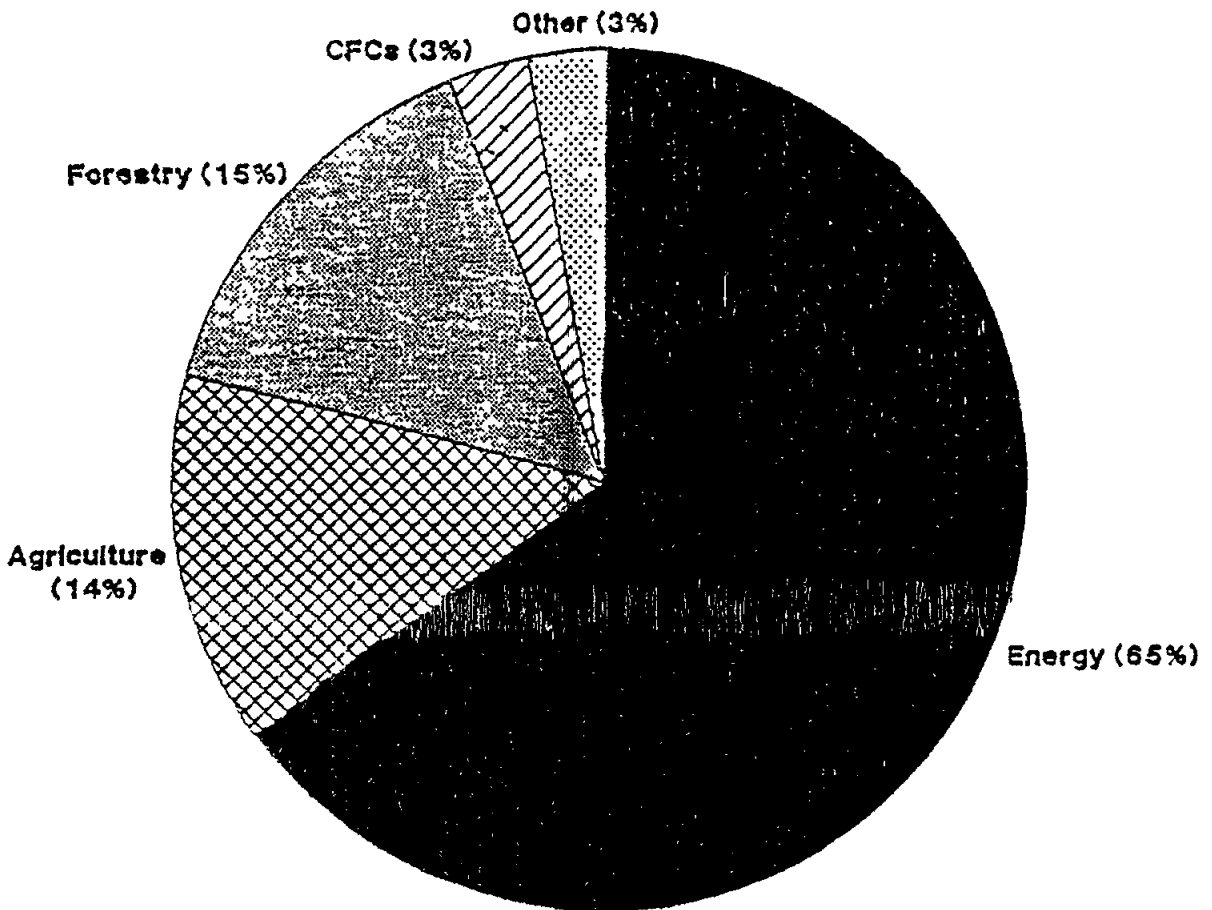
ppmv = parts per million by volume;

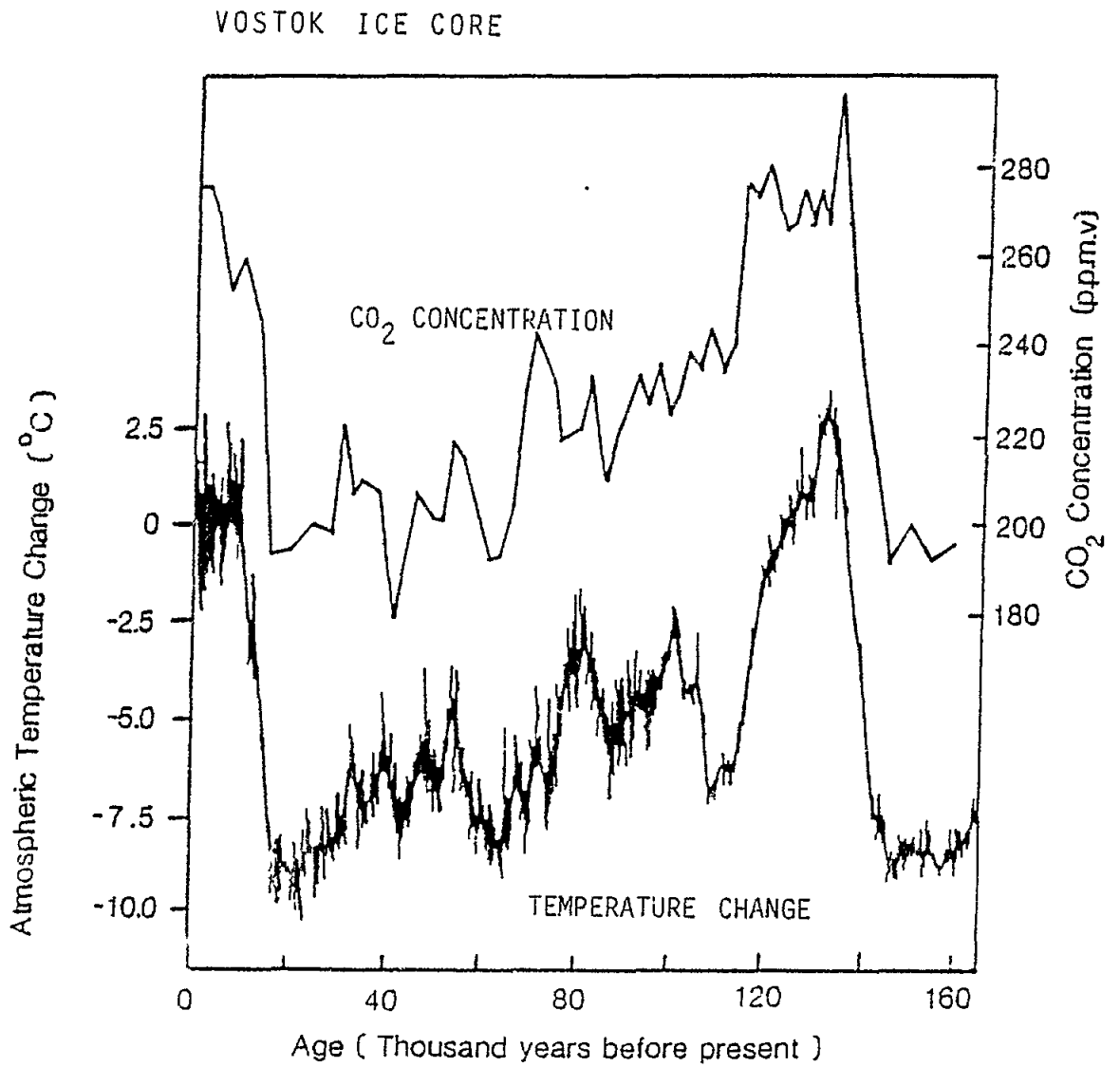
ppbv = parts per billion (thousand million) by volume;

pptv = parts per trillion (million million) by volume.

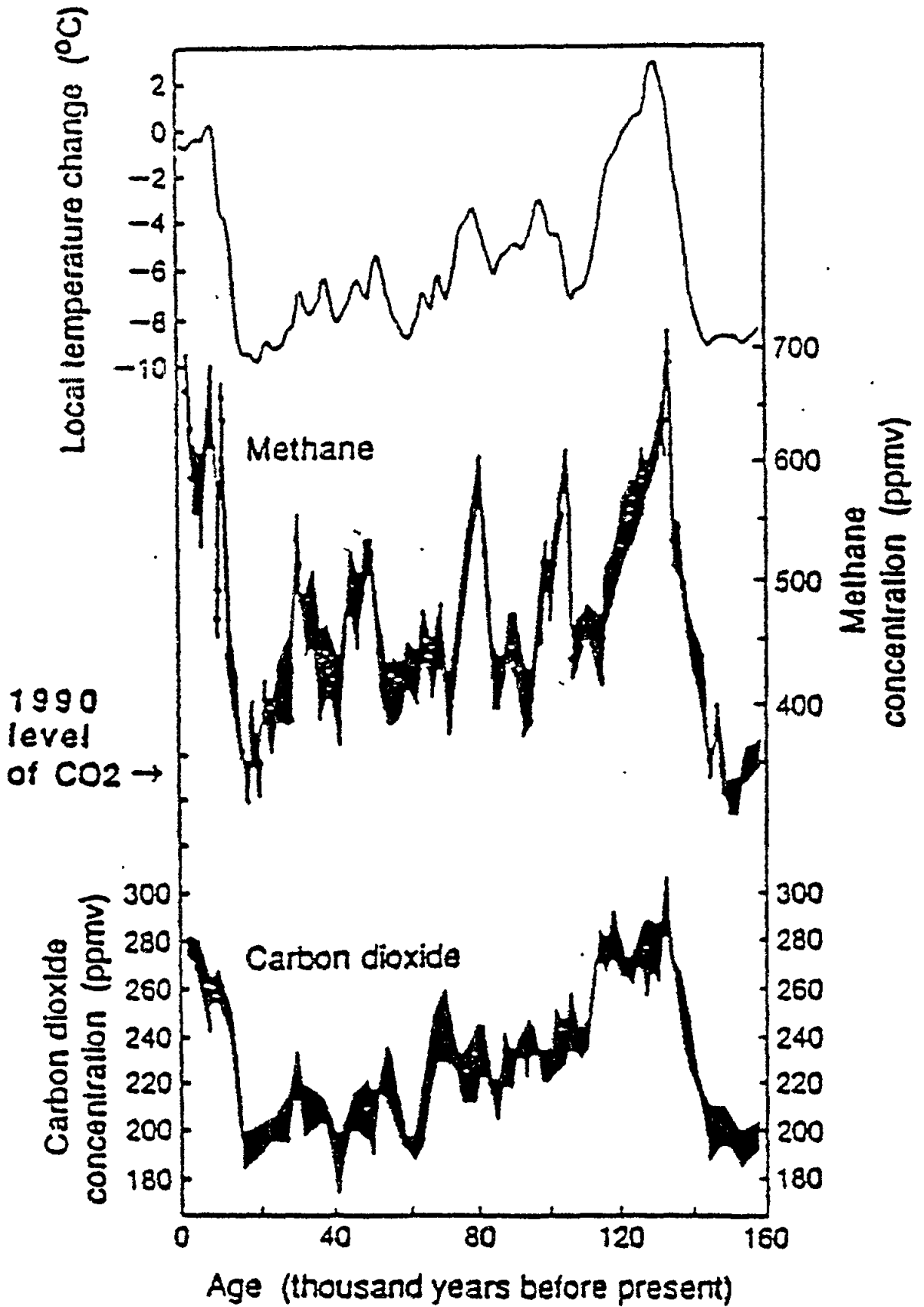
† The way in which CO₂ is absorbed by the oceans and biosphere is not simple and a single value cannot be given; refer to the main report for further discussion.

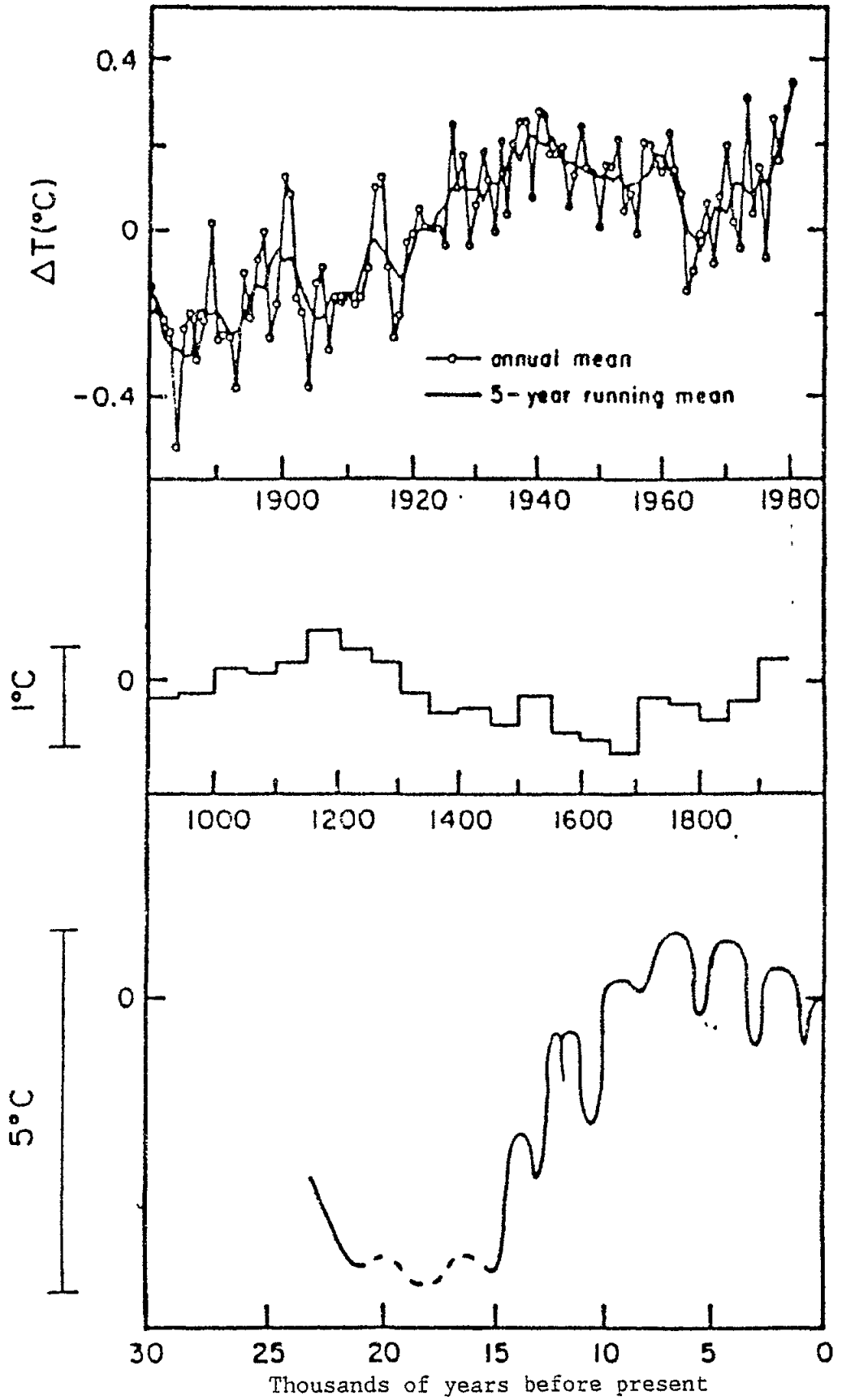
**CONTRIBUTION TO RADIATIVE FORCING BY SECTOR:
2025 EMISSIONS**
(Based on Global Warming Potentials For 100-Year Time Horizon)



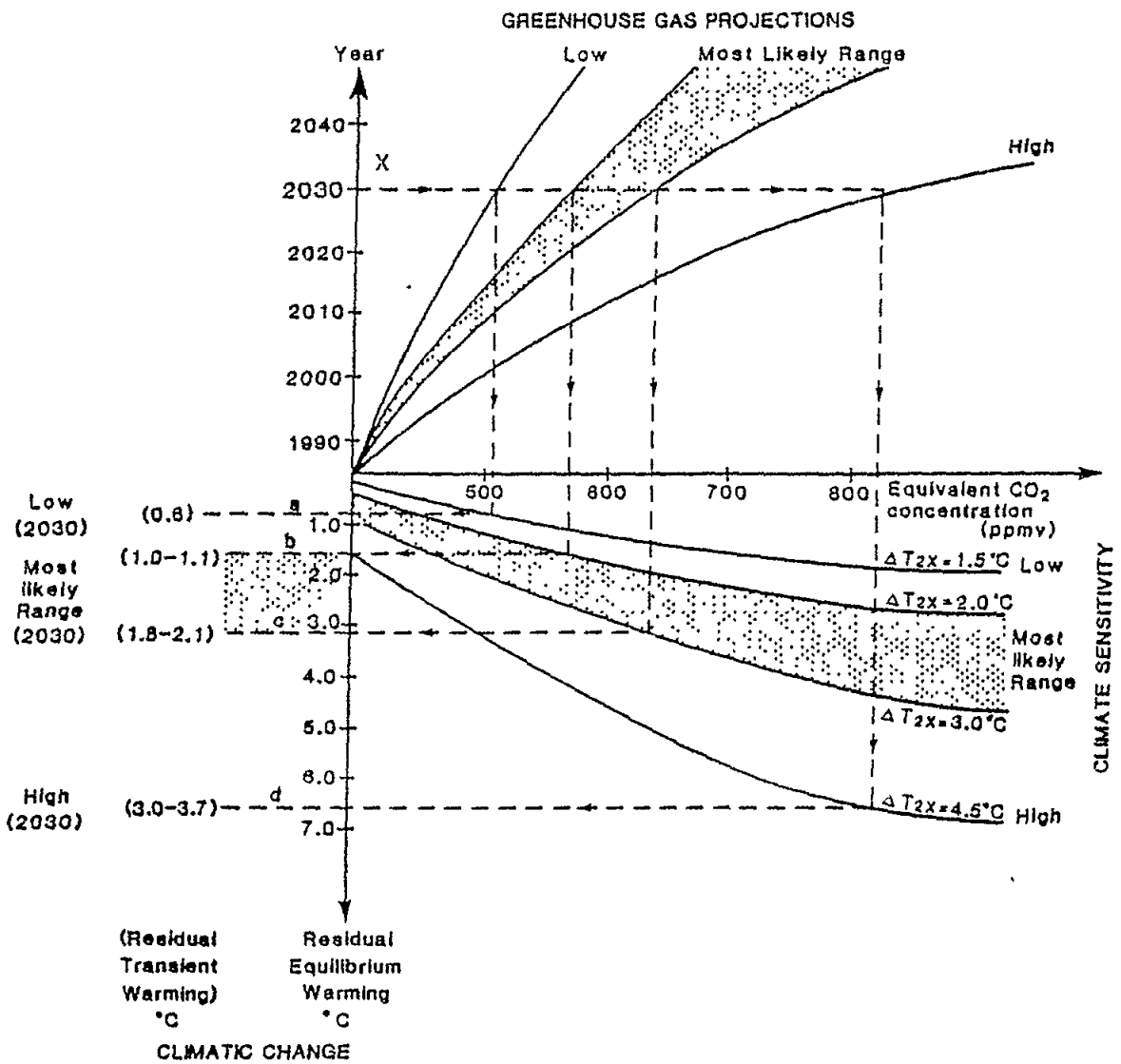


Source: Barnola (1987).





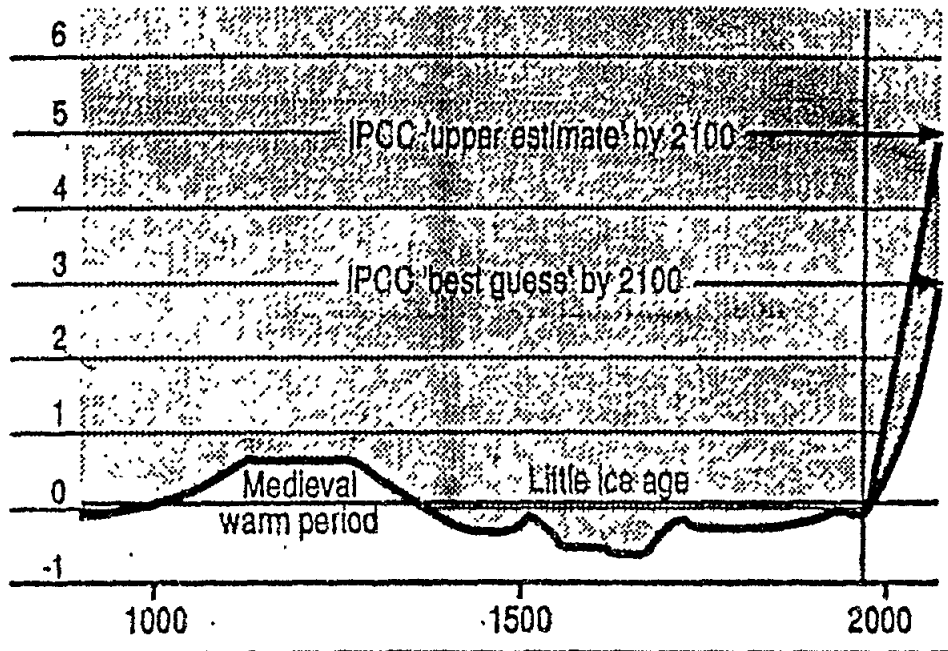
Estimates of the Climate Sensitivity



= 1.5 - 4.5°C warmer
 for a CO₂ doubling

UN prediction of climate changes

Temperature change (°C) from today's average



ESTIMATES FOR CHANGES BY 2030

(IPCC Business-as-Usual scenario; changes from **pre-industrial**)

The numbers given are based on high resolution models, scaled to be consistent with our best estimate of global mean warming of 1.8E by 2030. For values consistent with other estimates of global temperature rise, the numbers below should be reduced by 30% for the low estimate or increased by 50% for the high estimate. Precipitation estimates are also scaled in a similar way.

Confidence in these regional estimates is low

Central North America (35E-50EN 85E-105EW)

The warming varies from 2 to 4EC in winter and 2 to 3EC in summer. Precipitation increases range from 9 to 15% in winter whereas there are decreases of 5 to 10% in summer. Soil moisture decreases in summer by 15 to 20%.

Southern Asia (5E-30EN 70E-105EE)

The warming varies from 1 to 2EC throughout the year. Precipitation changes little in winter and generally increases throughout the region by 5 to 15% in summer. Summer soil moisture increases by 5 to 10%.

Sahel (10E-20EN 20EW-40EE)

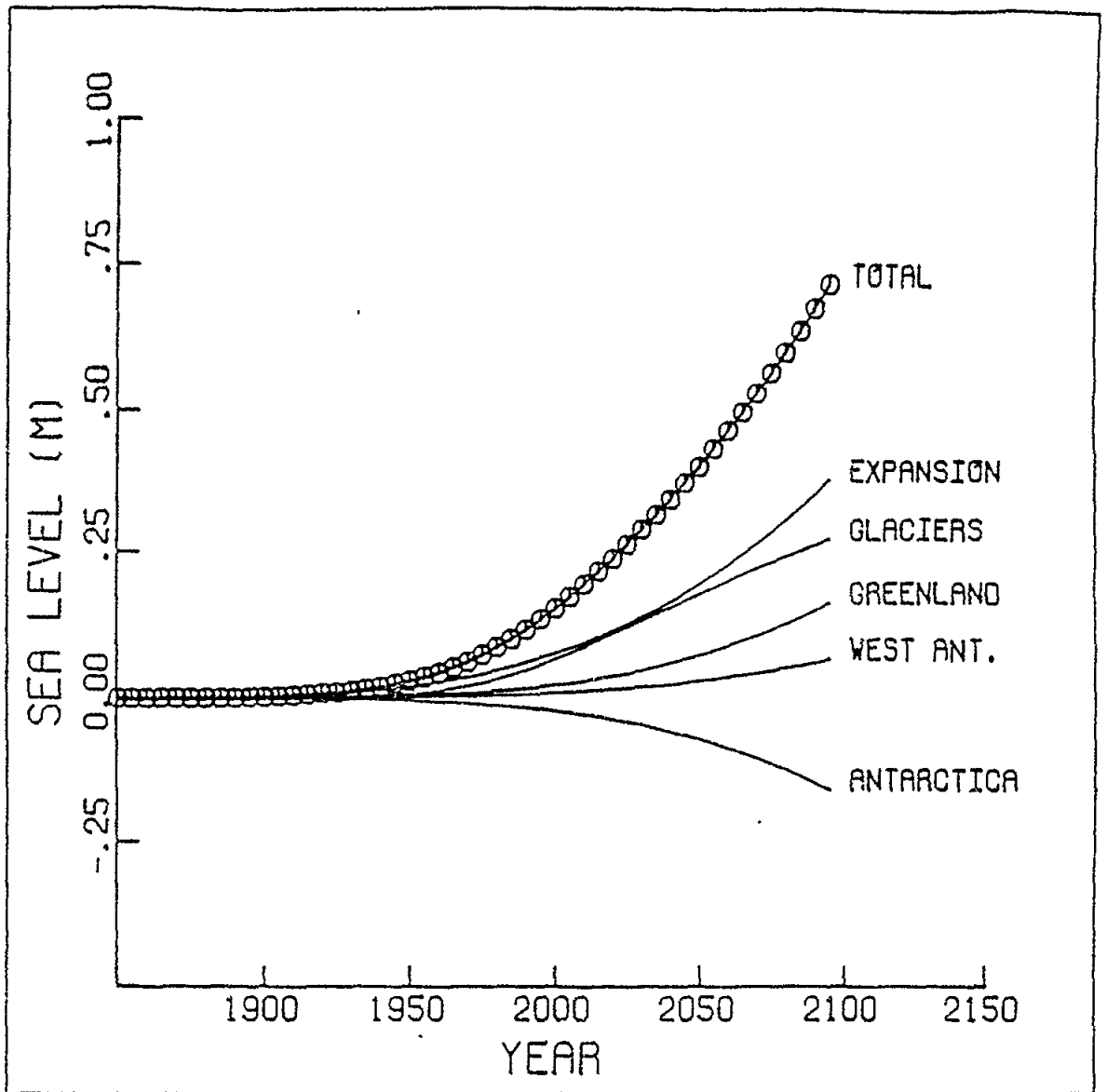
The warming ranges from 1 to 3EC. Area mean precipitation increases and area mean soil moisture decreases marginally in summer. However, throughout the region, there are areas of both increase and decrease in both parameters throughout the region.

Southern Europe (35E-50EN 10EW-45EE)

The warming is about 2EC in winter and varies from 2 to 3EC in summer. There is some indication of increased precipitation in winter, but summer precipitation decreases by 5 to 15%, and summer soil moisture by 15 to 25%.

Australia (12E-45ES 110E-115EE)

The warming ranges from 1 to 2EC in summer and is about 2EC in winter. Summer precipitation increases by around 10%, but the models do not produce consistent estimates of the changes in soil moisture. The area averages hide large variations at the sub-continental level.



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

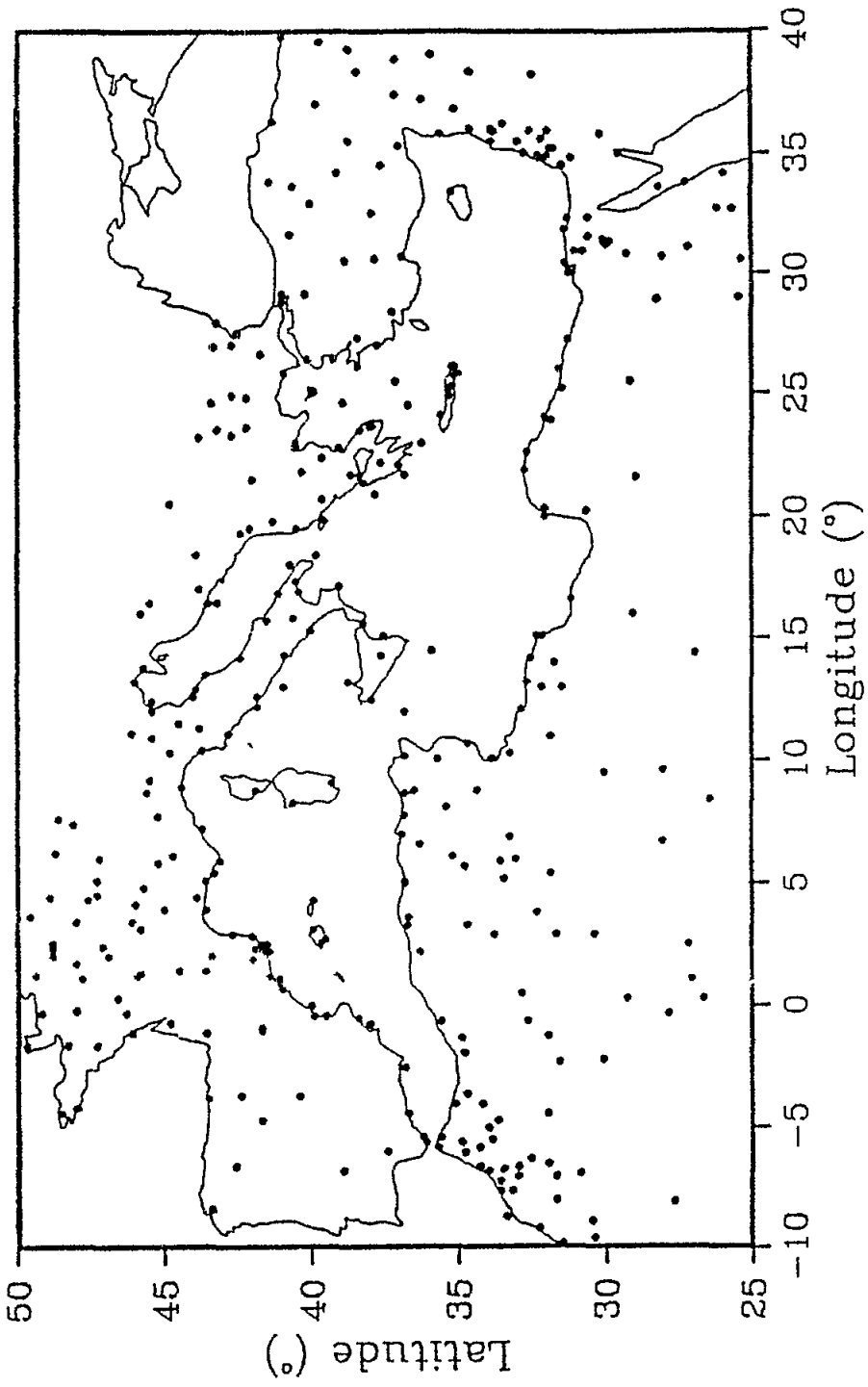
SCENARIA OF REGIONAL CHANGES IN CLIMATE IN THE MEDITERRANEAN

Approach taken by
Climate Research Unit, University of East Anglia

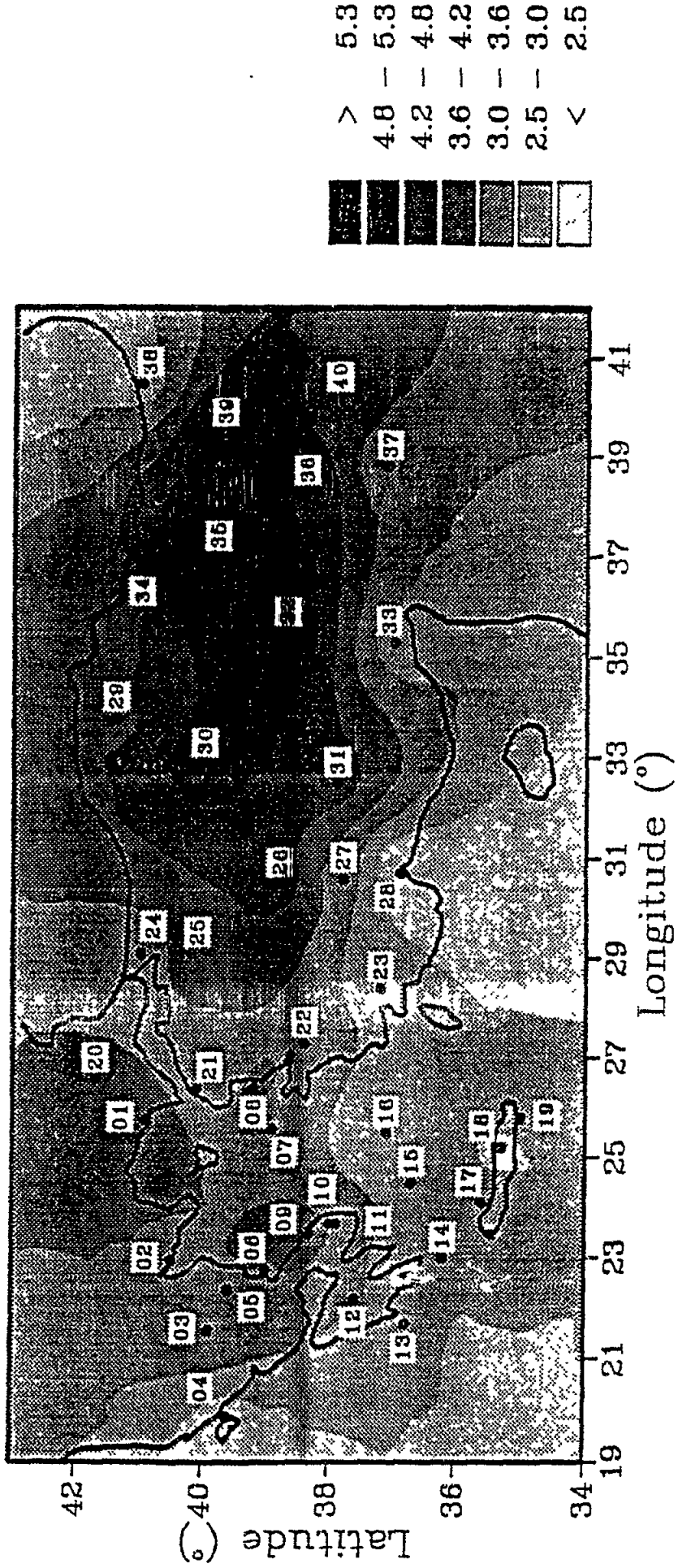
Statistical link between the large-scale grid-point
GCM predictions and the small-scale detail of
regional climates was achieved through the
following approach:

- 1. The approach is based on regression analysis techniques, whereby small-scale climate changes are related to regional-scale changes as predictors.**
- 2. The basic assumption of the method is that GCM-derived, grid-point values for temperature and precipitation, are equivalent to regionally-averaged observations of the same variable.**
- 3. Using observed climate data, a set of regionally-averaged time series is built up for each of the climate parameters which are to be considered as predictor variables.**
- 4. Regression equations are constructed using present-day instrumental climate data. These relate variations in regionally-averaged climate variables (the predictors) to variations in single-station values of the variables to be predicted.**
- 5. The regression equations are used to derive point values for the relevant climate variables in a high greenhouse gas world. The predictor variables used to construct the regression equations are replaced by GCM estimates of the perturbation due to a doubling of CO₂.**
- 6. The climate values derived from the regression equations for a number of sites in a region are then contoured to produce a map of the climate perturbation expected for that region in a high greenhouse gas world.**

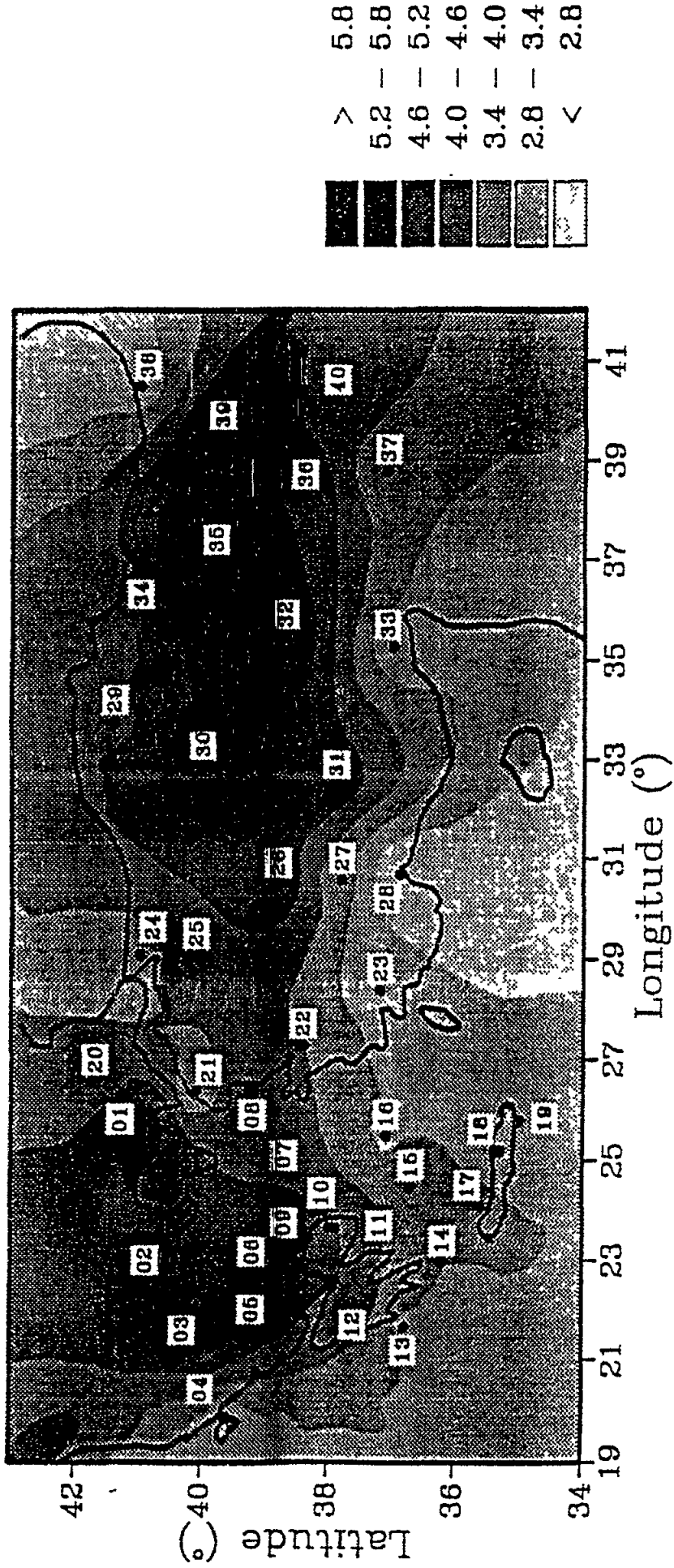
Fig. 1. Mediterranean stations for the UNEP project



2xCO₂ winter temperature increase (°C) in Turkey and Greece for OSU



2xCO₂ winter temperature increase (°C) in Turkey and Greece for CCM



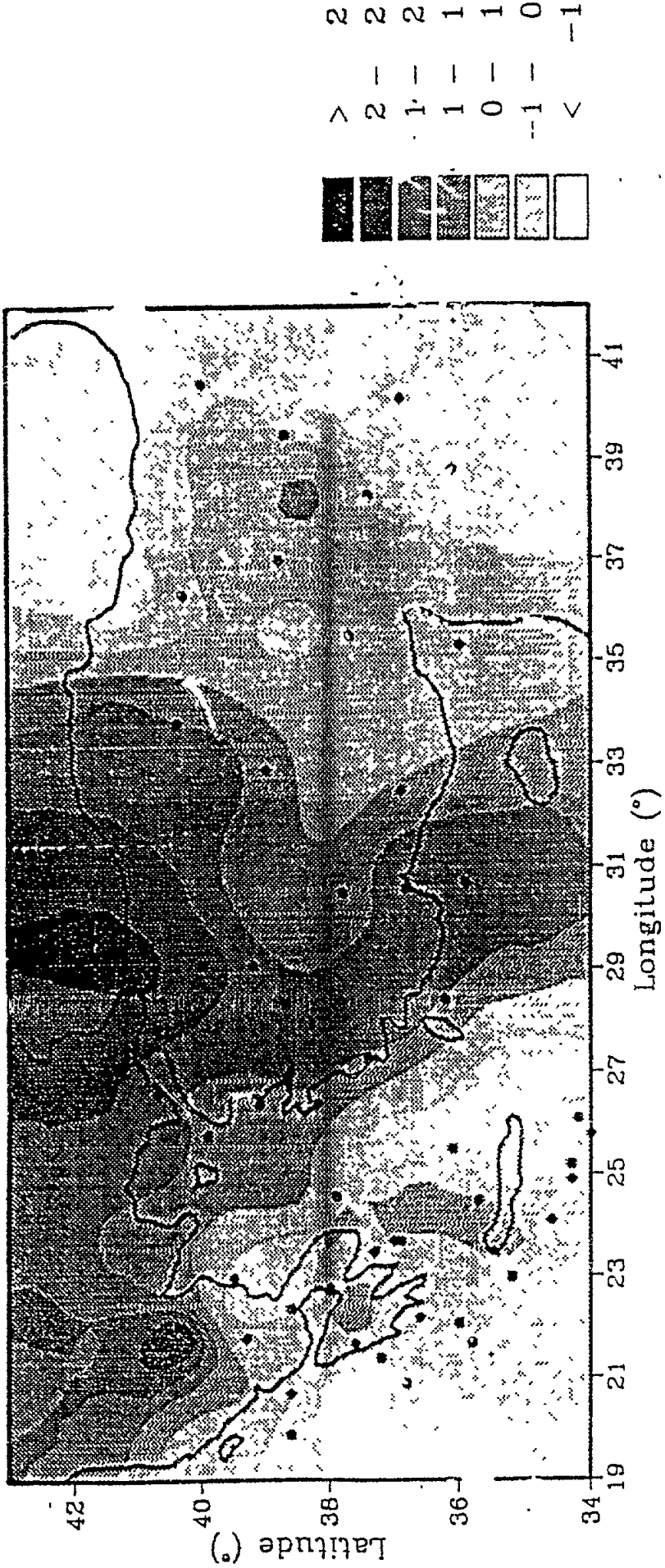


Fig. 15. Spring season 2xCO₂ CCM precipitation perturbation (mm/month) for Greece and Turkey.

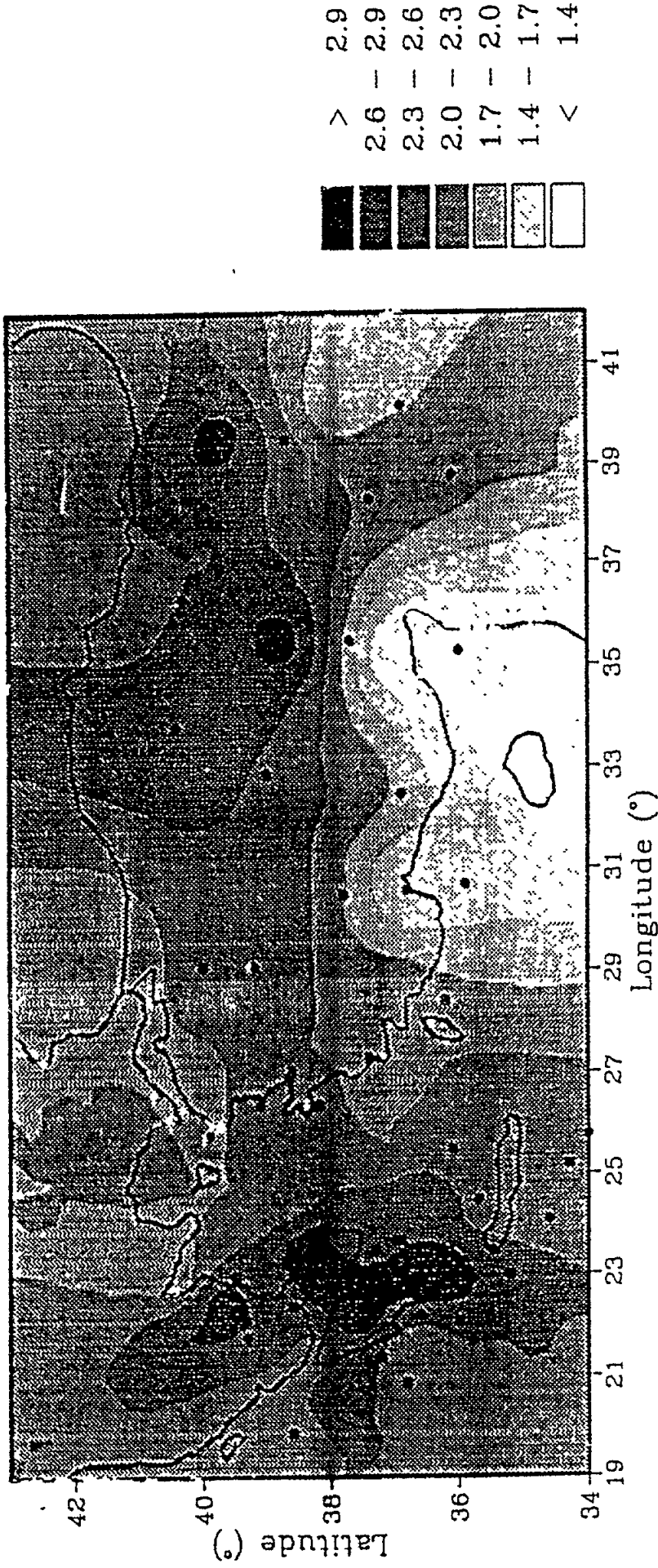
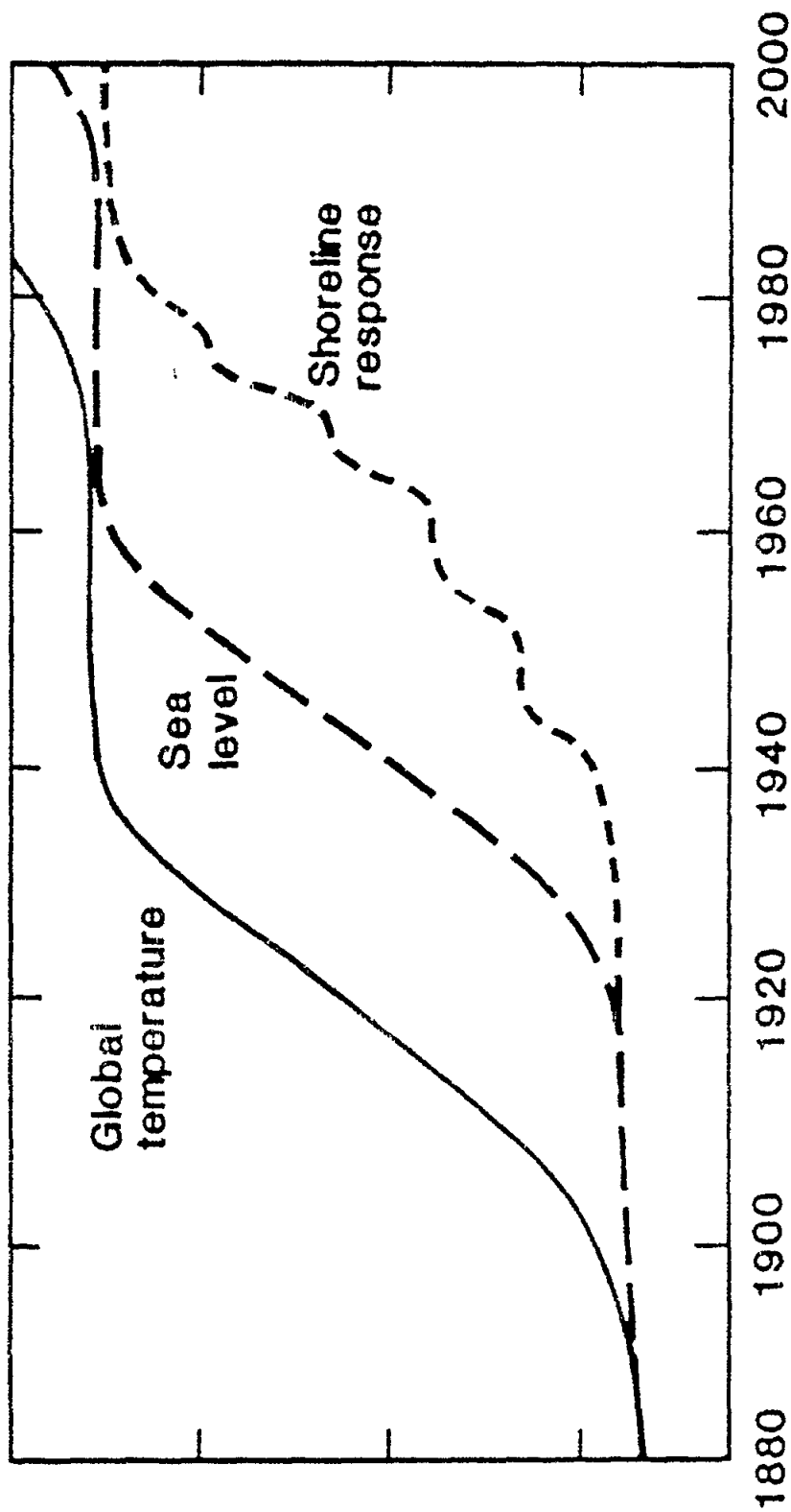
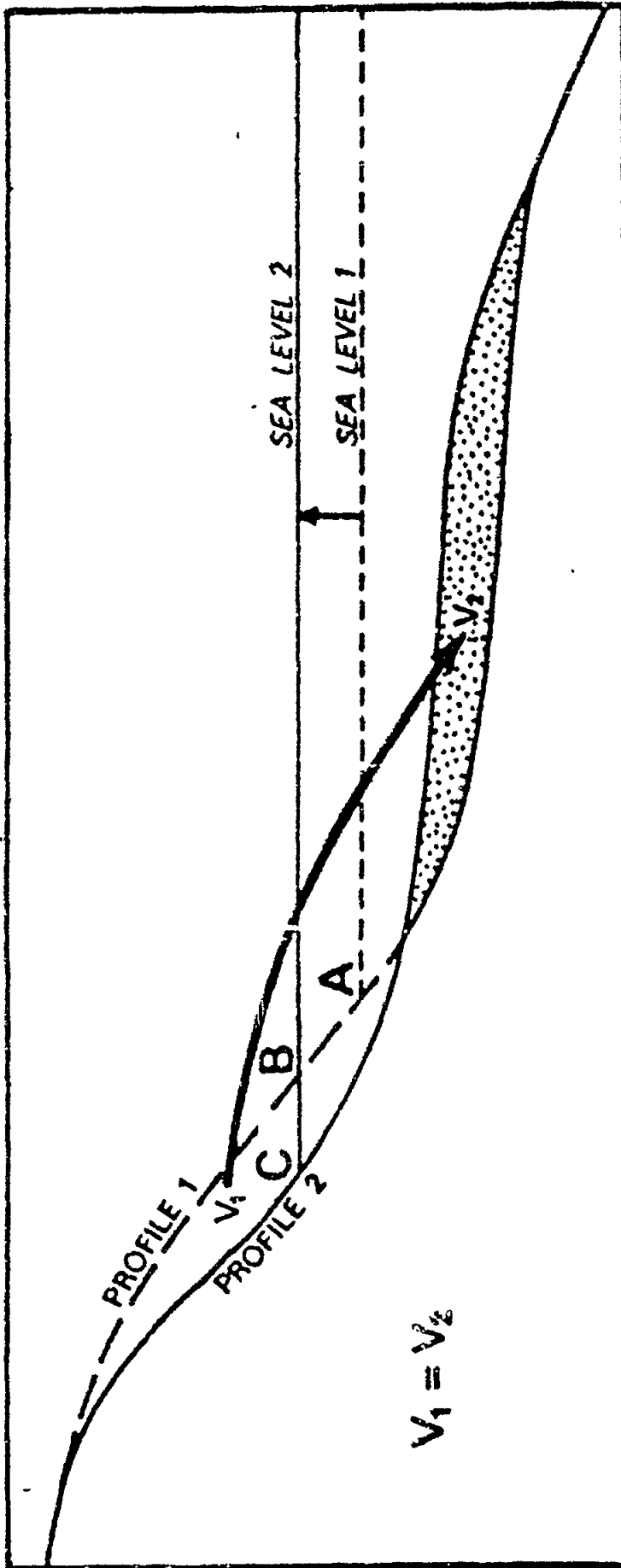


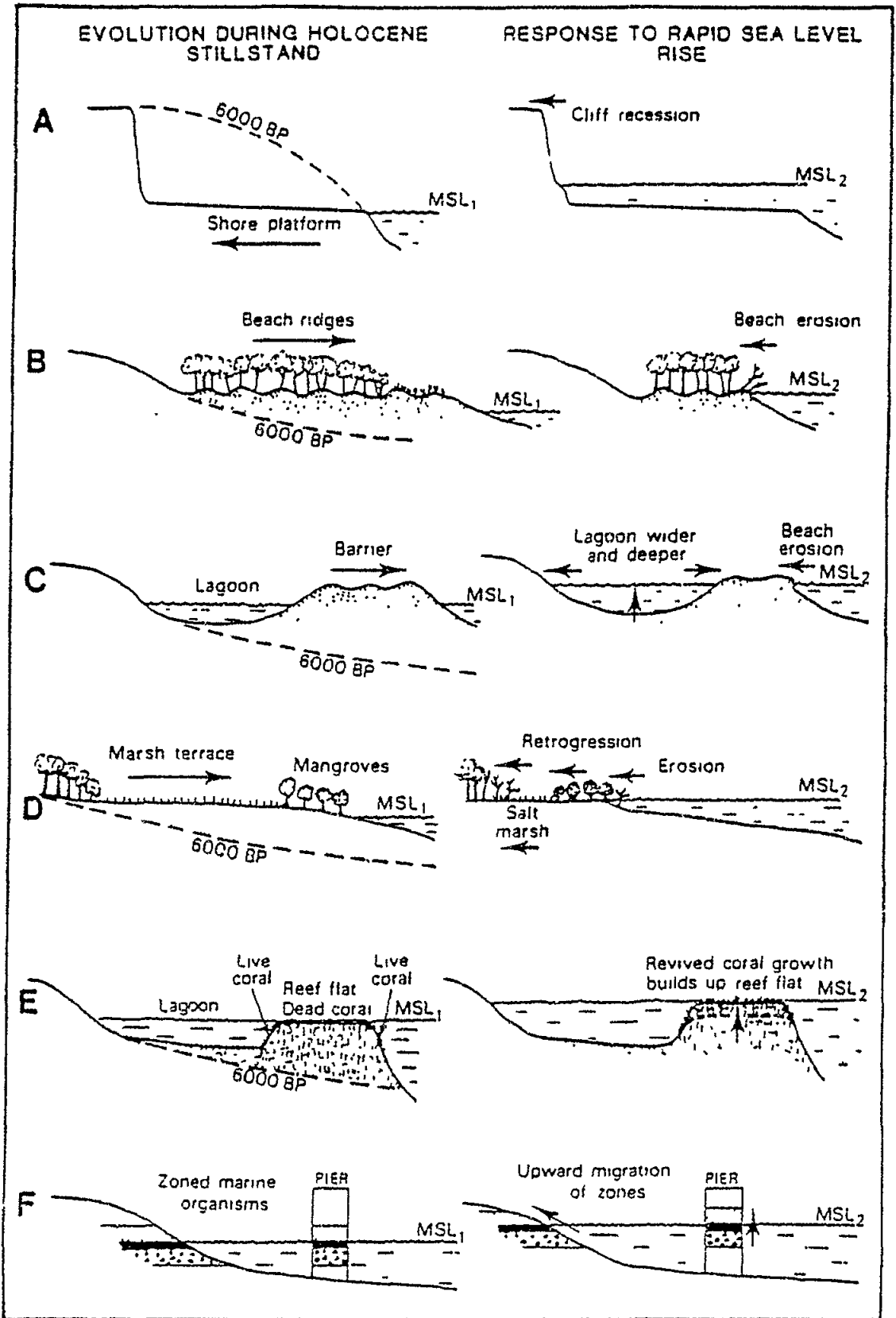
Fig 12. Summer season 2xCO₂ CCM temperature perturbation (°C) for Greece and Turkey.



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).



Brunn model of response of an equilibrium beach to a sea-level rise. The coastline retreats from A to C as the pre-existing transverse profile is restored by seaward transference of beach sediment. (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).

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:

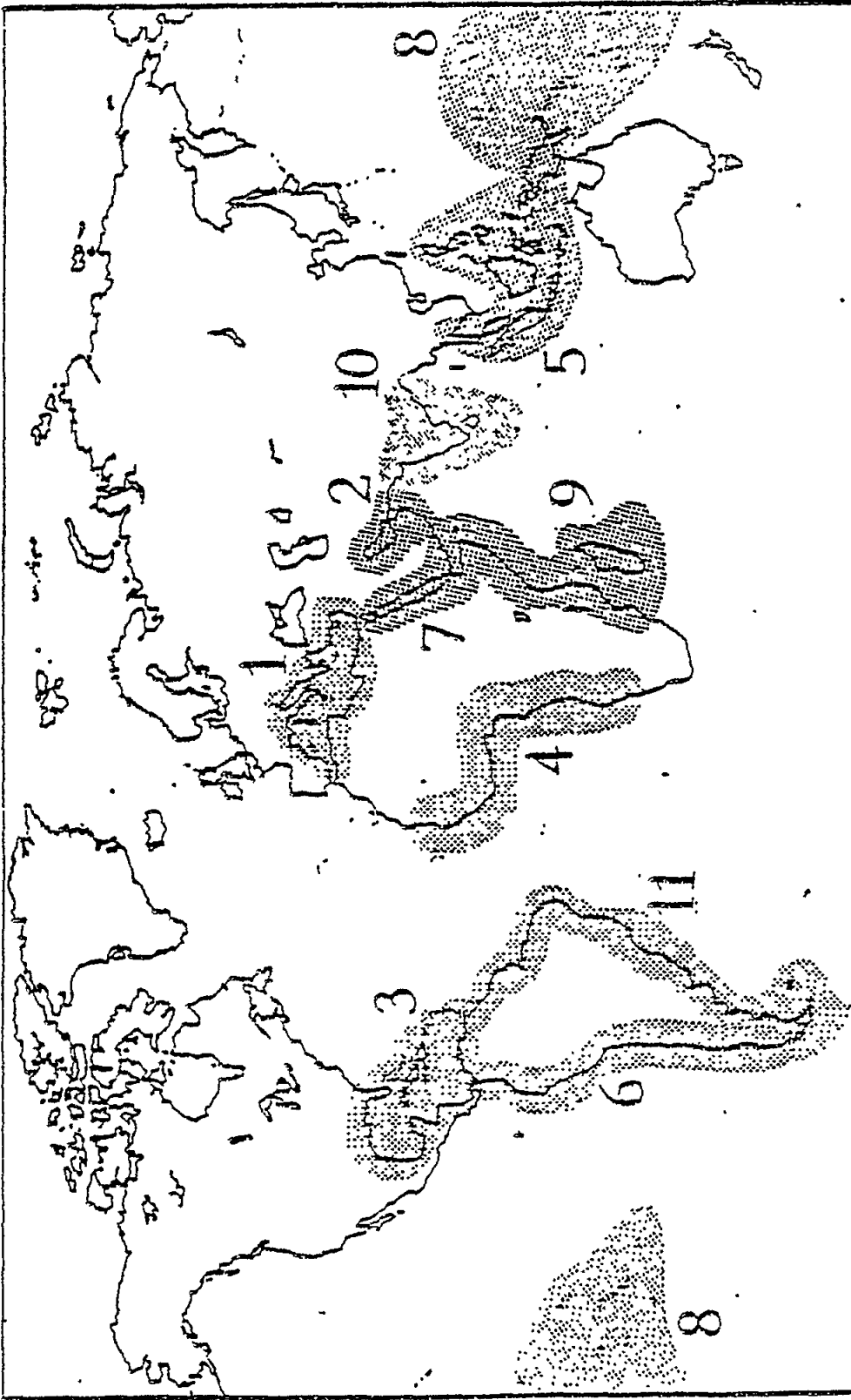
- ENERGY FLOW TO HIGHER TROPHIC LEVELS; HENCE
 - STANDING STOCKS OF HIGHER TROPHIC LEVELS; AND
 - OVERALL RATES OF SECONDARY PRODUCTION; AND ULTIMATELY
 - FINFISH AVAILABILITY FOR HUMAN CONSUMPTION.

CHANGES IN COASTAL/TERRESTRIAL VEGETATION AND WETLANDS WILL:

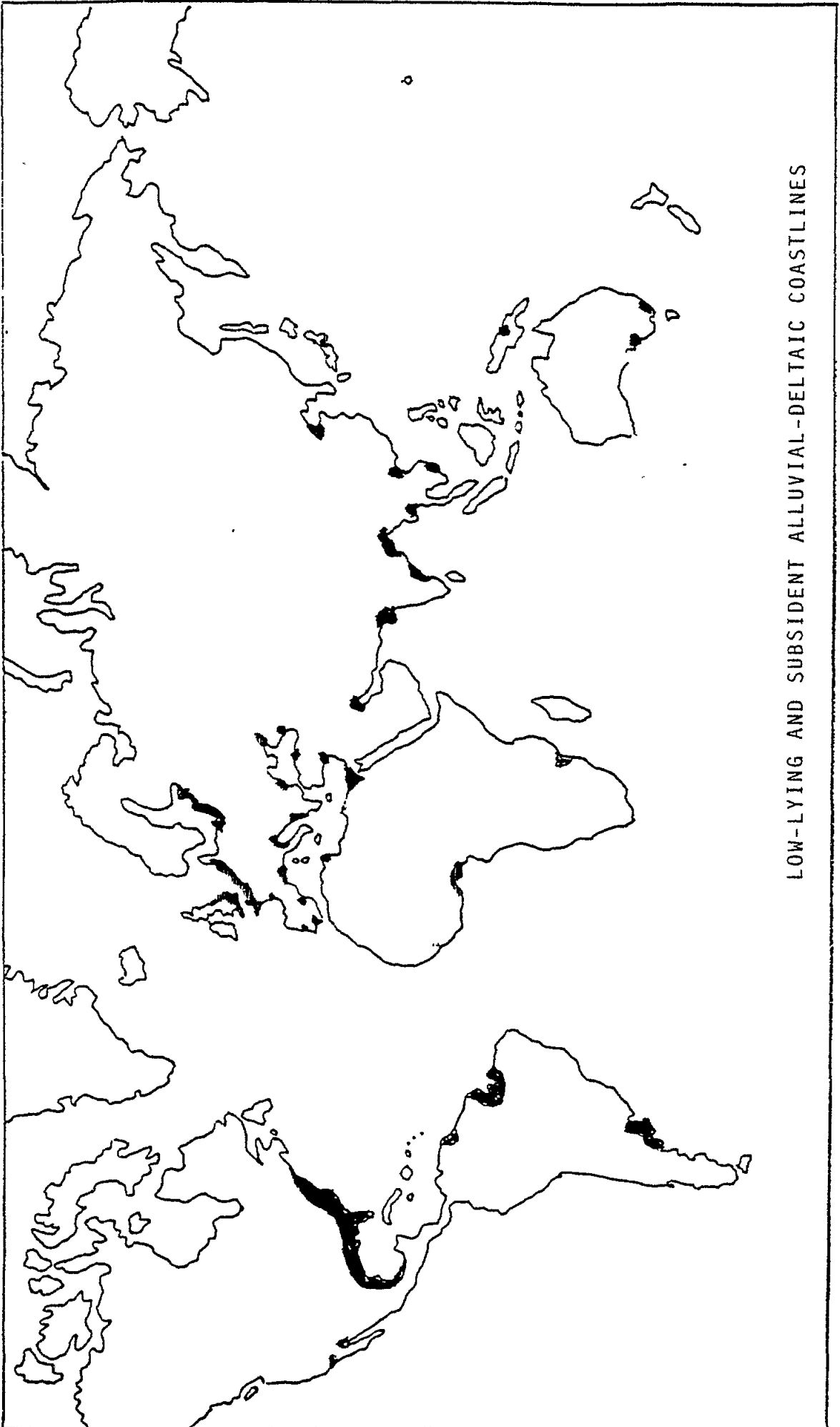
- ALTER THE DISTRIBUTION AND ABUNDANCE OF DEPENDENT ANIMALS;
- AFFECT ECONOMIC ACTIVITIES BY AFFECTING COMMERCIALY IMPORTANT SPECIES SUCH AS PENAEID PRAWNS AND SHRIMP;
- ALTER THE FLUX OF SEDIMENTS AND NUTRIENTS INTO THE MARINE ENVIRONMENT;
- ALTER DISTRIBUTIONS OF HUMAN DISEASE VECTORS; HENCE,
 - CHANGING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



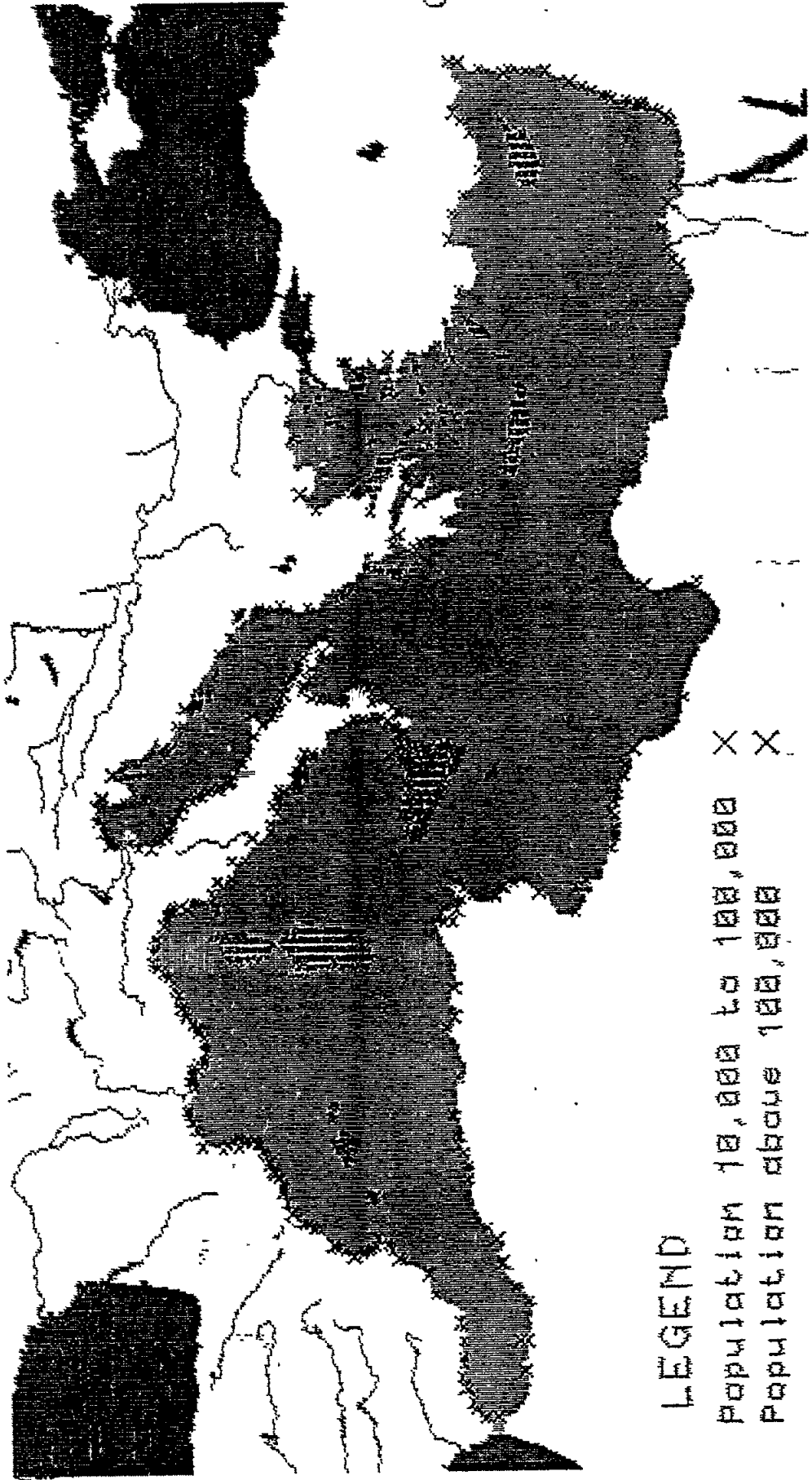
- 1. Mediterranean Region
- 2. Kuwait Action Plan Region
- 3. Wider Caribbean Region
- 4. West and Central African Region
- 5. East African Region
- 6. South East Pacific Region
- 7. Red Sea and Gulf of Aden Region
- 8. South Pacific Region
- 9. Eastern African Region
- 10. South Asian seas Region
-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



LOW-LYING AND SUBSIDENT ALLUVIAL-DELTAIC COASTLINES

Mediterranean Coastal Cities

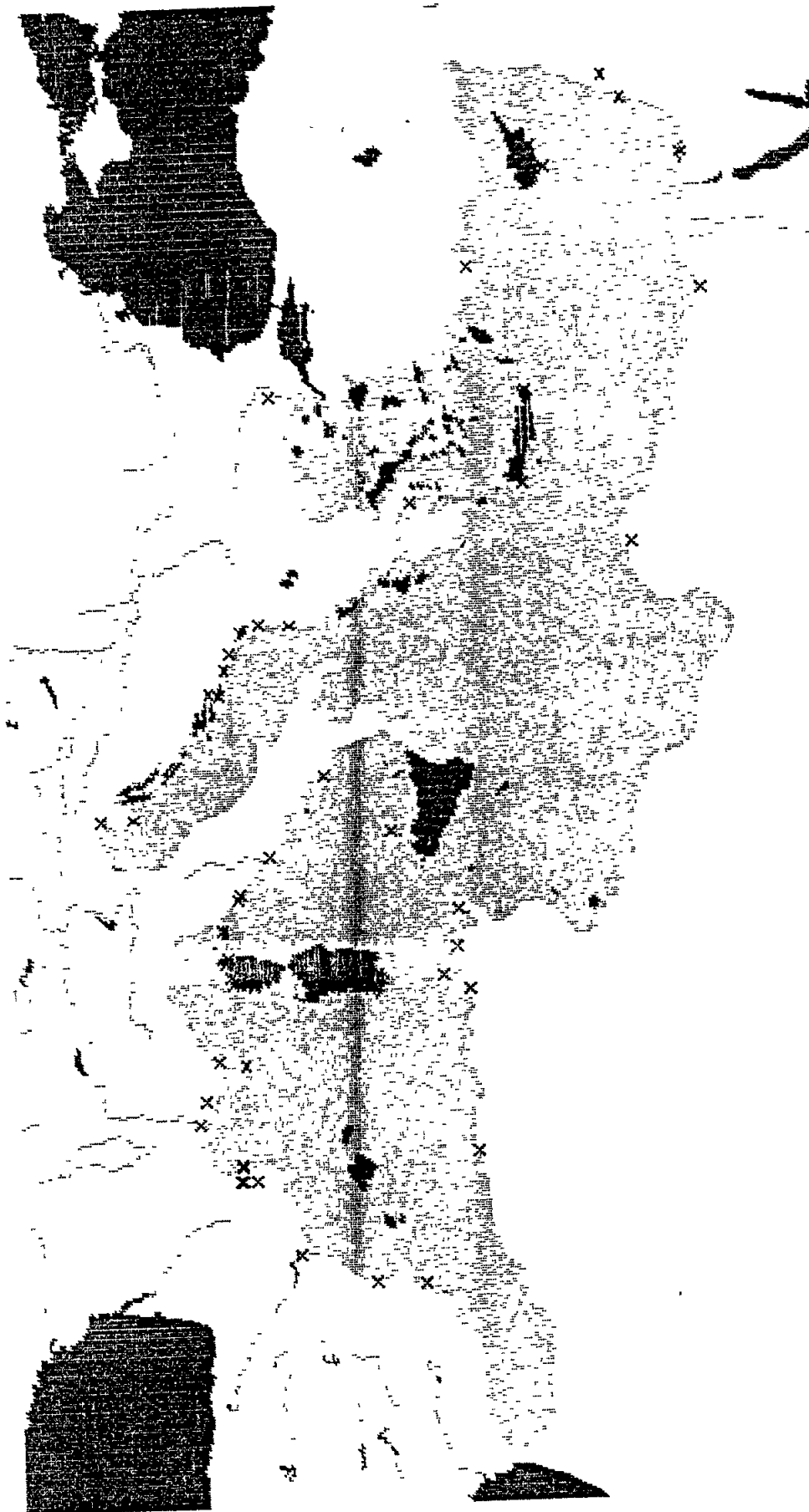
(Population above 10,000)



LEGEND

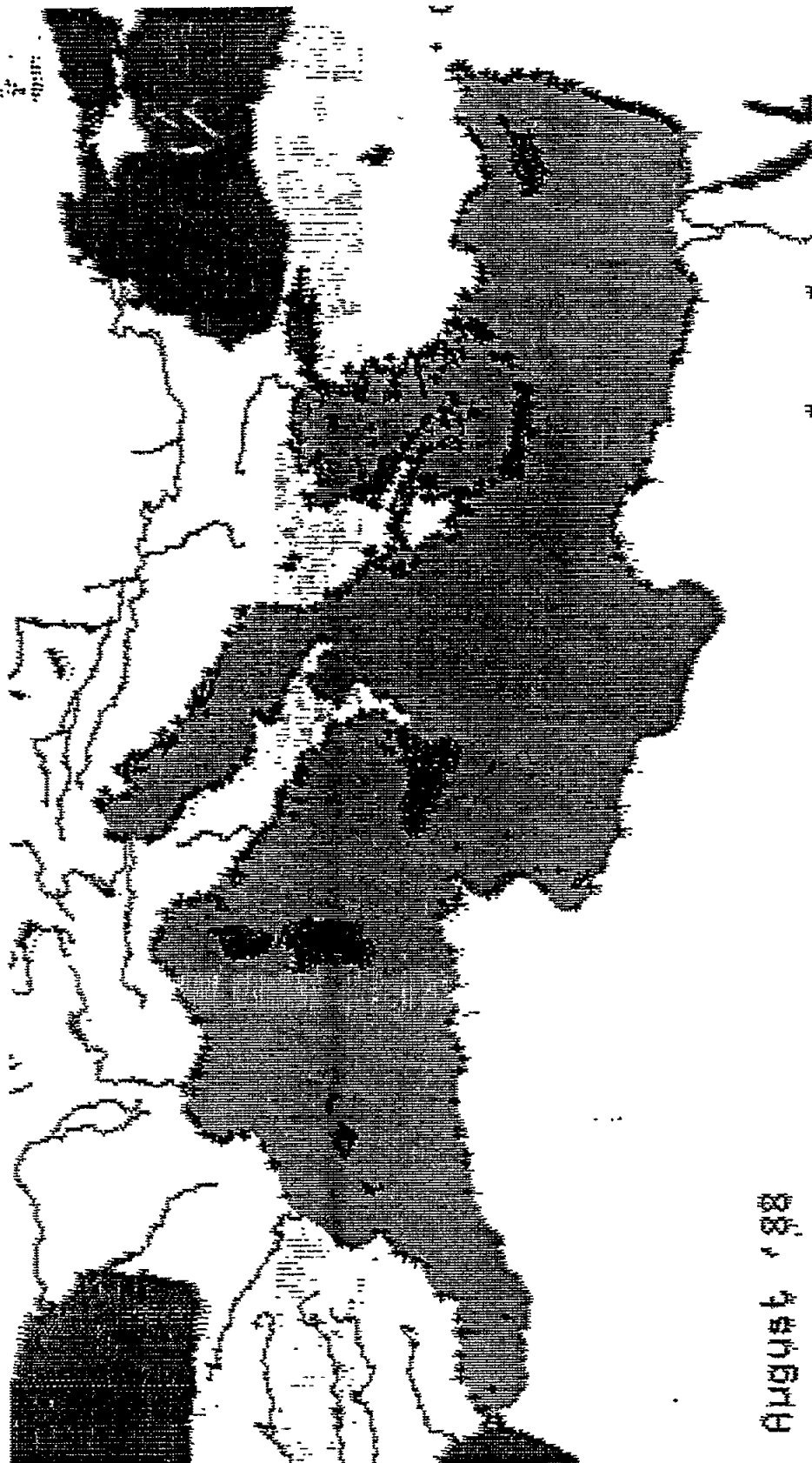
- Population 10,000 to 100,000 X
- Population above 100,000 X

Mediterranean Specially Protected Areas



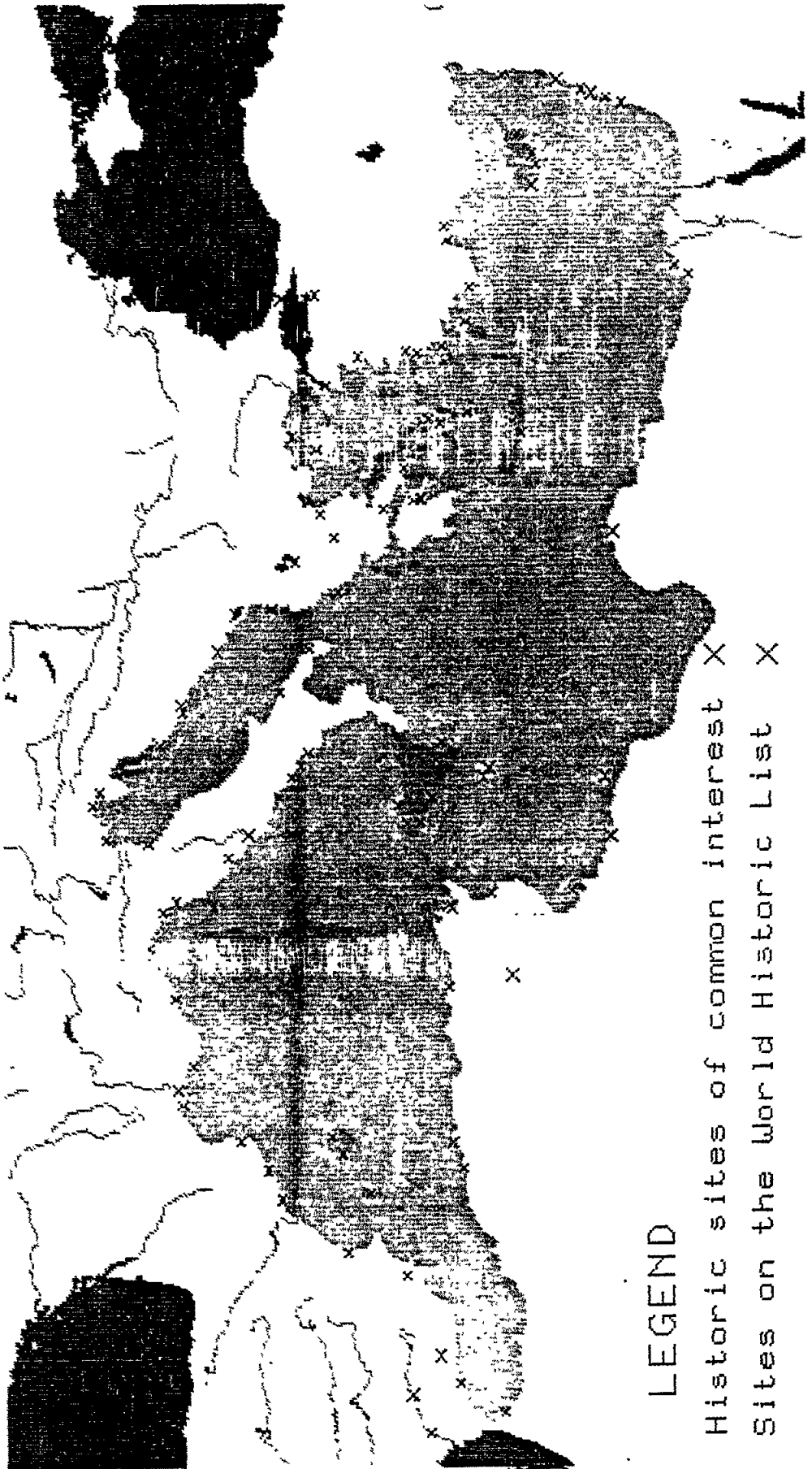
Coastal Archaeological Sites in the Mediterranean

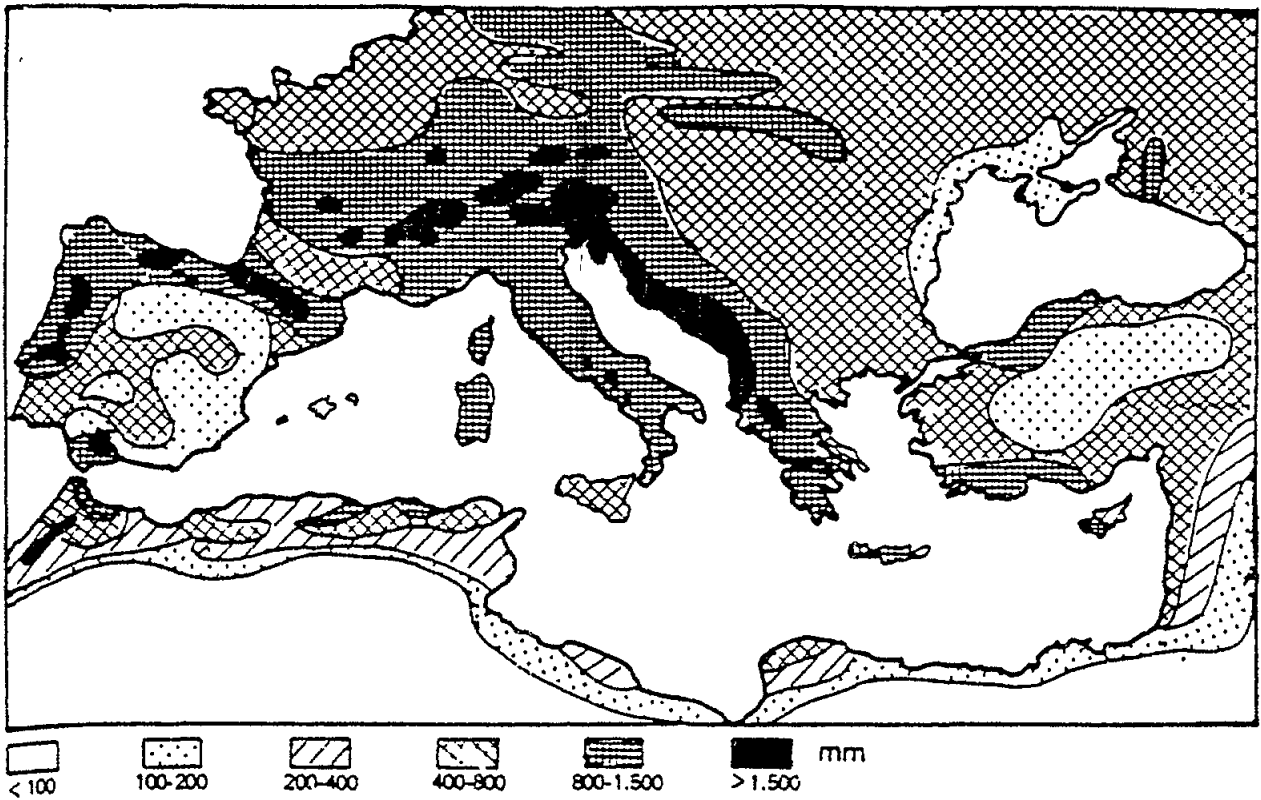
(Source: M.C. Flemming)



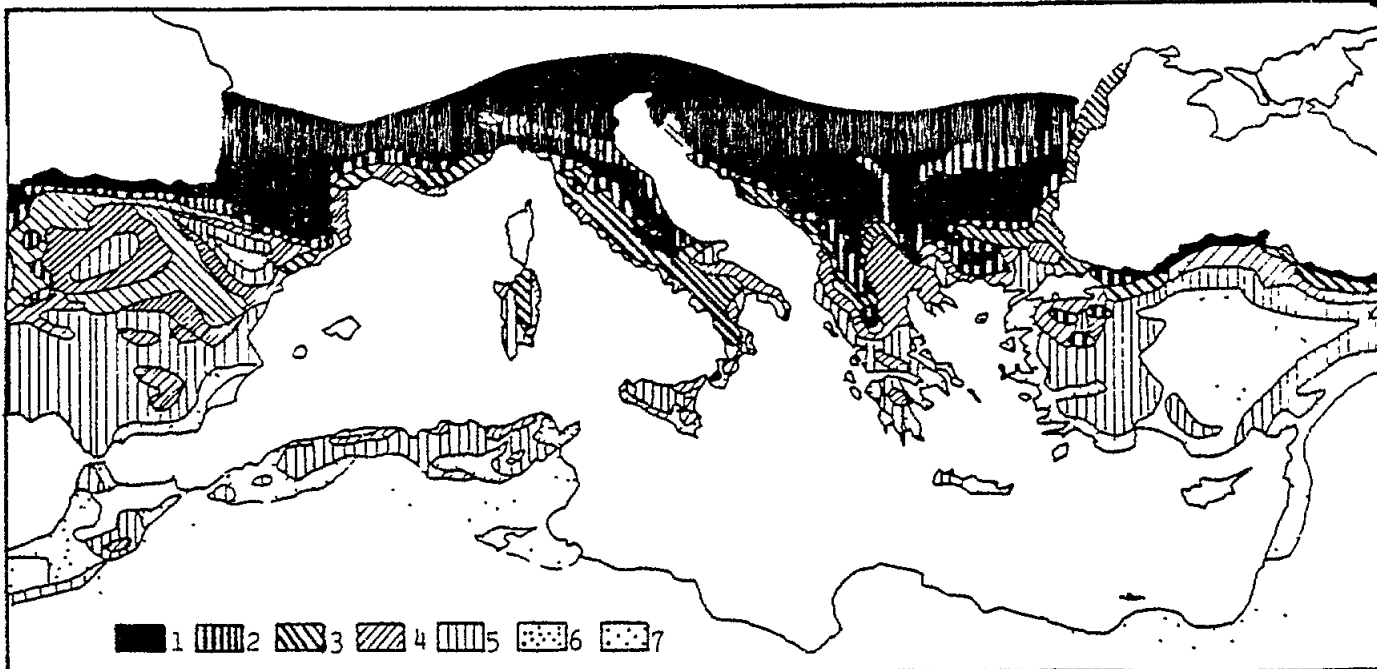
August '88

Mediterranean Historic Sites





Distribution of annual rainfall in the Mediterranean region



Extent of the dry season in the Mediterranean region (number of dry months: 1. None 2. One-two 3. Two-three 4. Three-four 5. Four-five 6. Five-seven 7. More than seven).

CASE STUDIES

1. EBRO
2. GULF OF LIONS - RHONE
3. PO - NW ADRIATIC
4. AXIOS - THESSALONIKI
5. NILE DELTA
6. LAKE ICHKEUL



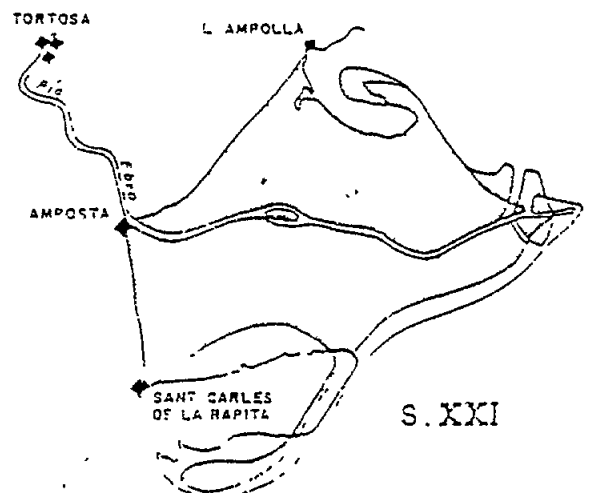
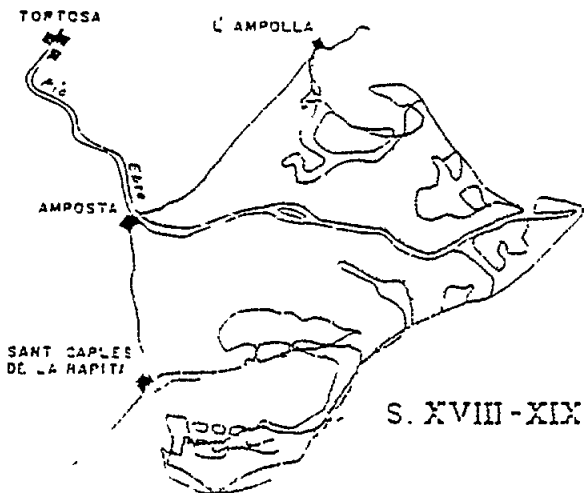
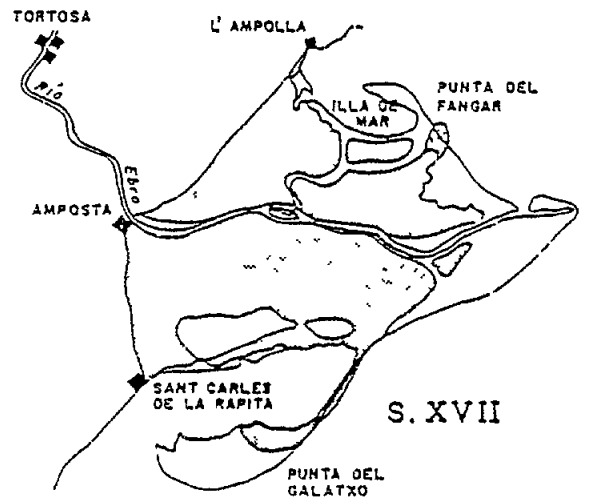
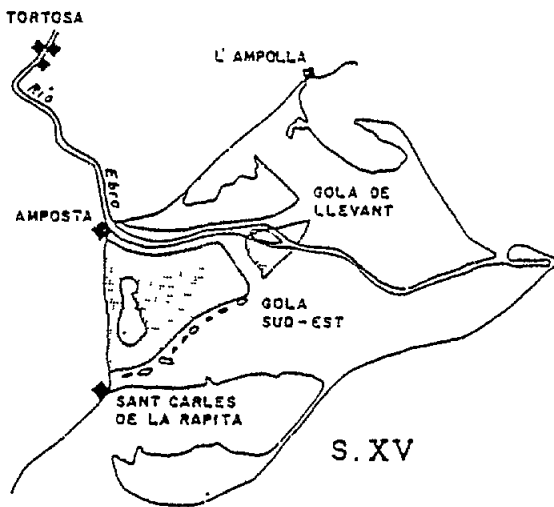
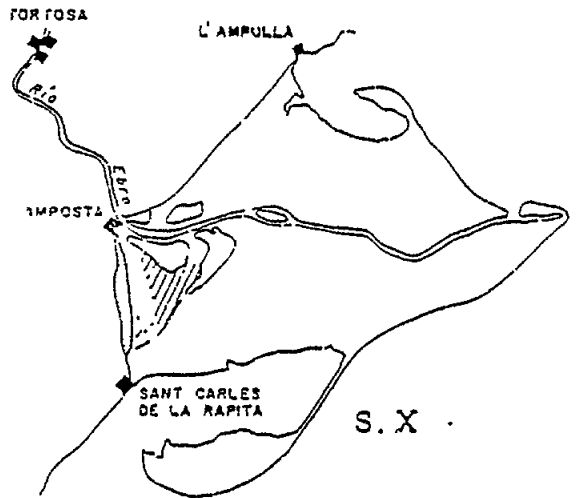
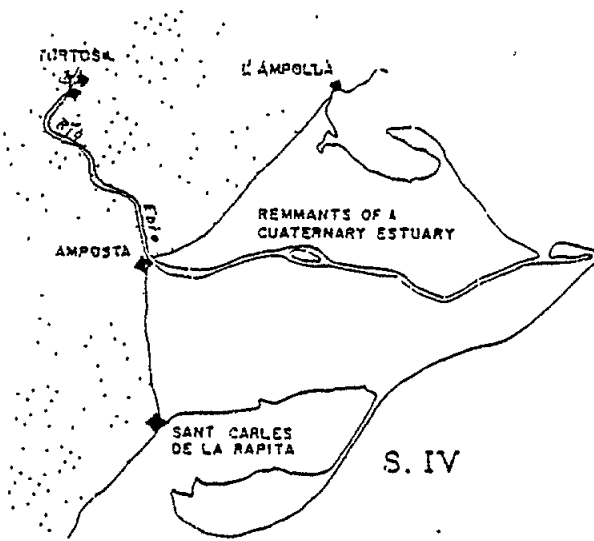
GENERAL CHAPTERS

1. OVERVIEW
2. CLIMATE CHANGES

REGIONAL IMPACT ASSESMENTS

- 1 OCEANOGRAPHY
- 2 COASTAL STABILITY
- 3 SEA LEVEL CHANGES
- 4 HYDROLOGY
- 5 ECOSYSTEMS
- 6 VEGETATION
- 7 SOCIO - ECONOMICS

IMPLICATIONS OF CLIMATIC
CHANGE
IN THE MEDITERRANEAN REGION
(UNEP 1989)



IMPACT OF CLIMATIC CHANGE

Changed mean annual and seasonal temperature, general air circulation and precipitation will affect:

- (a) surface and groundwater flow and river regimes, that is surface and ground-water availability, the incidence of floods and the amount of sediment transported and delivered to the sea;
- (b) the movement of marine water masses (waves, currents, tides), especially in terms of direction and intensity of storms (i.e. erosion of the coasts) and of tidal range;
- (c) natural ecosystems, due mainly to increased temperature and its effects on water and soil qualities;
- (d) occupation and use of the coastal lowland regions (0-5 m) because of sea-level rise, and altered parameters of agriculture, fishing, industry, tourism and the quality of the environment.

SUMMARY OF IMPACTS

Potential evapo-transpiration will increase throughout the Mediterranean, coupled with a possible decrease in precipitation in the south and an increase in the northern part. Climatic changes generally will occur gradually and will not be specifically manifested for another 3-4 decades. Hot dry summers and exceptional events of drought or rainfall and floods, marine storms, tidal surges and of water stagnation and eutrophication, however, could increase in frequency.

Increase in temperature would lead to an increase of land degradation, deterioration of water resources, decline in agricultural production and damage to natural terrestrial and aquatic ecosystems. Salinization of irrigation water would have negative consequence on sensitive grain yield. Consequently new varieties of crops have to be introduced, adapted to the new natural setting and yield standards.

Marine circulation could be altered both in the Mediterranean and the Atlantic, thus affecting marine productivity and the pattern of pollutant dispersal.

Generally marine and land weeds are expected to benefit from warmer, CO₂ richer atmosphere. Flora and fauna of the wetlands will be forced to a gradual adaptation to induced conditions which might be crucial for the species that possess reduced tolerance to high salinities. As bioclimatic zonation will gradually shift northwards, several species will migrate to the north, and insect populations might increase. There will be favourable conditions for an increasing risk of agricultural pests, bacteria and diseases, especially in the swamps.

The effects of sea level rise are most predictable even though the extent of sea level rise is difficult to foresee: **1)** direct wave impact on exposed coasts (e.g. the Venice lagoon coastal barrier, beach resorts) and on harbour installations (Alexandria, Port Said, La Golette-Tunis, etc); **2)** flooding of estuaries, canals, lagoons, which should be more serious for agriculture than for the increasingly more valuable lagoonal fishing. Degradation of lagoons (e.g. Venice Lagoon), however, could seriously affect wildlife and fish resources; **3)** a sea level rise of 10-20 cm will aggravate existing shore erosion problems.

A global mean eustatic rise in sea level of about 20 cm by 2025 would not, in itself, have a significant impact in the Mediterranean, except locally (e.g. lagoons). However, local sea level changes could be up to five times this amount because of natural land subsidence, that could be enhanced by excessive groundwater withdrawal. Particularly negative effects of this impact will be felt in low lying areas, deltas and coastal cities.

The future impacts on Mediterranean society by non-climatic factors (e.g. population increases, present development plans) may far exceed the direct impacts of climate change. Non-climatic factors will cause continuous increases in society's vulnerability to climatic stress, particularly in the south. Together, these demographic and climatic changes should increase the probability of catastrophic events and hasten their occurrence.

Most of the deltaic lowlands of the Mediterranean Sea are experiencing serious environmental problems because of agricultural, industrial, urban and tourist developments during the last two decades. Problems range from water pollution and salinization to land subsidence, shoreline erosion, and restriction and deterioration of wildlife habitats. This vulnerability is increased by adverse socio-economic conditions, the effect of which will be superimposed upon those of climatic change.

FUTURE STRATEGIES

To develop a strategy for responding to the impacts of change, it is essential to identify those parts of the Mediterranean coastal regions where knowledge is still inadequate.

The physical impact of sea level rise on the Mediterranean lowland coasts can be predicted, even modelled quantitatively on the basis of the present parameters of morphology, hydrodynamics, sediment budgets, land subsidence and the effects of artificial structures. Equally, the impacts of altered rainfall distribution on surface and groundwater could be modelled quantitatively, and the effects of increased air temperatures and changed soil-water parameters on biosystems can be estimated, at least qualitatively, which then give some idea of impacts on agriculture and fisheries. What is much more difficult to estimate, however, is the impact of these physical and biological changes on the future socio-economic framework of the threatened lowlands.

Coastal zone management must be based on "cost-effectiveness", which means an assessment of the "value" of the threatened land uses, not only in terms of their present functions, in the context of the local needs and of the importance of the lowland concerned to its hinterland and further, but especially of those of decades ahead.

Regarding sea level change, perspective actions can be either preventive or reactive. For example, entire coasts and lagoon margins can be walled in, or choices must be made between irreplaceable coastal uses (e.g. national and military harbours, towns of historical-artistic value, lagoonal resources, specialized agriculture) and adaptations. Examples of such relative actions would be **(a)** shifting land uses and **(b)** a different approach to beach recreation (i.e. less urbanized), the replacement of extensive, uneconomical crops in sub-zero lands, with lagoons destined to aquaculture and nature reserves. The lagoons would act as a buffer belt, since their inner margins can be more easily protected than the exposed coast.

Close attention needs to be paid to the conservation of soil, groundwater and wetlands resources in the Mediterranean, because they contribute substantially to environmental stability. The overall adverse effects on downstream human settlements and ecosystems by large dam schemes have not been considered sufficiently in past planning. Future water management plans must be scrutinized more closely in relation to climatic change.

Studies of the frequencies of extreme events (high temperatures, high and low precipitation events, storms surges, etc), and how these frequencies relate to mean climatic conditions, are required to help predict probabilities of occurrence.

The implications of climate impacts for some regions and processes are of very high complexity and therefore systems analysis seems to be the best approach to their study.

Attention should be given to identifying and accessing data that can be used for climatic impact assessment. The value of long-term data series is stressed. Monitoring programmes to collect such data should be maintained and/or extended.

Of particular importance is the need to initiate research on all climatically-induced changes and to control and plan coastal development well in advance of the postulated sea-level rise in order to minimize the negative effects of man-made dis-equilibriums already experienced in many parts and to make future protection cost-effective.

It is recommended that organisational and legal instruments be developed to control coastal development, land reclamation and groundwater exploitation. Lowlands could be analysed and zoned in high, medium and low risk categories.

PROPOSED CASE STUDIES IN THE MEDITERRANEAN REGION

A. MEDITERRANEAN ISLANDS

1. RHODES ISLAND
2. ISLAND OF MALTA
3. ADRIATIC ISLANDS

B. MEDITERRANEAN COASTAL AREAS

1. IZMIR BAY
2. KASTE LA BAY
3. COASTAL REGION OF SYRIA

ANNEX V

ANALYSIS OF TRENDS IN PRECIPITATION AND TEMPERATURE FOR MALTA

(supplied by Major J. Mifsud)

TEMPERATURE (Figs 1 and 2)

The Meteorological Office started taking weather observations in 1922 at Guardamangia. In 1927, the office was moved to St John's Cavalier in Valletta and in 1947 it was moved in Luqa. Only the temperature records from 1927 to 1988 were taken into consideration because no overlap of records for Guardamangia and Luqa are available. On the other hand, temperature was recorded simultaneously at Valletta and at Luqa for a period of five months from January to May 1947. Consequently, regression equations could be derived and the Valletta maximum and minimum temperature observations amended accordingly in order to add 20 years of temperature records to the 42 years available for Luqa.

The 10 year running mean curve for the mean maximum temperature has a positive slope. On the other hand the mean minimum temperature has a negative slope. The two graphs indicate a trend towards higher maximum temperatures and lower minimum temperatures.

RAINFALL (Figs 3 and 4)

Malta measurements of rainfall began in 1840. For only very brief periods during the past 150 years or so there is no acceptable record for the Valletta area (1840-1865). Hence the rainfall records for the Valletta region from 1865 to 1988 were analysed and the 10 year and 20 year running means for Valletta were plotted against the corresponding 10 and 20 year periods.

Again a negative gradient is evident for the rainfall records, thereby indicating a trend towards lower yearly rainfall totals for Malta.

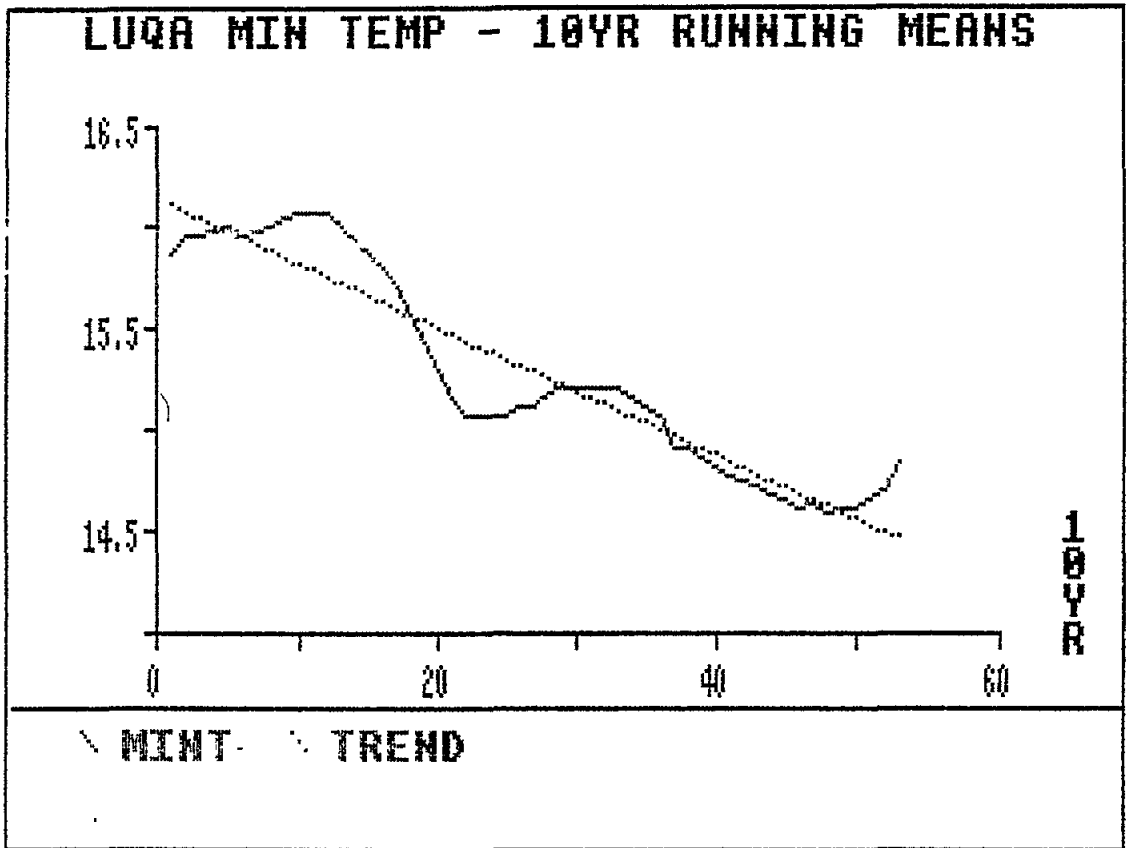


Fig. 1

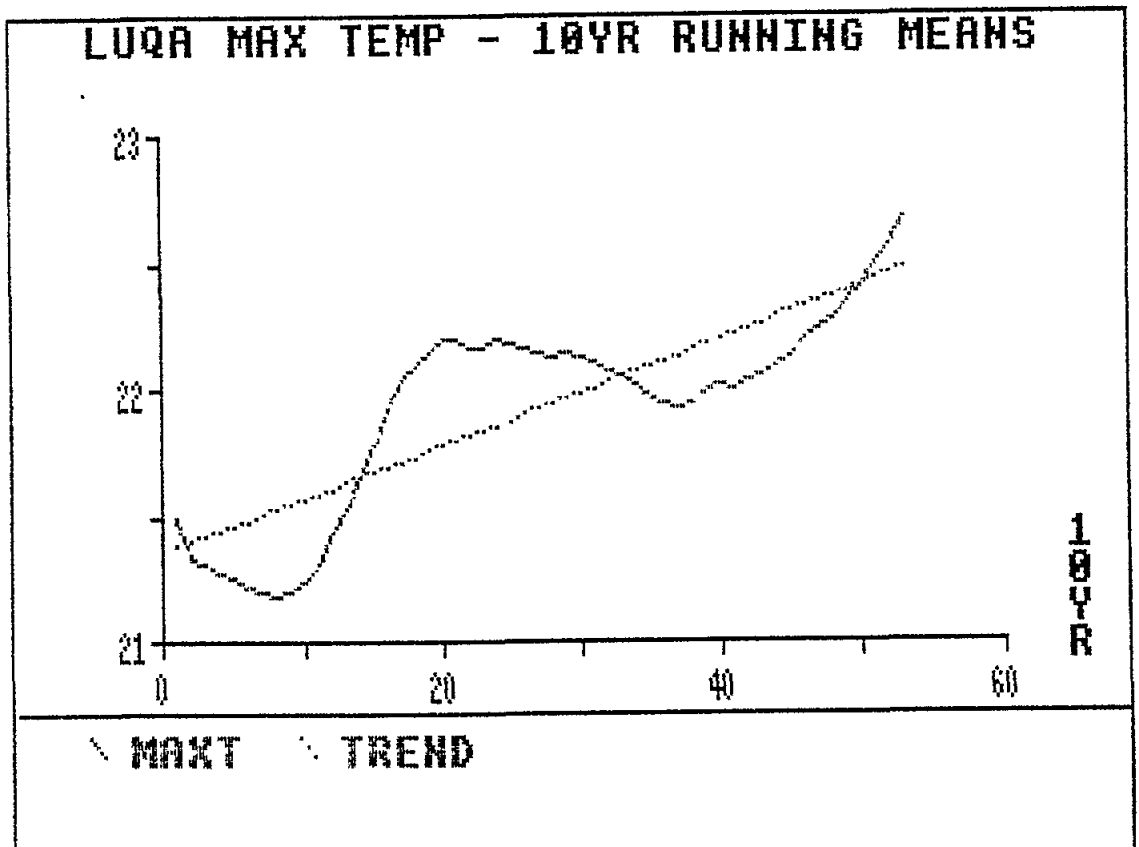


Fig. 2

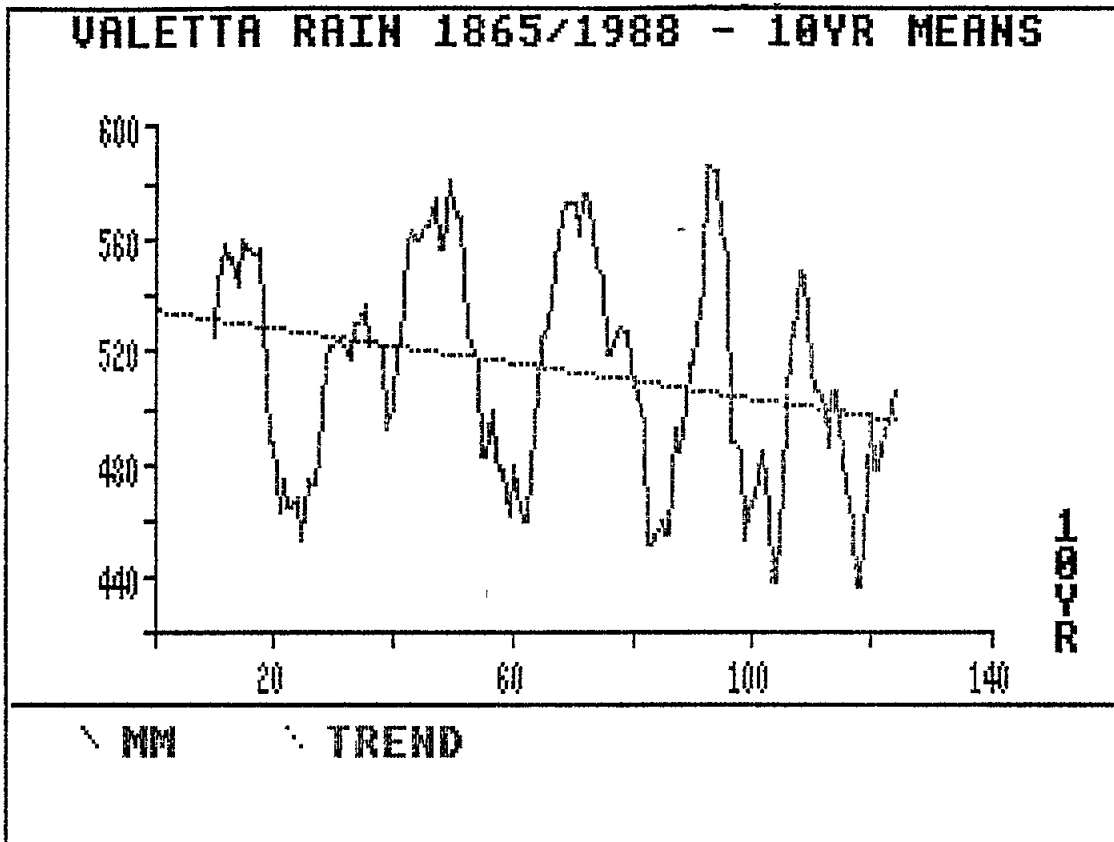


Fig. 3

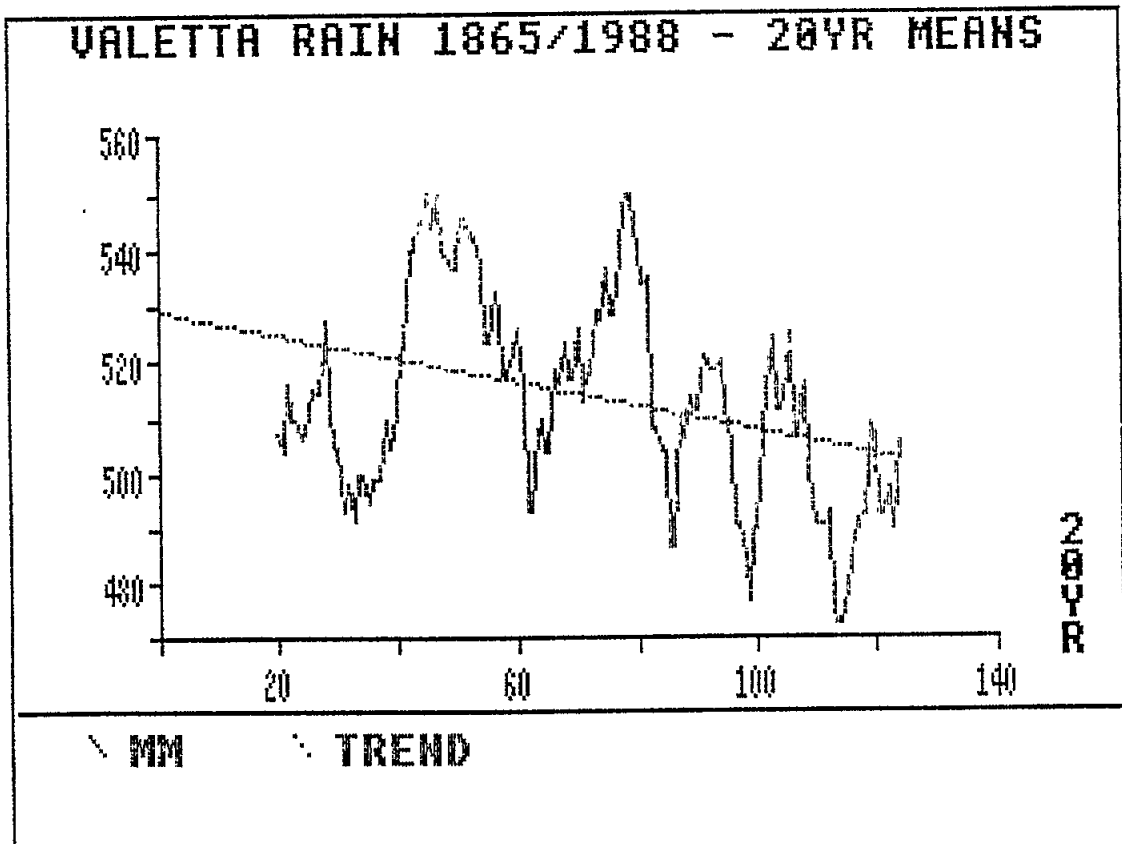


Fig. 4

ANNEX VI

BASIC FACTS ABOUT MALTA

The Maltese archipelago consists of the Islands of Malta, Gozo and Comino and two other uninhabited islands. This group is situated roughly in the centre of the Mediterranean Sea between 36E00'00" and 35E48'00" north latitude and 14E35'00" and 14E10'00" east longitude.

The distance between Malta and the nearest point in the south of Italy is 93 km and its distance from the nearest point in the north African mainland is 290 km. The total area of the Maltese islands is 315.6 square kilometers of which Malta, the largest, occupies 245.7 square kilometers and the second largest, Gozo occupies 67 square kilometers. At its longest, Malta extends to a maximum 27 km and it is 14.5 km at its widest.

The population of the Maltese Islands is about 350,000 persons. The population density works out to 1109 persons per square kilometer, making it the country with the second highest population in Europe after Gibraltar.

The climate of the Maltese islands is Mediterranean type with a mild, wet winter and a long dry summer. The seasonal rhythm is always clearly marked - a wet winter invariably followed by a long dry summer. Daily mean temperatures range from around 13E C in winter to 25E C in summer. The average daily sunshine hours range from 5.1 in December/January to 11.8 in July.

Since a large proportion of the potable water of the Islands is derived from rainfall, the rainfall pattern is very significant and rainfall records have been kept systematically for over one hundred years. The annual total averages about 550 millimeters. The rain season proper usually starts in earnest in October when rainfall is liable to be heavy. The bulk of the rainfall occurs between October and January.

There are no perennial surface streams in Malta. Water only flows along the bed of major valleys for a few days after heavy downpours. About 3% of total precipitation finds its way into the sea.

It is fortunate that the major surface drainage lines cross the entire width of the Island from their sources close to the western coast before entering the sea on the east. This gives the surface water maximum time to seep into the underground aquifers through the fissures and permeable rock formations.

A large number of dams have been constructed across these drainage lines, primarily to retard storm discharge and so serve the dual purpose of increasing percolation to the aquifers and retard the rate of soil erosion.

Field walls are also kept in good condition whenever possible to retard soil erosion. Roof catchments in towns and villages is mandatory by law. Every house built in town or village has to provide well-sealed cistern of 2 cubic feet capacity for every square foot of roof space of the house.

The Maltese Islands lie on the eastern edge of the north African continental shelf which extends from the Tunisian coast in the west to the Ionian Sea in the east and from the Libyan coast in the south to Sicily in the north.

There are two principal aquifers on the Maltese islands: Perched Aquifer and Mean Sea Level Aquifer.

The Perched Aquifer is situated in the porous upper coralline limestone which lies directly above the impermeable blue clay formation. No salt water intrusion in the aquifer south of the Victoria line is possible since it is everywhere located well above sea level. To the north of this line however, the aquifer is in many places in contact with the sea water and intrusion is a problem. Private extraction (by farmers) almost exploits this aquifer to the full, leaving only a small fraction for the public supply which come largely from gravity springs and underground galleries.

The Mean Sea Level Aquifer is the most important and accounts for about 50% of the total public freshwater supply. The aquifer lies in the pores and cracks of the globigerina and lower coralline limestone situated at an elevation around mean sea level. This freshwater body rests on a saturated zone but owes its existence to the fact that every winter the local rainfall adds more freshwater to the underground store than can be dissipated by direct discharge around the coast. There is no sharply defined plane of separation between the superficial freshwater and the saline water which is underneath. The equilibrium of this 'lens' is in state of flux depending on the fluctuations in rainfall, tides and other factors. Large areas in the central part of the island have a water table of 2-3.5 m above mean sea level under static conditions. Sea water intrusion into the Mean Sea Level Aquifer presents a permanent problem since rock permeability is mainly through fissures. A series of gauging boreholes scattered all over the aquifer are used to monitor the lens and adjust pumping rates to keep intrusion to a minimum.

ANNEX VII

OBJECTIVES, ASSUMPTIONS AND OUTPUTS OF THE STUDY

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 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.

ASSUMPTIONS

For the specific purpose of the study a sea level rise of 24-52 cm and a temperature elevation of 1.5 to 3 degrees Centigrade by the year 2050 will be used, taking into account:

- The best available information, knowledge and insights into the problems relevant to Malta including major projects, planned or under consideration;
- The assumptions accepted at the Second World Climate Conference (1990), i.e. an increased temperature of 2-5E C and sea level rise of 65 +/- 35 cm by the end of the 21st Century.
- The results of the University of East Anglia's Scenario analysis for the Mediterranean Basin with sub-regionally specific scenarios.

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 predicted consequences of expected climatic change.

ANNEX VIII

OUTLINE OF THE REPORT *

EXECUTIVE SUMMARY (D. Attard)

1. INTRODUCTION (D. Attard)

- 1.1. Background
- 1.2. Basic facts concerning Malta
- 1.3. Methodology and assumptions used in the study

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

- 2.1. Climate (J. Mifsud)
- 2.2. Lithosphere (J. Mifsud)
- 2.3. Hydrosphere (G. De Bono)
- 2.4. Atmosphere (J. Mifsud)
- 2.5. Natural ecosystems
 - 2.5.1. Terrestrial (J. Mifsud)
 - 2.5.2. Freshwater (to be nominated)
 - 2.5.3. Marine (to be nominated)
- 2.6. Managed ecosystems
 - 2.6.1. Agriculture (to be nominated)
 - 2.6.2. Fisheries (to be nominated)
 - 2.6.3. Aquaculture (to be nominated)
 - 2.6.4. Sylviculture (to be nominated)
- 2.7. Energy and industry (G. De Bono)
- 2.8. Tourism (S. Borg)

* Due to the need for additional expertise in the Task Team, the Co-ordinator will, in consultation with the Senior Marine Scientist of the Co-ordinating Unit, nominate additional Task Team members.

- 2.9. Transport and services (S. Borg)
- 2.10. Health and sanitation (R.E. Micallef)
- 2.11. Population and settlement pattern (R.E. Micallef)

- 3. SYNTHESIS OF FINDINGS (D. Attard/S. Scicluna)
 - 3.1. Present situation
 - 3.2. Major expected changes and their impacts

- 4. RECOMMENDATIONS FOR ACTION (D. Attard/S. Scicluna)
 - 4.1. Preventative policies and measures
 - 4.2. Adaptive policies and measures

References

ANNEX IX

WORKPLAN AND TIMETABLE *

- Nomination of the Co-ordinator of the Task Team July 1991
- Establishment of the Task Team September 1991
- First (preparatory) meeting of the Task Team November 1991
- Collection of data and relevant documentation by the members of the Task Team Dec. 91-Feb. 1992
- Analysis and evaluation of data and documentation collected by the Task Team Dec. 91-Feb. 1992
- Preparation of the first outline of individual substantive sections (chpt.2 of the outline) by the members of the Task Team, highlighting the main issues December 1991
- Second meeting of the Task Team to review the first outlines of substantive sections December 1991
- Preparation of extended versions of substantive sections by the members of the Task Team Dec. 91-Feb. 1992
- Submission of individual substantive sections by the Task Team members to the Co-ordinator February 1992
- Third meeting of the Task Team, with external participation, to review and revise the substantive sections of the report, and prepare the conclusions and recommendations April 1992
- Preparation of the final draft report, by the Co-ordinator of the Task Team May 1992
- Fourth meeting of the Task Team to finalize and adopt the report June 1992
- Publication of the report by the Co-ordinating Unit of the Mediterranean Action Plan July 1992
- Presentation of the report to the national and local authorities Oct./Nov. 1992

* 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.