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MEDITERRANEAN ACTION PLAN

Meeting on Implications of Climatic Changes on Mediterranean Coastal Areas (Island of Rhodes, Kastela Bay, Syrian Coast, Malta and Cres/Losinj Islands)

Valletta, 15-19 September 1992

REPORT

OF THE MEETING ON IMPLICATIONS OF CLIMATIC CHANGES ON MEDITERRANEAN COASTAL AREAS (ISLAND OF RHODES, KASTELA BAY, SYRIAN COAST, MALTA AND CRES/LOSINJ ISLANDS)

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BACKGROUND

As part of the efforts of the United Nations Environment Programme (UNEP) to analyse 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], 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 first site specific case studies had concentrated on low lying deltaic systems including these of the Ebro, Rhone, Po and Nile rivers. 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 these initial 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.

In order to consider the main findings, conclusions and recommendations of the Task Teams which dealt with five of these case studies, the present meeting of their representatives was organised in Malta by UNEP, Co-ordinating Unit for the Mediterranean Action Plan.

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

REPORT OF THE MEETING

Agenda item 1 - Opening of the Meeting

The meeting was opened by the Honourable Stanley Zammit, Parliamentary Secretary for the Environment, who thanked the United Nations Environment Programme (UNEP) for its initiative in assisting in the development of a case study of the implications of expected climatic changes on Malta and for organising this joint meeting of Task Teams from around the Mediterranean. In welcoming participants on behalf of the Government of Malta, the Honourable Secretary, made reference to the importance which his Government attaches to the various international initiatives concerned with addressing the issues of climate change and global warming. He further noted the importance of the present meeting in providing guidelines to Mediterranean Governments on the issues and actions necessary to mitigate the impacts of climate change. The full text of the speech of the Honourable Secretary is attached as Appendix I to this report.

Mr Salvino Busuttil, Co-ordinator of the Co-ordinating Unit for the Mediterranean Action Plan (MAP), welcomed participants on behalf of Mr Mostafa K. Tolba, Executive Director of UNEP. He thanked the Government of Malta and the Foundation for International Studies for their interest in, and support for the present meeting.

Mr Ljubomir Jeftic, Senior Marine Scientist in the Co-ordinating Unit for the Mediterranean Action Plan (MAP) and Co-ordinator for the Mediterranean Climate Impact Studies expressed his appreciation of the work of the Task Teams to date and to the Ministry of Foreign Affairs and the Foundation for International Studies for providing logistic and administrative support to the meeting.

Agenda item 2 - Organisation of the Meeting

The meeting unanimously elected Mr David Attard, as Chairman, Mr Ante Baric as Vice-Chairman, and Mr John Pernetta as Rapporteur of the meeting. Mr Jeftic acted as Technical Secretary of the meeting. The full list of participants appears as Annex I to this report.

In discussing the organisation of the meeting, the Chairman noted that this meeting co-incided with the initiation of a Programme for Climate Change Policy Studies at the Foundation for International Studies of the University of Malta and the decision of the University of Malta to launch an academic programme to provide the opportunity for research and training in the rapidly evolving sphere of climate change studies. The Chairman also referred to the remarkable speed with which the international community had responded to the threat of global climate change, particularly through the considerable collaborative work of the Intergovernmental Panel on Climate Change (IPCC).

Agenda item 3 - Adoption of the Agenda

The provisional agenda as proposed by the secretariat was adopted with minor amendments and appears as Annex II of this report.

Agenda item 4 - Scope and objectives of the meeting

In introducing this agenda item, Mr Jeftic noted that the work of the five Task Teams gathered at this meeting represented the third generation of studies in this important field. The initial studies had attempted a broad overview of potential impacts of climate change and sea level rise on the whole Mediterranean basin. The first site specific case studies had concentrated on low lying deltaic systems including those of the Ebro, Rhone, Po and Nile rivers. 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 Climate 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.

On the basis of these scenarios the present Task Teams had been asked:

- to identify and assess the implications of expected climate changes on the terrestrial, aquatic and marine ecosystems, populations, land and sea-use practices and other human activities;
- to determine areas or systems which appear to be most vulnerable to expected climate 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.

The present meeting therefore has as its primary goal the review and finalisation of the draft case study reports. In addition the meeting was convened to exchange ideas concerning important climate change impacts in the Mediterranean Basin and to decide on the way in which the work could be presented to government and other decision-makers.

Mr Jeftic introduced the working documents for the meeting, a list of which is attached as Annex III to this report.

Agenda item 5 - Regional changes in climate in the Mediterranean Basin due to Global Greenhouse Warming

In addressing this agenda item, Ms Jean Palutikof stressed that any regional scenario based on the output from General Circulation Models (GCMs) can be no better at predicting future climate change than the GCMs themselves. The problems of developing high resolution scenarios are in part related to the distribution of GCM grid points. Equilibrium response predictions for the grid points covering the Mediterranean basin from four GCMs (UK Meteorological Office, UKMO; Goddard Institute of Space Studies, GISS; Geophysical Fluid Dynamics Laboratory, GFDL; Oregon State University, OSU) were used by the Climatic Research Unit to develop composite GCM scenarios, since no one GCM was found to be consistently better than any other at simulating current climate.

The grid scale of the four GCMs, even after interpolation of model outputs onto a common grid of 5 E latitude by 10 E longitude, still leaves grid intersections separated by several hundreds of kilometers, a level of resolution inadequate for the case studies.

Through the use of statistical relationships between local and large-scale regionally averaged values of temperature and precipitation, various attempts have been made to develop high resolution scenarios of future climate changes due to the enhanced greenhouse effect. In the case of the Mediterranean Basin, data sets of monthly-mean temperature and total precipitation were compiled; anomalies calculated and regression equations constructed in which the independent variables were regionally-averaged climate anomalies, and the dependent variables were station temperature and precipitation anomalies. For each case study area annual and seasonal values for temperature and precipitation for the perturbed (2 x CO_2) and control (1 x CO_2) runs were obtained for each GCM. The differences between the perturbed and control run, standardized in the case of precipitation, were divided by the global mean equilibrium temperature change for each model, and the results averaged across the four GCMs to obtain a composite value. This composite value was then substituted in the regression equations to obtain a prediction for each station in each case study area (Annex IV). Maps of interpolated temperature and precipitation changes were then produced for each season and for the year as a whole.

Full details of the methodology used in developing the basin scale scenarios are contained in Palutikof et al., 1992 [2]. The model control run surface temperature and mean sea level pressure fields were validated against observations.

In general, temperature change due to the greenhouse effect for the Mediterranean Basin should be, in most areas of concern to the UNEP MAP teams, within ± 0.2 EC of the global response. Precipitation is shown to increase in autumn and winter, but decrease in spring and summer. However, confidence in the model scenarios of precipitation is low because of the uncertainty associated with the GCM results. Snow was not explicitely considered in these scenarios.

Considerable interest in the construction of the estimates was expressed by meeting participants who had found the results valuable in assessing impacts during the course of the case study work. Questions were raised concerning the method of presenting the scenarios as a function of the global equilibrium temperature change and Ms Palutikof stated that this mode of presentation enabled construction of scenarios for any stated degree of global change. This was important given the extent to which the prediction of changes in future climate were subject to constant revision. It was noted in this context that the 1992 IPCC report had reduced its 1990 scenario of temperature increase.

Agenda item 6 - Implications of climatic changes on the island of Rhodes

Following a detailed presentation of the results of this case study by the Co-ordinators and a member of the Task Team, considerable discussion took place covering matters of substance, and the conclusions of the report. The presentation included a video and a series of slides illustrating the wide variation and coastal morphology and habitats found around the island.

Several participants felt that they would have liked to see some further information concerning the marine environment, surrounding Rhodes. Questions were raised concerning the possible changes in local current system and other oceanographic characteristics around the island which might occur as a consequence of climatic changes. It was proposed that a map of the present oceanographic conditions be included in the final report.

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[2] J.P. Palutikof, X. Guo, T.M.L. Wigley and J.M. Gregory: Regional Changes in Climate in the Mediterranean Basin due to Global Greenhouse Gas Warming, UNEP, 1992.

Participants felt that if changes to patterns of upwelling and water movement in the Eastern Mediterranean basin were to change, this was likely to have important consequences for fisheries and marine ecosystems. The change in the heat budget of the Eastern Mediterranean basin might alter stratification and hence the movement of water masses around the island under enhanced temperature regimes. Such changes over a wider area needed to be analysed since their implications for the marine living resources around the island might be quite significant. It was noted that data concerning benthic communities surrounding Rhodes was lacking. The Co-ordinators stressed the point that marine ecosystems in Rhodes are of minor importance in comparison to the other systems examined. While the eventual changes in general oceanographic charasteristics of the north east Mediterranean have not been extensively studied, these will, in their opinion, have minor effects on the marine ecosystems of the island.

According to the report the rates of tectonic uplift observed in many parts of Rhodes (. 1 mm per year) "could easily compensate the expected sea level rise". Many participants felt that this was an overstatement and that, the expected increase in sea level could exceed that rate. It was noted that although the tide gauge data for the island may be extremely limited, they had not been included in the report.

Agenda item 7 - Implications of climatic changes on Kastela Bay

As in the case of Rhodes the case study of Kastela Bay elicited considerable discussion, particularly in relation to the potential changes to the marine environment. The Northern Adriatic influences, during certain seasons, the hydrographic, chemical and biological characteristics of the rest of the Adriatic. The hydrographic regime of the Northern Adriatic is itself influenced by freshwater inputs from the entire catchment of the Northern drainage basin, hence any changes to precipitation or ice melt in that area could potentially alter the oceanographic condition over the whole Adriatic. It would seem advisable to attempt to assess the possible consequences of such changes on the ocean conditions in the case study area. The Co-ordinator of the Kastela Bay Task Team noted that due to its semi-enclosed nature, the dominance of fresh water inputs and the general circulation pattern of the Adriatic, Kastela Bay was unlikely to be greatly influenced by oceanographic changes in the northern Adriatic.

As a consequence of the semi-enclosed status of Kastela Bay changes in stratification, particularly during the summer period under increased air temperatures, might be expected to occur although the extent of such changes was uncertain. Short and longer term wind driven, sea level oscillations and their impacts in terms of eventual flooding were difficult to assess and the impacts of changes in the temporal patterns of atmospheric pressure could potentially alter the vulnerability of low-lying areas to temporary or seasonal flooding. Some general information on residual currents in the Bay could be usefully added, together with further information on diurnal, lunar and seasonal current patterns.

It was noted that the implications of climate change and sea level rise on freshwater resources involved consideration of changes over a much wider geographic area than just the environs of Kastela Bay. Rainfall over the catchment feeding the coastal aquifer and the rivers passing through the area influences the available fresh water resources. Hence evaluating future changes to freshwater resources and inputs to the marine environment necessitates a detailed evaluation of precipitation changes over a very wide area.

It was further noted that a large number of recommendations for follow-up involved research, monitoring, and further study of various issues without justification directly related to the predicted climate change impacts. Whilst the need for additional data to reduce the uncertainties surrounding the magnitude of future impacts was recognised. Some participants felt that such recommendations were not appropriate for decision-makers and planners to whom the reports were primarily addressed.

Agenda item 8 - Implications of climatic changes on Malta

It was felt that further discussion of some items in the report was necessary and that other issues of importance should be concluded. In particular a lack of discussion of climatic factors of the Malta region in the context of the western Mediterranean depression and the winds for North Africa versus northern winds was noted. This will enable a more detailed assessment of the impacts of climate change in Malta beyond 2030.

The analysis of past trends in local meteorological variables contained in the report displayed some interesting patterns which stimulated discussion on the value of examining trends in means, extremes and frequency of episodic events.

During the discussions concerning the hydrography and the marine environment suggestions were made with a view to enhancing the report. These suggestions were to include hydrographic and bathymetric data, maps showing areas of coast with elevations below 1 m, and to concentrate to one single section the topographic and geological information currently found in different chapters of the report. An important element which needs further consideration concerns the nature and sources of beach sands. In view of the fact that no data were currently available it was considered necessary to collate additional information on physical oceanography that could be related to marine ecosystems on the one hand and to coastal dynamics on the other. This was also the case for marine living resources and the rates of exploitation. The difference in the reported thermo tolerance of *posidonia* in Malta and the northern Adriatic was noted, although an explanation is currently not available.

Given the prominent place afforded water resources in the report, considerable discussion of the complexities of this issue in Malta took place. It was recognised that apart from the negative socio-economic impact of a sea level rise on water resources, the increase in temperature could result directly in increased demand for domestic, industrial and agricultural purposes and that at the same time, it could result in water losses through enhanced evapotranspiration and wastage. As a consequence, drought conditions and water shortages could arise requiring action in the fields of resource development, conservation measures and drought management. These measures could only be effective when implemented through integrated planning and management.

Some concern was expressed about the contention that pests and pathogens would increase under scenarios of global change since it was felt by two participants that insufficient data existed to support the contention that this would prove a problem for Malta in the future.

Agenda item 9 - Implications of climatic changes on Cres/Losinj islands

Detailed presentation of the various sections of the report was accompanied by a wide selection of slides and centered around a cartographic presentation of site-specific impacts on the islands.

Some concern was expressed about the structure of this report in terms of its organisation into many sub-sections which resulted in information concerning the coastal zone being dispersed through several chapters and sub-chapters rather than being aggregated into a single substantive chapter.

A characteristic feature of the vegetation of the islands is the clear division between the evergreen forest cover of the south and the deciduous cover of the north. Increasing temperature may result in a northward shift of the boundary between these two forest types although from an economic stand point, this highly visible change may be of little importance.

The wider issue of changes in distribution of species as a consequence of shifts in climatic conditions was discussed *in extenso*. It was noted that species currently found in warmer, more southern latitudes might shift northwards, that the relative abundance of species and the composition of animal and plant communities was likely to change as a consequence of rising temperatures. At present the nature and extent of such changes is difficult to assess.

Question was raised on the suitability of polls done by sociologists with local population on their perception and awareness of possible implications of climatic changes. It was stressed that results of such polls could indicate the level of importance which the general public attaches to the problems of the implications of climatic changes. Consequently, such polls indicate how the general public will react in the case of the proposals for public expenditure in order to mitigate the impacts.

Agenda item 10 - Implications of climatic changes on the Syrian coast

Questions were raised concerning the state of coastal morphology, the stability of beaches and the sources of beach sand. It was noted that although most of the coast has high cliffs, other areas consist of low and narrow beaches and that low waves and micro-tidal conditions have encouraged the erection of summer houses and tourist resorts in close proximity to the waters edge.

Discussion of the problems of obtaining oceanographic data occured, and although the recent establishment of a marine research institution was noted, data were apparently lacking at the present time. The absence of any discussion of the implications of climatic change and sea level rise for health and sanitation was also noted.

It was further noted that throughout this report the extreme end of the range of sea level scenarios (1 m by 2100) had been used and it was suggested that consideration of the impacts of smaller increases in mean sea level over shorter time frames should be included for comparative purposes.

Agenda item 11 - General discussion and recommendations relevant to the Mediterranean

Mr Giuliano Sestini briefly discussed the methodology of the case studies, stressing the need to consider, first, the vulnerability of physical, biological and socio-economic systems and, second, the need to recommend action to government civil servants and decision-makers. Analysis of vulnerability is still hampered by lack of knowledge of the complex interrelated nature of the systems. With regard to sea level rise, for example, geologic, climatic and oceanographic factors must be taken into account. Yet, throughout the Mediterranean region, the economic impact of sea level rise would be considerable, due to the cost of repairing and raising coastal and harbour protection structures. Recommendations must take into account the need for sensible proposals within a realistic time framework, addressing problems which will only arise in several decades time. They should not neglect the low level of confidence that accompanies current models of climate change. Concrete action should only relate to activities that can be carried out during the next 10-20 years, ensuring preparedness in case the threats of climate change and sea level rise materialise later in the next century.

The presentation of each of the draft reports by the members of the individual Task Teams was followed by discussions during which comments, questions and suggestions for the improvement of the drafts were offered.

The following comments and suggestions are generally valid for all draft reports, though not to the same degree.

The descriptions of the present situation and past trends are generally too long, when compared with the space devoted to the assessment of the possible implications of the expected climate changes. Some parts of these descriptions are even irrelevant, since they are not used in analysing the possible impact of expected climate changes.

Most recommendations are formulated in a language that is not suitable for managers and policy-makers. They are either too general to form a basis for concrete action, or merely refer to the need for more data, research and observation as the solution to the problem. In most cases a credible justification for such a recommendation is lacking.

Almost all reports assume that the low-lying parts of the case study areas would be lost (flooded) with increasing mean sea level unless protected by engineering works. While this may be true for coastlines already modified by human activities (such as coastal settlements, harbours), shorelines consisting of, or fringed by sedimentary material (such as sandy beaches) may be more resistant to flooding due to the natural processes governing shoreline (beach) dynamics.

In order to evaluate the impacts of sea level rise on beaches, the behaviour of the beach in relation to seasonal wave action and storm surges must be assessed. The main parameters that need to be analysed are: wave direction and height, tidal range, width and thickness of the beach, the nature and source of the sands, land subsidence and uplift. Sand budgets relate to the input and loss of sand in relation to sea level and wave energy. If the budget is positive, beaches can withstand moderate rates of sea level rise, remaining stable or gradually retreating. If the budget is negative, beaches may disappear, and this could be the general case for beaches in small bays on rocky islands.

The automatic flooding of land as a consequence of sea level rise is an over simplification: flooding and/or coastal erosion generally occur in association with storm surges. Exceptional events can be particularly destructive and therefore data on the height and frequency of storm surges are required to evaluate the impacts of sea level rise.

While some of the reports were too "thin" on factual information (data), some others made an insufficient use of available data and statistics in developing conclusions about the possible impact of expected climate changes.

With the expected increase in the temperature of the marine environment in the study areas, a shift towards more thermophilic species could be expected in the composition of the ecosystems. Using information on the composition of marine ecosystems in areas of the Mediterranean which are warmer than those studied, should enable one to make some rough estimates of the expected changes in species distributions and abundance.

In order to allow for an easier comparison of the consequences which may be ascribed to climate changes, it was agreed from the outset that as assumptiopns for the changes in sea level, temperature and precipitation the figures derived from IPCC and the work carried out by the East Anglia University for three time horizons (years 2030, 2050, 2100) would be used. Reports which did not follow these "operative scenarios" should reconsider and revise their conclusions, if necessary. Details of the derivation of these scenarios and the values used in each case study are presented in Annex IV.

During discussion it was noted that the data and figures in both this and other reports required careful checking since a number of typographical errors had arisen due to the rapid production of the drafts for the meeting. It was agreed by all participants that maps for each case study with details of the off-shore bathymetry should be included in each report. Short summaries of the basic facts concerning each of the study areas are presented in Annex V.

Agenda item 12 - Conclusions

The case studies concluded that, at least before 2050, the perturbation of the mean climate as predicted by the UEA scenarios would have little effect. However, attention was drawn by a number of the groups to impacts due to potential changes in the frequency and severity of extreme events. It was concluded that, given the non-linear relationship between changes in the mean and changes in extreme events, more work is required in this area. The purpose of the work would be to investigate the behaviour of extreme events in a high greenhouse gas world.

Participants agreed that the work had been extremely valuable in bringing together experts from diverse disciplines to address a common problem within an integrated framework. The case studies have been successful in identifying problems which may arise under different scenarios of climate change, and in assessing their relative importance in the context of different time horizons. As such, the conclusions of the reports provide a sound basis for future planning and the development of appropriate policies and mitigative measures.

The need to ensure wide dissemination and implementation of the conclusions and recommendations via extensive distribution of a clear, concise executive summary, and via national and local seminars for planners, managers and decision-makers, was also agreed. The general conclusions and recommendations for action and those specific to each case study are detailed in Annex VI.

Agenda item 13 - Other business

Under this agenda item the method and workplan for production of the final reports was discussed. In introducing this item Mr Jeftic suggested that each Task Team undertake a final revision of the draft reports considered by the meeting. The Task Team co-ordinators shall submit to the Mediterranean Co-ordinating Unit final texts in hard and electronic copy by 1st of November 1992, and no later than 15 November 1992. Copies should be simultaneously submitted to the series editor, Mr J. Pernetta.

Task Team Co-ordinators were supplied with current electronic files on diskette for final editing. The electronic versions of the edited report must be submitted in IBM Dos compatible Word Perfect 5.1. All figures should be submitted as high quality camera ready originals. Where figures are submitted in a size larger than they will appear on publication, all lettering, legends, numbers and other written matter should be of sufficient size to be readable on reduction to A4.

Regarding the final form and structure of the report, it was agreed that:

- the section on lithosphere should contain a clear exposition on the physical features of the coastal zone, including processes such as subsidence and uplift, sand genesis and dynamics;

- the physical features of the marine environment should be treated if possible under the hydrosphere;

- the executive summary should be around 1% of the main text length and no longer than 2 to 3 pages;

- the conclusions and recommendations should be no longer than 5 pages and recommendations for action should be directly related to the identified impacts;

- references should be cited in accordance with the style adopted in the Cres/Losinj report (UNEP(OCA)/MED WG.55/5).

Agenda item 14 - Adoption of the report of the meeting

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

Agenda item 15 - Closure of the Meeting

Mr Busuttil welcomed the Honourable Deputy Prime Minister and Minister for Foreign Affairs, Mr Guido di Marco, on behalf of Mr Tolba, Executive Director of UNEP. He thanked the Deputy Prime Minister who had taken a time out of a busy schedule to address the meeting. The Deputy Prime Minister expressed his appreciation for the work of the Mediterranean Action Plan, and the five Task Teams in preparing the detailed impact assessments that had been the subject of discussion during the meeting. He referred to the fact that climate change was a common concern of humanity and that planning for a changed environment required close and continued cooperation between the countries of the Mediterranean basin. The full text of Minister's speech appears in Appendix II of this report.

Mr Jeftic expressed his satisfaction with the progress to date and with the results of the meeting. He thanked the Chairman, Vice-Chairman and Rapporteur; the Government of Malta and the Foundation for International Studies for technical and logistic assistance.

An exchange of courtesies followed after which the Chairman closed the meeting on 19th September 1992.

APPENDIX I

SPEECH BY THE HON. PARLIAMENTARY SECRETARY FOR THE ENVIRONMENT ON THE OCCASION OF THE OPENING OF THE MEETING OF THE "MEDITERRANEAN TASK TEAM ON CLIMATE CHANGE"

Your excellencies, Honourable Rector, distinguished delegates, it is a pleasure for me to be amongst you to open this meeting.

I must first and foremost congratulate the United Nations Environment Programme which through the Mediterranean Action Plan has promoted this study on the Implications of Climate Change in the Mediterranean. This study is an expression of co-operation amongst Mediterranean States and rightly so, because an appropriate conservation strategy cannot be restricted by national boundaries but should have as its objective the common good of the Mediterranean people.

It is difficult to picture a country more Mediterranean than Malta, placed as it is with uncanny precision in its centre. The Mediterranean Sea's concerns and interests are definitely our very own. Any change in the Mediterranean Climate must be a top priority on our agenda and it should prompt us to formulate the appropriate preventive and response strategies required to react to the implications of such change.

It is worth remembering Malta's initiative on Climate change, in 1988 before the United Nations General Assembly. Malta had expressed its concern at that time, about the inadequate consideration that was being given to the phenomenon of climate change, at the political level, despite the formidable work on the subject which was being carried out by numerous scientific bodies, within and outside the U.N. system. Malta then had insisted and it still does, that a comprehensive and effective global strategy requires the co-ordination of resources between scientists and policy makers alike.

Since that day there followed lengthy and arduous negotiations within the Intergovernmental Negotiating Committee leading to a Framework Convention on Climate Change. One could, perhaps, even complain now that there has been <u>too much</u> political consideration on the subject. This was inevitable within the international community but it has certainly been fruitful in promoting more scientific cooperation among states, coupled with a political determination to confront this phenomenon.

Since current International Environmental Law is still in its embryonic stage, its development is dependent to a large extent on the results of scientific assessments particularly when it comes to the special circumstances and characteristics of the various regions of the world. The Mediterranean Action Plan, established under the auspices of the United Nations Environment Programme, is a remarkable case in point. The scientific statements which direct the work of the Barcelona Convention and its Protocols in combatting pollution in the Mediterranean Sea, are an indispensable basis for this convention if it is to achieve its objectives.

In this context, the Mediterranean Action Plan's study on the probable impacts of Climate Change in the Mediterranean represents the realisation of Malta's work within the International Community. Malta and all the Mediterranean states will undoubtedly benefit immensely from the scientific results of this meeting, which I am very happy to be inaugurating today.

I am sure that the Maltese Government, will find your final report to be an essential set of guidelines upon which we should be able to formulate the required response strategies and policy to react to the possible adverse effects of Climate Change on Malta.

We consider climate change to be a matter of common concern to all humanity and it is therefore our responsibility to protect the Mediterranean for the sake of our people and our future generations. May the Mediterranean States take this opportunity to establish and renew bonds of friendship and cooperation. Irrespective of our political, social and religious diversity the Mediterranean Sea unites us all. We owe to this Sea our very existence, its protection signifies our safekeeping.

I wish you all a busy time which, I am sure, will be both interesting and fruitful.

APPENDIX II

SPEECH BY THE HON. DEPUTY PRIME MINISTER AND MINISTER FOR FOREIGN AFFAIRS ON THE OCCASION OF THE CLOSING OF THE MEETING OF THE "MEDITERRANEAN TASK TEAM ON CLIMATE CHANGE"

Mr Chairman, Distinguished Participants,

The Meeting on Implications of Climatic Changes on Mediterranean Coastal Areas is drawing to a close. For these last five days, you have combined your efforts to analyse and assess the implications of expected climate change on the Mediterranean - a subject which continues to intrigue both man in the street and scientific minds. Since the dawn of history, climate has played an important role in the shaping of oceans and continents, in nourishing and sustaining human life, in protecting and conserving the environment and in designing the pattern of socio-economic development. It is therefore of no surprise that any change in climatic conditions could disrupt and threaten not only the ecological balance but the accepted pattern of life itself.

Climate change as a result of global warming has increased worldwide concern and has prompted the international community to give more and more attention to this problem. The fact that action has been taken by UNEP to launch a study on climatic change in the Mediterranean should embolden the littoral States of this region to work together and in a joint effort develop response strategies to protect their own environment particularly from global warming.

The current Meeting must be viewed as the culmination of an important exercise in this direction. Once again, following in the footsteps of the Mediterranean Action Plan itself, representatives of Mediterranean countries have sat together, and have animated the proceedings of this Meeting by highlighting through statistical data the pros and cons of expected climate change; by presenting in a clear and impressive manner the findings of years of careful monitoring and observations of climatic conditions in diverse localities; by elucidating on those grey areas that perhaps continue to escape the intelligence of the human mind; by identifying possible preventive and adaptive policies and measures to combat major expected changes and their impacts.

The case studies submitted by the Task Teams involved in the exercise have been of a very high standard reflecting the dedication and the energy that have been spent in their preparation and compilation. The five site-specific case studies are a treasure of knowledge for scholars and students alike. They present a solid basis for further research and evaluation. I would like to congratulate you on your meticulous and articulated efforts. The assessment made of the possible consequences of climate change on the coastal and marine ecosystems, as well as on the socio-economic structures and activities in the Mediterranean region should provide the necessary inputs for future policy decisions. In this respect, and in the Maltese context, careful note has been taken of the impacts and the recommendations for actions adopted by the Meeting.

We are all aware that the Mediterranean continues to be an example of tremendous potential for research and development which could enhance stronger co-operation and understanding in many fields, particularly in the protection and conservation of the environment. The Mediterranean offers its people an array of opportunities that need to be fostered and encouraged. The Mediterranean Action Plan, as I have already stated, is a concrete illustration of the resolve of the Mediterranean countries to act together for the well-being of our people. Of course, there must be an appropriate environment - or should we say no drastic "change in climate" - in order that cooperation and development can be strengthened.

The five case studies, while dwelling in large part on the impacts of climatic changes predicted in the future, have as their ultimate objective the protection of our societies from a phenomenon where no boundaries exist. The socio-economic as well as the cultural impacts that possible changes in climatic conditions might have on the Mediterranean population are a matter that need constant and careful attention and monitoring. It is a daunting task and responsibility which requires not only a scientific assessment but also appropriate political, economic, social and cultural responses.

Human and financial resources are urgently required to address the problems that result from climate change. This is also true to implement the recommendations and response strategies identified during this Meeting. I believe that Mediterranean countries should make every effort to combine their resources, both human and financial, and all the scientific and technological knowledge available, to protect their environment.

Resolution 43/53 adopted three years ago by the U.N. General Assembly "convinced that climate change affects humanity as a whole and should be confronted within a global framework so as to take into account the vital interests of all mankind", recognised that "climate change is a common concern of mankind, since climate is an essential condition which sustains life on earth".

This recognition was further acknowledged by the historic first step taken at the United Nations Conference on Environment and Development held last June in Rio de Janeiro when over 150 States signed the Convention. It is now not only for Governments to act quickly to bring into force the Climate Convention but also to take steps to bring in line with what scientists are predicting by stabilising the gaseous composition of the atmosphere which if carbon emissions continue to remain unchecked will increase global warming.

The result of your endeavours goes a long way to address some of these issues. The critical importance of your recommendations lies in what further action the Contracting Parties to the Barcelona will take in the near future.

Economic activities of a country are intimately related to the climate. In the words of Professor Obasi, Secretary-General of the World Meteorological Organisation "the crops grown and the agricultural practices, the trees that flourish, the renewable energy potential and heating and cooling needs the water available and required earnings from tourism in recurrence in devastating floods and droughts and many of the diseases that occur are all affected by the climate". National activities are intimately linked with climate but so also are treating patterns into other countries in agriculture and other commodities.

The propitious predicted by the Intergovernmental patterns on Climate Change IPCC shows that the earth will be warmer by the year 2040, than at any time in the past 150,000 years.

Mahatma Gandhi, a sage for all countries, asked "how can we not be so violent with nature, when we are violent among ourselves ?" Events so close to us are a great reminder of their tragic situation.

We have to move however from a pessimistic approach to a new ethics in international behaviour although the realisation shows that "actions in one country which pollutes the atmosphere result in effects in other countries and over the whole globe."

We have only one sky. Let us protect the air which we all breath.

ANNEX I

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ANNEX II

AGENDA

1. Opening of the meeting
2. Organization of the meeting
3. Adoption of the agenda
4. Scope and objectives of the meeting
5. Regional changes in climate in the Mediterranean Basin due to Global Greenhouse Warming
6. Implications of climatic changes on the island of Rhodes
7. Implications of climatic changes on Kastela Bay
8. Implications of climatic changes on Malta
9. Implications of climatic changes on Cres/Losinj islands
10. Implications of climatic changes on the Syrian coast
11. General discussion and recommendations relevant to the Mediterranean
12. Conclusions
13. Other business
14. Adoption of the report of the meeting
15. Closure of the meeting

ANNEX III

LIST OF DOCUMENTS

UNEP(OCA)/MED WG.55/1	Provisional agenda
MAP Technical Reports No. 66	J.P. Palutikof, X. Guo, T.M.L. Wigley and J.M. Gregory: Regional changes in climate in the Mediterranean Basin due to global greenhouse gas warming, UNEP, Athens, 1992
UNEP(OCA)/MED WG.55/2	Implications of expected climatic changes on the island of Rhodes
UNEP(OCA)/MED WG.55/3	Implications of expected climatic changes on Malta
UNEP(OCA)/MED WG.55/4	Implications of expected climatic changes on Kastela Bay
UNEP(OCA)/MED WG.55/5	Implications of expected climatic changes on Cres/Losinj islands
UNEP(OCA)/MED WG.55/6	Implications of expected climatic changes on the Syrian coast
UNEP(OCA)/MED WG.55/7	Report of the Meeting
UNEP(OCA)/MED WG.55/Inf.1	Provisional list of documents
UNEP(OCA)/MED WG.55/Inf.2	Provisional list of participants

ANNEX IV

OPERATIVE SCENARIOS

The Climatic Research Unit of the University of East Anglia used the results from four General Circulation Models (complex three-dimensional models of the atmosphere) to create detailed Mediterranean scenarios of climate change due to the enhanced greenhouse effect. By harnessing the statistical relationship between regionally-averaged climate variables and point observations, scenarios were produced with a much higher spatial resolution than the underlying General Circulation Model output. The method is fully explained in the MAP Technical Report Series No. 66 (J.P. Palutikof, X. Guo, T.M.L. Wigley and J.M. Gregory, Regional Changes in Climate in the Mediterranean Basin due to Global Greenhouse Gas Warming, UNEP, Athens, 1992). Scenarios for both mean temperature and precipitation change, at the annual and seasonal level, were constructed for the five case study areas considered by this meeting (Island of Rhodes, Kastela Bay, Malta, Cres/Losinj islands, Syrian Coast).

The temperature and precipitation perturbations were expressed as the change per degree Celsius global temperature change due to the enhanced greenhouse effect. This has the advantage that it allows time-dependent scenarios to be constructed, in this case for 2030 and, with increasing uncertainty, for 2050 and 2100. The global temperature changes were taken, for 2030 and 2100, from the results of the International Panel for Climatic Changes (IPCC 1990) and, for 2050, from the UNEP Mediterranean Task Teams assumptions. The estimates of the two groups are entirely consistent. For 2030, the global temperature increase predicted by IPCC 90 is 1.8 EC. For 2050, the suggested increase is 2.25 EC (the average of the range + 1.5 EC to + 3 EC) and for 2100, 3.5 EC (the average of the range + 2 to + 5 EC). Table I shows global and regional (Mediterranean basin) changes in climate and sea level due to the enhanced greenhouse effect, predicted for three time horizons. Then, the local change (per degree Celsius global change) was multiplied by the expected global temperature change at each time horizon in order to produce the operative climate scenarios presented in each case study.

The scenarios of temperature and precipitation change for the five case study areas are shown in Tables II to VI. The smallest annual temperature change is indicated for Rhodes, 1.3 to 1.4 EC by 2030, and 2.5 to 2.8 EC by 2100. The greatest annual warming should occur over Cres island, 1.8 to 2.0 EC by 2030, and 3.5 to 3.9 EC by 2100.

An increase in annual precipitation is suggested for Rhodes and Kastela Bay. Lower annual precipitation is indicated for Syria, whereas for Malta and the Cres-Losinj islands the scenarios suggest little change. For precipitation, the annual change is less significant than the change between October and March since summer rainfall is, in many parts of the Mediterranean basin, negligible. It is encouraging that all the scenarios indicate an increase in precipitation in at least some months of the winter half year.

It is important to emphasise that these scenarios can only be taken as an indication of the range of possible changes that might occur as a result of enhanced greenhouse warming. Their accuracy is constrained by the reliability of the GCM results on which they are based. In particular, our confidence in the precipitation scenarios must be low because the spatial variability of precipitation is, in reality, much greater than can be resolved by the coarse grid of General Circulation Models. The value of high resolution regional scenarios is that they permit exploration of response and mitigation strategies to a plausible and internally-consistent climate future.

TABLE I

GLOBAL AND REGIONAL CLIMATE AND SEA LEVEL CHANGE DUE TO THE ENHANCED GREENHOUSE EFFECT FOR SPECIFIC TIME HORIZONS

SCENARIOS	TIME HORIZON		
	2030	2050	2100
IPCC 90 GLOBAL			
Temperature	+1.8 EC	-	+2 to +5 EC
Sea level	+ 18 cm ± 12 cm	-	+ 65 cm ± 35 cm
IPCC 90 Southern Europe			
Temperature	+2 EC winter +2 to + 3 EC summer	-	-
Precipitation	+ 0 to + 10% winter - 5 to + 15% summer	-	-
Soil moisture	- 15 to - 25% summer	-	-
Univ. East Anglia Med			
Precipitation	for each EC Global + 3% winter - 3% summer		
UNEP Task Teams			
Temperature	-	+ 1.5 to + 3 EC	-
Sea level	-	+ 38 ± 14 cm	-

TABLE II

SCENARIOS OF CLIMATE CHANGE FOR THE ISLAND OF RHODES

SCENARIOS	TIME HORIZON		
	2030	2050	2100
Univ. East Anglia for Rhodes			
Temperature			
Annual	+ 0.7 to + 0.8 EC		
Winter	+ 0.5 to + 0.8 EC		
Spring	+ 0.6 to + 0.8 EC	as for 2030	as for 2030
Summer	+ 1.0 to + 1.1 EC		
Autumn	+ 0.7 to + 0.8 EC		
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 EC	+ 1.6 to + 1.8 EC	+ 2.5 to + 2.8 EC
Winter	+ 0.9 to + 1.4 EC	+ 1.1 to + 1.8 EC	+ 1.8 to + 2.8 EC
Spring	+ 1.1 to + 1.4 EC	+ 1.4 to + 1.8 EC	+ 2.1 to + 2.8 EC
Summer	+ 1.8 to + 2.0 EC	+ 2.3 to + 2.5 EC	+ 3.5 to + 3.9 EC
Autumn	+ 1.3 to + 1.4 EC	+ 1.6 to + 1.8 EC	+ 2.5 to + 2.8 EC
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.

TABLE III

SCENARIOS OF CLIMATE CHANGE FOR KASTELA BAY

SCENARIOS	TIME HORIZON		
	2030	2050	2100
University of East Anglia for Kastela			
Temperature			
Annual	+ 0.8 to + 0.9 EC	as for 2030	as for 2030
Winter	+ 0.9 to + 1.0 EC		
Spring	+ 0.8 to + 0.9 EC		
Summer	+ 0.9 to + 1.0 EC		
Autumn	+ 0.8 to + 1.0 EC		
Precipitation			
Annual	+ 2%	as for 2030	as for 2030
Winter	+ 1 to + 2%		
Spring	+ 4 to + 6%		
Summer	+ 10%		
Autumn	- 2 to 0%		
Oper. Scenario for Kastela Bay			
Temperature			
Annual	+1.4 to +1.6 EC	+ 1.8 to + 2.0 EC	+ 2.8 to + 3.2 EC
Winter	+1.6 to +1.8 EC	+ 2.0 to + 2.3 EC	+ 3.2 to + 3.5 EC
Spring	+1.4 to +1.6 EC	+ 1.8 to + 2.0 EC	+ 2.8 to + 3.2 EC
Summer	+1.6 to +1.8 EC	+ 2.0 to + 2.3 EC	+ 3.2 to + 3.5 EC
Autumn	+1.4 to +1.8 EC	+ 1.8 to + 2.3 EC	+ 2.8 to + 3.5 EC
Sea level*	+ 18 ± 12 cm	+ 38 ± 14 cm	+ 65 ± 35 cm
Precipitation			
Annual	+ 3.6%	+ 4.5%	+ 7%
Winter	+ 1.8 to + 3.6%	+ 2.25 to + 4.5%	+ 3.5 to + 7%
Spring	+ 7.2 to + 10.8%	+ 9 to + 13.5%	+ 14 to + 21%
Summer	+ 18.0%	+ 22.5%	+ 35%
Autumn	- 3.6 to 0%	- 4.5 to 0%	- 7 to 0%

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

TABLE IV

SCENARIOS OF CLIMATE CHANGE FOR MALTA

SCENARIOS	TIME HORIZON		
	2030	2050	2100
Univ. East Anglia for Malta			
Temperature	for each EC Global + 0.8 to + 0.9 EC		
Precipitation*			
Annual	no change		
Winter	- 9%		
Spring	- 15 to - 12%	as for 2030	as for 2030
Summer	no prediction		
Autumn	+ 14%		
Operative Scenarios for Malta			
Temperature	+ 1.4 to + 1.6 EC	+ 1.8 to + 2.0 EC	+ 2.8 to + 3.2 EC
Sea level**	+ 18 ± 12 cm	+ 38 ± 14 cm	+ 65 ± 35 cm
Precipitation*			
Annual	no change	no change	no change
Winter	- 16.2%	- 20.3%	- 31.5%
Spring	- 27 to - 21.6%	- 33.8 to - 27%	- 52.5 to - 42%
Summer	no change	no change	no change
Autumn	+ 25.2%	+ 31.5%	+ 49%

* Percentage change in rainfall should be related to present values.

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

TABLE V

SCENARIOS OF CLIMATE CHANGE FOR CRES/LOSINJ

SCENARIOS	TIME HORIZON		
	2030	2050	2100
University of East Anglia for Cres/Losinj			
Temperature for Cres			
Annual	+ 1.0 to + 1.1 EC	as for 2030	as for 2030
Winter	+ 0.8 to + 1.0 EC		
Spring	+ 1.0 to + 1.1 EC		
Summer	+ 1.1 to + 1.3 EC		
Autumn	+ 1.1 to + 1.2 EC		
Temperature for Losinj			
Annual	+ 0.9 to + 1.0 EC	as for 2030	as for 2030
Winter	+ 0.8 to + 1.0 EC		
Spring	+ 1.0 to + 1.1 EC		
Summer	+ 1.0 to + 1.1 EC		
Autumn	+ 1.0 to + 1.1 EC		
Precipitation for Cres			
Annual	0 to + 3%	as for 2030	as for 2030
Winter	+ 3 to + 6%		
Spring	+ 4 to + 10%		
Summer	- 7 to - 4%		
Autumn	- 7 to 0%		
Precipitation for Losinj			
Annual	- 3 to 0%	as for 2030	as for 2030
Winter	+ 3 to + 6%		
Spring	- 1 to + 4%		
Summer	- 7 to - 4%		
Autumn	0 to + 4%		
Oper. Scenario for Cres/Losinj			
Temperature for Cres			
Annual	+ 1.8 to + 2.0 EC	+ 2.3 to + 2.5 EC	+ 3.5 to + 3.9 EC
Winter	+ 1.4 to + 1.8 EC	+ 1.8 to + 2.3 EC	+ 2.8 to + 3.5 EC
Spring	+ 1.8 to + 2.0 EC	+ 2.3 to + 2.5 EC	+ 3.5 to + 3.9 EC
Summer	+ 2.0 to + 2.3 EC	+ 2.5 to + 2.9 EC	+ 3.9 to + 4.6 EC
Autumn	+ 2.0 to + 2.2 EC	+ 2.5 to + 2.7 EC	+ 3.9 to + 4.2 EC
Temperature for Losinj			
Annual	+ 1.6 to + 1.8 EC	+ 2.0 to + 2.3 EC	+ 3.2 to + 3.5 EC
Winter	+ 1.4 to + 1.8 EC	+ 1.8 to + 2.3 EC	+ 2.8 to + 3.5 EC
Spring	+ 1.8 to + 2.0 EC	+ 2.3 to + 2.5 EC	+ 3.5 to + 3.9 EC
Summer	+ 1.8 to + 2.0 EC	+ 2.3 to + 2.5 EC	+ 3.5 to + 3.9 EC
Autumn	+ 1.8 to + 2.0 EC	+ 2.3 to + 2.5 EC	+ 3.5 to + 3.9 EC
Sea level*	+ 18 ± 12 cm	+ 38 ± 14 cm	+ 65 ± 35 cm
Precipitation for Cres			
Annual	0 to + 5.4%	+ 0 to + 6.8%	0 to + 10.5%
Winter	+ 5.4 to + 10.8%	+ 6.8 to + 13.5%	+ 10.5 to + 21%
Spring	+ 7.2 to + 18%	+ 9 to + 22.5%	+ 14 to + 35%
Summer	- 12.6 to - 7.2%	- 15.8 to - 9%	- 24.5 to - 14%
Autumn	- 12.6 to 0%	- 15.8 to 0%	- 24.5% to 0
Precipitation for Losinj			
Annual	- 5.4 to 0%	- 6.8 to 0%	- 10.5 to 0%
Winter	+ 5.4 to + 10.8%	+ 6.8 to + 13.5%	+ 10.5 to + 21%
Spring	- 1.8 to + 7.2%	- 2.3 to + 9%	- 3.5 to + 14%
Summer	- 12.6 to - 7.2%	- 15.8 to - 9%	- 24.5 to - 14%
Autumn	0 to + 7.2%	0 to + 9%	0 to + 24.5%

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

TABLE VI

SCENARIOS OF CLIMATE CHANGE FOR SYRIA

SCENARIOS	TIME HORIZON		
	2030	2050	2100
Univ. East Anglia for Syria			
Temperature (1)			
Annual	+ 0.8 to + 1.0 EC (2) + 1.0 to + 1.2 EC (3)	as for 2030	as for 2030
Winter	+ 1.0 to + 1.2 EC (2) + 1.0 to + 1.2 EC (3)		
Spring	+ 0.8 to + 1.0 EC (2) + 1.0 to + 1.2 EC (3)		
Summer	+ 1.1 to + 1.2 EC (2) + 1.2 to + 1.6 EC (3)		
Autumn	+ 1.0 to + 1.2 EC (2) + 1.2 to + 1.4 EC (3)		
Precipitation (4)			
Annual	- 2 to 0% (2) - 2 to 0% (3)	as for 2030	as for 2030
Winter	+ 2 to + 6% (2) 0 to + 2% (3)		
Spring	+ 4 to + 6% (2) 0 to + 2% (3)		
Summer	- 22 to 0% (2) - 22 to 0% (3)		
Autumn	- 18 to - 2% (2) - 18 to - 2% (3)		
Operative Scenarios for Syria			
Temperature (1)			
Annual	+ 1.4 to + 1.8 EC (2) + 1.8 to + 2.2 EC (3)	+ 1.8 to + 2.3 EC (2) + 2.3 to + 2.7 EC (3)	+ 2.8 to + 3.5 EC (2) + 3.5 to + 4.2 EC (3)
Winter	+ 1.8 to + 2.2 EC (2) + 1.8 to + 2.2 EC (3)	+ 2.3 to + 2.7 EC (2) + 2.3 to + 2.7 EC (3)	+ 3.5 to + 4.2 EC (2) + 3.5 to + 4.2 EC (3)
Spring	+ 1.4 to + 1.8 EC (2) + 1.8 to + 2.2 EC (3)	+ 1.8 to + 2.3 EC (2) + 2.3 to + 2.7 EC (3)	+ 2.8 to + 3.5 EC (2) + 3.5 to + 4.2 EC (3)
Summer	+ 2.0 to + 2.2 EC (2) + 2.2 to + 2.9 EC (3)	+ 2.5 to + 2.7 EC (2) + 2.7 to + 3.6 EC (3)	+ 3.9 to + 4.2 EC (2) + 4.2 to + 5.6 EC (3)
Autumn	+ 1.8 to + 2.2 EC (2) + 2.2 to + 2.5 EC (3)	+ 2.5 to + 2.7 EC (2) + 2.7 to + 3.2 EC (3)	+ 3.5 to + 4.2 EC (2) + 4.2 to + 4.9 EC (3)
Sea level*	+ 18 ± 12 cm	+ 38 ± 14 cm	+ 65 ± 35 cm
Precipitation(4)			
Annual	- 3.6 to 0% (2) - 3.6 to 0% (3)	- 4.5 to 0% (2) - 4.5 to 0% (3)	- 7 to 0% (2) - 7 to 0% (3)
Winter	+ 3.6 to + 10.8% (2) 0 to + 3.6% (3)	+ 4.5 to + 13.5% (2) 0 to + 4.5% (3)	+ 7 to + 21% (2) 0 to + 7% (3)
Spring	+ 7.2 to + 10.8% (2) 0 to + 3.6% (3)	+ 9 to + 13.5% (2) 0 to + 4.5% (3)	+ 14 to + 21% (2) 0 to + 7% (3)
Summer	- 39.6 to 0% (2) - 39.6 to 0% (3)	- 49.5 to 0% (2) - 49.5 to 0% (3)	- 77 to 0% (2) - 77 to 0% (3)
Autumn	- 32.4 to - 3.6% (2) - 32.4 to - 3.6% (3)	- 40.5 to - 4.5% (2) - 40.5 to - 4.5% (3)	- 63 to - 7% (2) - 63 to - 7% (3)

(1) Temperature change calculated from East Anglia scenario
(2) Coastal plain
(3) Mountains region
(4) Percentage change in rainfall should be related to present value
* Where local sea level data clearly indicate a trend these values should be adjusted accordingly.

ANNEX V

BASIC FACTS CONCERNING THE CASE STUDY AREAS

RHODES ISLAND

Rhodes island is situated at the SE corner of the Aegean Sea and is the capital of the Dodenanese Prefecture. It has an elongated shape with maximum length of 77 km, areal extent of 1400 km^2 and 221 km of coastline. It is a major tourist center (about 850 000 tourist visitors in 1990) with a current population of 110 000 inhabitants.

The climate of Rhodes is typical Mediterranean with one cold and rainy period (November to March) and one warm and dry (April to October). The island is however less warm in summer and less cold in winter than the other Aegean islands. Rainfall averages 714 mm/year, higher than other islands, while the winds are mainly from the NE and, to a lesser extent, from the SW.

The island is formed from a variety of rock types (limestones, conglomerates, sands, gravels) and is characterised by smooth relief bisected by a number of valleys running NW-SE. Two thirds of the coastal zone is quite wide (500 to 2500 m) especially where soft rock outcrops (alluvial gravels and sands). Many beaches in the NW part of the island experience high erosion rates while many landfalls and landslides occur in the nearshore zone. Tectonism is quite intense and along the eastern shore uplift of 1 mm per year has been noted. The island is affected by two different oceanographic regimes, one pelagic to the NW (Aegean) and one oceanic to the SE (Levantine), strong currents pass through the Rhodes-Asia Minor Strait and long shore currents affect both the eastern and western coasts, which are also subject to severe wave attack in the rather rare event of strong Etesian and other winds.

The water requirements of Rhodes are about 30 Mm^3/year, an amount which is constantly increasing due to the tourist demands. The total precipitation input on the island amounts to more than 160 Mm^3/year. The main sources of water are wells, springs and a dam, while the main aquifers lie in the alluvial deposits and the limestone karsts. Overpumping of the alluvial aquifer has resulted in its salinisation in many parts of the island, making adequate water supply more difficult. The terrestrial ecosystems on the island are forests and shrublands, that have been badly damaged by fires in recent years. A unique butterfly community resides at the so called "Petaludes Valley", where special temperature and humidity conditions seem to occur.

The economy of Rhodes is principally based on tourism, the services of which depends on islands beaches where a large number of hotels have been built. The other sectors of the economy are marginal compared to the tourist enterprise.

KASTELA BAY

The study area covers the Kastela Bay and neighbouring maritime areas including Brac and Split channels and coastal strip limited by slopes of the Kozjak mountain on the north, city of Trogir on the west, and the river Zrnovica.

The present population of the study area is 300,000 inhabitants, concentrated in the towns of Split (250,000), Solin (15,000), Trogir (10,000) and in smaller settlements, such as seven Kastelas.

The town of Split is the center of the Dalmatia region, and initial number of inhabitants increased five times in the last fifty years. The major activities are industry (shipbuilding, chemical industry, cement production, cloth-making and foodwear industry), building, commercial activities and transport. Tourism and agriculture are not major activities, although there are potentials for such development.

The intensive economic development and population growth have not been accompanied by adequate development of infrastructure, such as urban sanitation (sewage in particular), treatment and disposal of industrial wastes, surface transport system for goods and people. Therefore the conflicts in the Region among the environment and development are strong resulting in pollution and destruction of the environment.

MALTA

The Maltese islands have a total surface area of 316 km^2 with a population, concentrated mainly in the coastal areas, which at the end of 1991 stood at 359,455. The natural water resources of the Maltese islands depend entirely on the local hydrological cycle. The local catchment characteristics are favourable for the storage of rain water and 37 % (45,500 m^3/day) of all the potable water in the public supply and 84 % of irrigation water (17,300 m^3/day) is derived from underground aquifers. The rest of the water supply depends on desalinisation plants.

The major socio-economic activities are aquaculture and fisheries, tourism and industry, particularly the building sector and ship repair. A considerable part of the annual budget is devoted to education and public health facilities.

The Maltese islands support a diverse wild life. The natural vegetation is mostly garrigue, covering only about 21.3 percent of the islands, whilst 44.1 percent is cultivated. The coastal areas are environmentally very important because they support rare habitats. Although in the past Malta had forests, today less than 1 % of the Maltese islands are wooded. Maltese agriculture is geared to cope with water shortage but anthropogenic activities have contributed to soil erosion and to increasing aridity. The major current problems are the lack of water and continuous pressure on land as more green areas become built up. The coastal areas are also over-exploited and under threat.

CRES/LOSINJ ISLANDS

The Cres-Losinj islands consist of two medium-sized and several smaller islands (Cres (404 km^2), Losinj (75 km^2), Unije, Male and Vele Srakane, Susak, Ilovik, Zeca and Sv. Petar (total 34 km^2).

These islands make up the western part of the Kvarner island group with the highest peaks at Sis (638 m) on the island of Cres and Osorcica (588) on the island of Losinj.

The islands Cres and Losinj are about 100 km long with the long axis lying in a NW-SE direction. They lie some 5.5 km offshore from the mainland.

The coast is mostly rocky and steep, except at the southern end of Cres and inside larger bays.

The Cres-Losinj islands have a maritime climate with little diurnal and seasonal variation. The average temperature in the warmest month is 22 EC and in the coldest 6 EC at the north and 8 EC at the south part of the islands. The prevailing winds are bora (NE) and scirocco (SE).

The islands are covered with maquis vegetation on Cres, and Mediterranean pine woods on Losinj. Agricultural lands are limited.

The only fresh water resource is lake Vrana which has a maximum depth of 70 m and a surface area of 575 ha. The surface of the lake is 10 m above sea level. There are no permanent streams.

The marine environment around the Cres-Losinj islands is typically oligotropic. It is characterized by high salinity, surface temperature fluctuation, low primary productivity and wide variety of marine organisms. Small blue fish, white fish and scampi are the most important commercially exploited species.

There are 39 settlements in the islands, with 11 369 inhabitants. The total number of tourist beds is around 36000, while the annual number of tourists is 328 000.

SYRIAN COAST

1. The Syrian coastal region covers 2 % of the whole area of Syria equal to about 4190 km^2 with a total length of 183 km and accommodates 11 % of the country population.

The coastal region is well supplied with fresh water resources including rivers, springs and ground water. The most important activities in the coastal region are agriculture and tourism.

The state of the environment in the coastal region is affected by factors such as air, water and soil pollution, and by the aggregation of population in the main cities in the area.

Some of the current problems are:

a) sea pollution from the discharge of untreated sewage
b) soil pollution from the uncontrolled use of the fertilizers and pesticides.

ANNEX VI

CONCLUSIONS AND RECOMMENDATIONS

A. 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.

In order to maximise the gains from the 11 site-specific case studies carried out to date (Deltas of Po, Ebro, Nile, Rhone; Thermaikos Gulf, Bizerte/Ichkeul; Cres/Losinj islands, Malta, Kastela Bay, Rhodes island, Syrian coast), it is recommended that the Co-ordinating Unit of the Mediterranean Action Plan (MAP) should prepare: an in-depth analysis; a synthesis of main findings; conclusions and recommendations; and an evaluation of the effectiveness of the methodology used in the preparation of the studies as well as an assessment of the impacts of the studies on decision-making and planning. The results of this analysis, synthesis and evaluation should be brought to the attention of MAP Focal Points and used as appropriate in the preparation of additional site-specific case studies.

The quality of information on the past, present and expected trends in parameters indicating the rate of climate change depends on the availability of long time series of measurements and observations. Therefore, the Co-ordinating Unit of MAP should, in the framework of MAP's Co-ordinated Programme of Monitoring and Research of Pollution in the Mediterranean (MED POL), assemble available historic data on relevant parameters (such as sea level and sea temperature variations, changes in ecosystem composition) and include in the existing and new national MED POL monitoring programmes the systematic collection of such data, whenever possible.

The Coastal Areas Management Programme (CAMP) which is being launched with the support of MAP in Albania, Egypt, Algeria, Tunisia and Morocco, should include, from the outset, consideration of factors related to climate change.

B. THE MAJOR IMPACTS EXPECTED FROM THE PREDICTED CLIMATE CHANGE AND REMEDIES SUGGESTED TO COPE WITH THEM

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 E 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.

KASTELA BAY

a) The rise in mean sea level over the next century would cause gradual and permanent inundation of the Pantana spring as well as areas around the Zrnovica estuary. An increased frequency of episodic flooding of low-lying coastal areas up to 2 m altitude is likely to occur during the second half of the next century when the mean sea level is expected to exceed 50 cm.

b) Rising sea levels will result in intrusion of saline water into the estuaries of the rivers Jadro and Zrnovica and into ground water resulting in river flooding and changes to local ecosystems.

c) Even a small rise in the water table, and increased ground water salinity will have negative impacts on coastal services and infrastructure with associated maintenance costs, as well as causing accelerated deterioration of the valuable historical buildings.

ACTION: Take into account the findings of this study in on-going and future construction projects in the region (sewerage system construction, port reconstruction, etc); re-evaluate existing land use plans, zoning policies for building, sanitary and other regulatory codes and instruments, technical standards and recommendations involving coastal areas; revise major policies and programmes and analyse the economic costs and benefits of flood hazard mitigation measures.

d) The expected increase in temperature may increase domestic, industrial and agricultural water requirements and enhance aridity of the land.

ACTION: To reconsider energy and water demands and sources of supply, in the light of expected changes.

MALTA

a) No major impacts due to climate change are expected to occur by the year 2030. It is likely that Malta will face bigger environmental problems during the intervening period from intensive land use and increasing coastal zone use.

ACTION: It is strongly recommended that any local or national structure plans should take into consideration the possible impacts of climate change on the natural environment as well as on the socio-economic sector, so as to ensure that any future developments (including land and coastal use) will not increase the vulnerability to these impacts.

b) The potential future rise in mean sea level will increase the problems of water resources which are already under critical pressure.

ACTION: Assess in detail the impact of sea level rise and the local climate changes on the local aquifers. This study should be quantitative and be based on mathematical hydrological models calibrated for Malta. The study should also include economic aspects attributed to any changes in availability of water from the aquifers. It is further recommended that measures for water conservation be adopted.

c) Increased aridity leading to soil erosion and loss of fresh water habitats.

ACTION: Prevention of soil erosion by proper maintenance of existing dry stone walls and terrace systems and by planting suitable trees and plants to retain the soil.

d) Increase in potential risk for human health, livestock and crops from pathogens and pests.

ACTION: Assessment through further research of vulnerability of humans, lifestock and crops to future increases in pests and pathogens as well as on the consequences of climate change and the adoption and implementation of appropriate response strategies to mitigate anticipated impacts.

e) Possible changes in air circulation patterns which will adversely affect precipitation and other meteorological parameters.

ACTION: Seek through UNEP to obtain and implement a central Mediterranean, limited area Climate Model.

CRES/LOSINJ ISLANDS

a) Mean sea level rise of more than 50 cm (expected to happen during the second half of the next century) could lead to an increase in the salinity of Lake Vrana, presently the only source of fresh water on the islands.

ACTION: Trapping and storage of peak flows of karstic rivers over the Kvarner mainland and artificial recharge of the karstic underground aquifers during the prolonged summer dry season; or supply of additional quantities of drinking water from mainland in response to projected demands for fresh water.

b) Mean sea level rise of up to 30 cm (likely to occur towards the middle of the next century) is not expected to have a significant effect on coastal urban areas and constructions; mean sea-level rise of 1 m (not expected to be reached before the end of the next century) would inundate about 35 hectares of the economically or historically most important urban areas (about 600 buildings in 12 coastal settlements, many of them of great historic value, housing about 13 percent of the islands' present population) and some of the present tourist facilities.

ACTION: Elevation of coastal defense structures in order to protect valuable existing buildings and structures; during periodic revisions of physical and urban development plans, the expected impacts of climate change should be taken duly into account.

c) An increase of about 2 EC (may be expected by the year 2030) in the mean temperature would probably extend the tourist season from the present three to five months.

> **ACTION: The requirements of the extended tourist season should be examined in the light of their implications for demand on additional space and services.**

d) Any increase in the temperature, with the concomitant decrease in humidity, would lead to incurred risk from forest fires.

> **ACTION: Application of suitable protective measures against forest fires such as clearing of undergrowth, cutting of fire breaks.**

SYRIAN COAST

a) Gradual acceleration in the next century of soil erosion and general modification of vegetation cover due to increased aridity.

b) Increased salinisation (expected by 2030) of underground water due to increased evaporation during a longer dry season and to sea level rise.

c) Erosion of beaches and significant damage to coastal structures and human settlements close to the shore will occur as a consequence of exceptional storm surges even if mean sea level rise is only of the order of 10 cm.

> **ACTION: Problems of soil and coastal erosion and increased salinisation should be dealt with through integrated coastal zone management and planning. Such planning should include development of water management plans, monitoring programmes; and, establishment of a data bank on natural and cultivated vegetation.**