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IMPLICATIONS OF CLIMATIC CHANGES IN THE MEDITERRANEAN REGION

U N E P
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1. THE GREENHOUSE EFFECT

The greenhouse effect* is Man's most pressing environmental problem, one which presents major scientific challenges across 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 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.

The question of the probable climate warming in the next few decades is a question concerning both the world in general and the Mediterranean in particular. Unlike the ozone question which is relatively well defined and which has given rise to international agreements which are relatively precise and graduated in the short term, climate warming is more difficult to deal with. There are many causes at the root of the problem and CO_2 is not the only gas to be considered, even if at the present time it is responsible for over 50% of the greenhouse effect: other parameters must be taken into consideration, such as oceans, deforestation, methane, etc.

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

The concentration of carbon dioxide in the atmosphere increased from 270-290 ppmv to 356 ppmv between 1900 and 1985. A large part of this increase, and especially of the nitrous oxide and the chlorofluorocarbons, is to be attributed to industrial emissions.

2. THE GREENHOUSE EFFECT AND CLIMATIC CHANGES

2.1. Increase in temperature

There is a consensus in the scientific community that if allowed to continue to build up, a doubling of the greenhouse gases concentration (relative to the pre-industrial era) will occur sometime in the 21st century, possibly as early as 2030 AD. A corresponding global increase of temperature of between 1.5°-4°C is predicted, to become effective 2-3 decades later, in consideration of the lag in homogenization effect.

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* Carbon dioxide and the other gases (methane, nitrous oxide, ozone, chlorofluorocarbons) are essentially transparent to incoming short wave solar radiation, but they adsorb and emit long wave radiations and are thus able to trap the earths back radiation (the greenhouse effect).

Not since the dawn of civilization, 10,000 years ago, has the earth been 1^{o} warmer than it is today; temperature oscillations since 2000 years have been within 1^{o}C, although greater local or regional oscillations have been noted (e.g. the little ice Age). Only during the oscillations associated with Pleistocene glacial advance and retreat, did temperature vary by $\pm$ 5^{o}C. The predicted temperature change, therefore, would have profound effects on global ecosystems, water resources and agriculture.

The mode of climatic change and its impacts on environments and human activities have been discussed extensively in recent years, especially at the 1985 Villach Conference (UNEP/UNESCO/WMO) (Bolin et al, 1986) and at the 1987 European Workshop on Interrelated Bioclimatic and Land Use Changes in Nordwijkershout (Kwadijk and de Boois, 1989). A few theoretical models have been elaborated to predict the distribution of temperature and rainfall with $2xCO_2$.

Regional changes in all climatic variables will occur. So far General Circulation Models (GCMs) cannot simulate the regional details of today's climate reliably. Projections using these models therefore must be treated cautiously.

The impacts of any global-mean climatic change will depend on the regional details of changes in a wide variety of climate variables and in changes in the interannual variability of these variables. At present, these changes cannot be predicted. However, GCM results do give us data which can be used to develop scenarios of future changes. For the Mediterranean Basin, GCM results point to a warming similar in magnitude to the global-mean value, with no evidence for any marked seasonal differences. Although the magnitude of this warming is uncertain, we can be fairly confident that, as a prediction, it is qualitatively correct.

It may be many decades before the change can be statistically detected above the noise of natural regional-scale climatic variability, the existence of a background warming trend will still be of considerable importance. With time, the probability of periods of extreme warmth will increase; increased air temperatures will also lead to greater evapotranspiration.

2.2. Precipitation

Projected precipitation changes vary so much from model to model that one cannot say on the basis of model results alone whether precipitation will increase or decrease. Depending on location, model used and season considered, projected changes over the period between now and around 2050 range between $\pm$1mm/day, which is roughly the mean precipitation rate for the Mediterranean Basin as a whole. Such large changes are undoubtedly unrealistic and probably reflect model deficiencies. However, the possibility of substantial changes (up to $\pm$30% over the next 40-70 years) must be considered. These possibilities will certainly be amended by more detailed investigation using existing data and models. GCMs themselves are constantly being improved, and much better results can be expected to appear within the next 5-10 years (Wigley, 1989).

Cyclogenesis and rainfall are often promoted by land-sea temperature contrasts. Because land and sea have different effective thermal inertias, a large-scale warming could affect this contrast, possibly reducing it in winter months. This could in turn lead to reductions in rainfall and in storminess, particularly in the eastern Basin. On the other hand, warmer sea surface temperatures both in the Mediterranean and in the North Atlantic could lead to increases in atmospheric moisture and thus precipitation. In addition, since the monsoon circulation is expected to intensify, the number of extreme events resulting from the incursion of monsoon air masses may increase in the east. A more intense monsoon may also lead to increases in precipitation in the headwaters of the Nile, with important consequences for Egypt. The situation here, however, is unclear because the tropical easterly jet, which is an integral part of the monsoon system and which extends over the Nile headwaters area in summer, can also affect precipitation amounts and patterns. A northward movement of the easterly jet could reduce rainfall in Ethiopia and the Sudan.

Much of the Mediterranean region's precipitation is influenced by interactions between the large-scale flow and orography. Changes in the former are virtually certain, and a northward shift of the main upper westerly flow could reduce the length of the rainy season, particularly in the western and central parts of the Basin.

2.3. Sea level rise

Another main consequence of a warmer atmosphere is an accelerated rise of sea level, due to the melting of alpine and polar glaciers and to the thermal expansion of oceanic waters. Sea-level has been rising since the last glacial maximum (120m rise in last 16,000 years at rates as rapid as 8 to 12 mm/year). In recent historical times, the rate has been 0.5 to 1.5 mm/yr. Analysis of tide gauge data, the principal source of evidence for detecting relatively short-term sea level trends, suggest the world-wise rise has been about 10-15 cm in the past 100 years. In Holland the rise from 1870 to 1980 was 18-20 cm, accompanied by a 15-44 cm rise of high tide level (Hekstra, 1986). Discounting local subsidence and uplift, the average global rise has been calculated at 1.22 mm (0.9-1.4 mm) a year (Gornitz and Lebedeff, 1982); or 1.5 ± 0.3mm/year, between 1940 and 1975 (Emery, 1980). According to French National Geographic Institute data, from 1885 to 1979, there was a rise of 10 cm, with an acceleration between 1944-1955 and a decrease afterwards (Wigley, 1989a).

However, there are considerable difficulties in interpreting the tide gauge data on which the above estimates are based, particularly regional tectonics, local subsidence, variations in river discharge, etc. This uncertainty is consistent with our uncertainty regarding the causes of past sea level change. Thermal expansion of the oceans has probably caused a 2-5 cm rise and the melting of small mountain glaciers has probably added another 3-5 cm. The contribution from the large ice sheets of Greenland and Antarctica is unknown, possibly either increasing or decreasing sea level.

Depending on the extent of oceanic thermal expansion and (especially) the behaviour of the polar ice caps (Greenland of the western Antarctic ice shelf), conservative to moderate estimates of sea level rise range 13-39 cm (by 2025), 24-52 cm (by 2050) and 38-91 cm (by 2075) (Hoffman, 1984; Robin, 1986). The Villach 1985 Conference (Bolin et al., 1986) concluded that a global warming of 1.5°-4.5° would lead to a sea-level rise of 20 to 140 cm. Future sea level rises have been estimated at the UNEP Meeting in Norwich, September 1987. The best estimate of change between 1985 and 2030 is 14-22 cm, the approximate rise of sea level over the past 100 years.

There will be a significant lag in sea level rise, however coupled with oceanic thermal inertia. For example, if greenhouse gas concentrations stopped increasing in the year 2030, warming would continue for many decades. Since the glacial melting and thermal expansion of the oceans would continue, so would sea level rise.

Superimposed on sea level rise will be the effects of local tectonic and sediment compaction. Vertical earth movements in the Mediterranean commonly occur at a rate of 1-5 mm/year averaged over thousands of years, and 3-20 mm/year averaged over 15-20 years. Local subsidence can exceed 5 mm/yr. It follows that in the future the economic cost of protecting or abandoning structures or land on the Mediterranean coast will depend strongly upon the local land movement coupled with sea level rise. Where land is subsiding, the net relative change could be much more than the global eustatic rise of sea level; where land is rising, the relative change will be significantly reduced.

3. SOME GLOBAL ACTIONS CONCERNING GREENHOUSE EFFECT

Recognizing that a global climate change will result from increases in the concentration of greenhouse gases from human activities, UNEP, at the Fourteenth and Fifteenth Sessions of the Governing Council adopted the decision concerning global climate change (Annex I to this document);

UNEP developed a comprehensive programme of actions concerning the analysis of expected climatic changes and their impact on ecosystems and socio-economic structures and activities, as well as on the development of policy options and the formulation of management measures which would totally or partially counter the negative consequences of expected climatic changes.

An Intergovernmental Panel on Climate Change (IPCC) was established by UNEP and WMO in November 1988. The work of IPCC (assessment of all scientific information on climate change, assessment of the latter's environmental and socio-economic impact and response strategies to cope with climate change) will be the basis for the drafting of a comprehensive report; this report is expected to be discussed in the framework of international negotiations to lead, it is hoped, to the drafting of a global convention on climate change (see Annex I).

The Second session of the IPCC (Nairobi, June 1989) concluded that a comprehensive report will be ready by September 1990 on the basis of which appropriate action on climate change can be taken (see Annex I).

In March 1989, representatives of 24 governments (among them the Mediterranean countries Egypt, France, Italy, Malta, Spain and Tunisia) adopted The Hague declaration which calls for tough measures to combat both ozone layer destruction and global warming (Annex II to this document).

On 26 May 1989, the European Parliament passed a resolution on the consequences of a rapid rise in the sea level along the coastline of Europe; it contains both general and specific measures to be taken against sea level rise (Annex III to this document).

4. ACTIONS BY THE REGIONAL SEAS PROGRAMME OF UNEP CONCERNING GREENHOUSE EFFECT

The environmental problems associated with the potential impact of expected climate changes may prove to be among the major environmental problems facing the marine environment and adjacent coastal areas in the near future. Therefore, in line with the Decision of the Fourteenth Session of the UNEP Governing Council on "Global climate change" (Annex I to this document), the Oceans and Coastal Areas Programme Activity Centre (OCA/PAC) of UNEP launched and supported a number of activities designed to assess the potential impact of climate changes and to assist the Governments in identification and implementation of suitable response measures which may mitigate the negative consequences of the impact.

In 1987, Task Teams on Implications of Climate Change were established for six regions covered by the UNEP Regional Seas Programme (Mediterranean, Wider Caribbean, South Pacific, East Asian Seas, South Asian Seas and South-East Pacific).

The initial objective of the Task Teams was to prepare regional overviews and site specific case studies on the possible impact of predicted climate changes on the ecological systems, as well as on the socio-economic structures and activities of their respective regions. The overviews and case studies were expected:

- to examine the possible effects of the sea level changes on the coastal ecosystems (deltas, estuaries, wetlands, coastal plains, coral reefs, mangroves, lagoons, etc.);

- to examine the possible effects of temperature elevations on the terrestrial and aquatic ecosystems, including the possible effects on economically important species;

- to examine the possible effects of climatic, physiographic and ecological changes on the socio-economic structures and activities; and

- to determine areas or systems which appear to be most vulnerable to the above changes.

The regional studies were intended to cover the marine environment and adjacent coastal areas influenced by or influencing the marine environment.

The regional studies prepared by the Task Teams were planned to be presented to the intergovernmental meetings convened in the framework of the relevant Regional Seas Action Plans in order to draw the countries' attention to the problems associated with expected climate change and to prompt their involvement in development of policy options and response measures suitable for their region.

The site specific case studies developed by the Task Teams were planned to be presented to national seminars.

Once the initial objective of the Task Teams (impact studies) is achieved, they concentrate on providing assistance to national authorities in defining specific policy options and suitable response measures.

The initial objectives of the Mediterranean, Caribbean and the South Pacific Task Teams have been achieved and were reviewed by a meeting of the representatives of the Task Teams (Split, 3-8 October 1988) (UNEP, 1988). The work of the other three Task Teams, as well as that of the newly established Task Teams for the West and Central African region and for the Eastern African region, is in progress.

The draft texts of the regional studies (overviews) of the Task Teams were already examined by meetings convened under the Mediterranean, Caribbean, South Pacific, South-East Pacific and East Asian Seas Action Plans.

A special intergovernmental meeting was convened in July 1989 in the Marshall islands for the 19 island States of the South Pacific to consider their policy options, suitable response mechanisms and additional site specific case studies to be developed (STC/UNEP/ASPEI, 1989).

A detailed case study on the Maldives was prepared with the assistance of the South Pacific and Mediterranean Task Teams and will probably lead to a large-scale country project (UNEP, 1989a).

A review on the interaction of the oceans with greenhouse gases and atmospheric aerosols on a global scale which was based on the work carried out by a GESAMP working group was published (GESAMP, 1980; GESAMP, 1985) .

Two site specific case studies (Delta of Nile and Delta of Po) were presented at national seminars (December 1988 and June 1989). Two additional seminars are planned for 1989 (Delta of Ebro and Thermaikos Gulf), and two for the beginning of 1990 (Delta of Rhone and Ichkeul/Bizerte lakes).

An overview of the implications of expected climate changes in the Mediterranean region was published by UNEP (UNEP, 1989b and UNEP, 1989c).

A popular booklet High and Dry, Mediterranean Climate in the Twenty-first Century was also published (UNEP, 1989d).

A bibliography on the effects of climatic change and related topics, including about 1500 references was prepared and published by the Mediterranean Unit (UNEP, 1989e).

The development of climate scenarios for the Mediterranean region is in progress. They are planned to be completed in 1990 and to be used in connection with the revision of the Mediterranean regional study.

5. IMPLICATIONS OF CLIMATIC CHANGES IN THE MEDITERRANEAN REGION

Many important economic and social decisions being made today (such as water resources management, coastal engineering projects, urban, communications and energy planning, nature conservation) are based on the assumption that past climatic data provide a reliable guide to the future. This is no longer a safe assumption. Climatic changes must be taken into consideration in view of the current population explosion, increasing use of coastal areas (tourism, agriculture, fishing, harbours, industries), and the limited resources of the Mediterranean countries, especially in regard to water, soil and fisheries.

The Task Team on Implications of Climatic Changes in the Mediterranean region was established in mid-1987 with the aim of preparing a Mediterranean regional overview of the implications of climatic changes for coastal, terrestrial and aquatic ecosystems, as well as for socio-economic structures and activities. The aim of the Task Team was to use all relevant information available, including Blue Plan, Priority Actions Programme and MED POL data. The Task Team also aimed at identifying the geographical areas which appear to be most vulnerable to climatic changes.

The Task Team met twice (Geneva, 11-13 May 1987, Haarlem, 21-22 October 1987) and identified 9 topics for regional studies and 6 geographical areas for case studies (deltas of rivers Ebro, Rhone, Po and Nile, Thermaikos Gulf and Lake Bizerte/Ichkeul). Also, the Task Team agreed that a bibliography of papers dealing with climatic changes and its implications should be prepared.

The Mediterranean Task Team presented its results at the Joint Meeting of the Task Team on Implications of Climatic Changes in the Mediterranean and the Co-ordinators of the Task Teams for the Caribbean, South-East Pacific, South Pacific, East Asian Seas and South Asian Seas Regions (Split, 3-8 October 1988) at which 17 papers concerning the Mediterranean were presented (UNEP, 1988). The list of papers presented at the Split Meeting is included in Annex IV to this document.

On the basis of the papers presented and other available information, an overview of the implications of expected climatic changes in the Mediterranean region was prepared and published (UNEP, 1989b and UNEP, 1989c).

6. EVALUATION OF THE IMPACTS OF CLIMATE CHANGE ON THE MEDITERRANEAN COASTAL ENVIRONMENT (UNEP, 1989b and 1989c)

6.1. Impacts on marine parameters

To understand the Mediterranean response to predicted climatic changes it is necessary to understand both forcing functions and responses over the entire subtidal frequency range. The forcing variable at shorter time scales, like atmospheric pressure and wind variations, will be influenced by changes in climate. The likely general northward shift of the atmospheric circulation pattern will influence the path and frequency of passage of midlatitude cyclones over some parts of the Mediterranean area and various marine parameters will also be affected (Gacic et al., 1989).

The horizontal density gradient set up by evaporation is an important source of the large scale wintertime circulation. On the other hand, transients in the residual circulation are also strongly affected by local winds. Therefore, any appreciable change in the seasonal distribution of the winds frequency will result in changes of the volume of the formed deep water as well as in changes of the circulation pattern of parts of the Mediterranean (e.g. northern Adriatic).

The wind affects not only the sea level changes but also is very important in generating the vertical convection and deep water formation processes. The sea level slope between connected basins, which dictates water exchange between them, is not due exclusively to differences in the atmospheric pressure between the two areas. Therefore, studies of the sea level response to the atmospheric forcing are rather important from the point of view of the barotropic water exchange between connected basins.

The impact of large scale climatic variations of the order of a few years, probably will not be restricted to the observed salinity and sea level changes, but will influence also other parameters such as horizontal density gradients, evaporation rates etc., and therefore general circulation, production rates of deep and intermediate waters, etc.

In the shallower areas, temperature rise might establish stratification of the seawater masses, especially during the summer months, which will affect the sediment depositional regime in and out of the bays, causing blocking of navigation channels. Stratification would negatively effect the primary producers of the eutrophic zone, which initially might benefit from the warmer environment but will be adversely affected by oxygen depletion. High summer temperatures might lead to frequent anaerobic conditions in the polluted embayments (e.g. Thessaloniki, Abuqir, Izmir bays).

6.2. Impacts on the coastal zone

A significant rise of sea-level, coupled with storm surges and high tidal ranges, would cause the retreat of beaches and possibly the transformation of some lagoons into bays, the flooding of reclaimed lands, salt wedges to move farther inland in rivers, as well as direct damage to harbours, towns and roads. The impact analysis of these effects is complicated, however, by the growing anthropic interference with natural environments and the enormously accrued economic value of the coastal regions.

Deltaic coasts that are shaped by marine processes have the capacity to reform themselves after major storms, and to rise gradually in phase with the average rise of sea level. This response, however, is sharply curtailed if the tributary river(s) is/are dammed and/or diverted. The stretches of the shore that are already unstable or retreating, will be even more so in 2025.

As the level of the sea rises, a normal beach and barrier island would be expected to migrate gradually inland (Brunn and Schwartz, 1985). Actual examples of this recession are available from the upper Adriatic and the Nile delta coasts (Sestini, 1989 and 1989a).

In terms of physical impacts, increases of more than 30 cm should be considered to be moderate, because they could be coped with by gradual adjustments to existing coastal defenses and by acceptance of modest losses. Higher water levels in the lagoons and the flooding of estuaries and canals, especially if associated with land subsidence (e.g. Romagna, Italy) would continue. The beaches in most countries will continue to retreat, in spite, and (in some cases) because of defence structures. Greater increases (more than 50 cm), however, at least locally would have catastrophic consequences, involving hard economic decisions about the cost of coastal protection and political decisions about what to protect and what to abandon.

Main concerns would be wave attack on harbour structures, the retreat of the headlands, the flooding of the residential and industrial quarters and the management of the lagoons.

6.3. Impacts on rainfall and water resources

As regards rainfall, the most important climatic change would be the northward shift of winter cyclonic patterns affecting the western and central Mediterranean in winter. There might be a deceleration of cyclonic activity and more erratic rainfall, drier summers, higher evapo-transpiration rates. Air circulation to the mountain masses would, in principle, remain the same, i.e. greater rainfall would characterize, the western Pyrenees, the Eastern Alps, the western Balkan mountains, the mountains of the Near East. The areas of lesser reliable rainfall (presently Africa, Sicily, south Spain, interior Turkey) might increase and shift northward. Overall, rainfall is expected to decrease in the south (Wigley, 1989).

Precipitation and evaporation over the Alps are not expected to change, but larger areas will be frost-free in winter and less water will be stored as snow. This would lead to retreat of the snow-line (upslope by ca. 500m); the disappearance of the eastern alpine glaciers, and a 70-80% reduction of the western glaciers.

Lesser and more erratic precipitation would cause reduced groundwater recharge (also due to lower percolation rates) and therefore lesser groundwater levels and spring discharge. Decreased percolation would result in greater flood risks as well as higher sediment loads. There would be greater sedimentation in channels, with possible increase of braided versus meandering streams. The lifetime of reservoirs will be reduced. The cost of maintaining a sufficient amount of good quality drinking water will increase, because of salinization and waterborne environmental risks (pollution, diseases).

Actual evapo-transpiration in the region will increase by around 10% when mean air temperature rises by 1.5°C. This will result in, at least, a 10% decline in riverflow and a corresponding increase in freshwater salinities. Potential evapo-transpiration and open water evaporation will rise by at least 10%. Despite an increased need for irrigation water, the average storage in the reservoirs will fall by up to 25% due to decreased river flow and precipitation and increased evapotranspiration; reservoirs will be nearly empty up to 19% of the time. An expected 25% filling of the reservoirs with sediment will seriously increase the water supply problems, with mean storage falling to around 60% of the projected levels under present conditions.

Climatic zones may shift northward thus increasing the length of summer at the expense of the other seasons. Increased variability and patchiness of the rainfall might extend summer aridity. Scattered rainfall may totally disappear during the warm season and might be transferred to winter. Reduction of rainfall during the hot summer period might cause deficiency in soil moisture, thus degrading soil structure and agricultural fertility. Moreover, the reduced run-off could cause seasonal salt-accumulation in the top soil of several reclaimed lowlands.

6.4. Impacts on Soils

There is a great diversity of soil types in the Mediterranean region, reflecting differences in the major soil-forming factors, one of which is climate. Some soil parameters are particularly sensitive to temperature and rainfall changes, e.g. soil composition and salt balance, chemical processes and the supply and breakdown of organic matter. The expected climatic changes should not result in a major shift in the boundaries of the main soil types (Imeson and Immer, 1989).

Evapo-transpiration and any decreases in the rainfall duration and intensity would increase salt accumulation. This would particularly affect areas where annual rainfall is less than 600 mm. Areas with salt and sodic conditions will expand, because of greater evaporation, decreased water precipitation and runoff, resulting in the slaking and dispersion of the soil surface.

The impact of climatic change on land degradation in the Mediterranean region will be most serious in areas where soils have an inherently high erodibility, in regions already under environmental stress and in drier regions. Forested areas will also be adversely affected by the increased frequency of fire. Direct impacts on degradation resulting from changes in the magnitude and distribution of precipitation could be extremely important but no information is available concerning precipitation changes. An increased temperature, by influencing the mineralization of organic matter and the form of organic soil material, the water balance, the salt balance and the soil temperature will impart to the soil an increased susceptibility to physical degradation. Special attention is given to the effect of organic matter on soil stability and infiltration in areas having silty and sandy soils. Poor physical properties are likely to be caused by increased areas affected by clay dispersion. Gully erosion and piping could spread into areas that develop slightly drier conditions as a result of quantitatively small changes in the chemical composition of the soils (Imeson and Immer, 1989).

To assess the impact of climatic change, relationships should be established between climatic parameters and "climate sensitive" processes. Threshold conditions should be identified by laboratory experiments and by field investigation along climatic gradients. The "site specific" impact of climatic change will determine the exact effects of degradation and erosion. Local studies will have to be made to establish exactly how site specific factors determine the impact of general trends.

6.5. Impacts on ecosystems

Aquatic ecology is likely to be affected profoundly by temperature rise. Shallow onshore marine areas would become warmer, and more saline, locally hypersaline. In the ocean a $2^{\circ}C$ rise in air temperature would result in a water temperature rise of $0.8^{\circ}C$-1.5° down to 200 m between Lat. $30^{\circ}N$ and $30^{\circ}S$; surface currents would change over large parts of the oceans, possibly also in the Mediterranean. Conditions of fish stock and other biological parameters would be dramatically altered. In some areas even a $1^{\circ}C$ rise might have a marked adverse effect on fish life because of changes of oxygen concentration and changed water chemistry.

Aquatic species have different temperature tolerance and thus assemblages could change in consequence of removal of competition. Cold water species would be forced to migrate or would disappear, sea-river species would be adversely affected by alteration of coastal physiography and inland hydrology. The impact of higher temperatures on inland waters might include algal blooms, massive fish kills, possibly the invasion of diseases (e.g. bilharzia, malaria).

Changes in seasonal rainfall distribution patterns could, no doubt, have significant impacts on natural vegetation. Significant changes in the amount of mean annual rainfall or in its seasonal distribution pattern would have dramatic effects.

An increase in the mean annual evapo-transpiration of 180-220 mm, would have a slight impact on natural vegetation and crops, but it could be significant in areas where climatic or soil conditions are marginal in respect of types of vegetation or crop. One may also expect a slight shift in vegetation belts due to increasing aridity. Expanding desertification at the margins of the Sahara and Near-East deserts will happen, in any case, the result of the exponential growth of population. Climate change would just aggravate the phenomenon (Le Houérou, 1989).

A general 2ºC warming would lead to a shift of the natural range of species by 300 - 500 km northwards and 300 m in altitude. In the Alps ecosystems would move upwards 600 - 700 m; evergreen species of oak would expand in the mixed woodlands at lower altitudes on the southern and eastern margins of the chain.

Forests are likely to suffer from the increased temperature and aridity. The longer periods of drought will affect forest species that survive at the limit between semi-arid and humid conditions, shifting their occurrence to higher altitude. Forests of deciduous trees require ample moisture during the growing season; many species, would therefore disappear. The coastal plantations will suffer from salinization and, probably, remobilized sand dunes. The Mediterranean maquis cover could be affected by desertification. Finally, forest fires will become more frequent, also involving higher areas than at present.

Nature conservation will require re-assessment and new policies. The protection of species through the maintenance of present natural conditions will be increasingly difficult,if not impossible. In some environments, only species adapted to unpredictable, rapidly changing environments will be able to survive; rare species living in restricted ecological islands might not be able to migrate. Bird migrations will be affected by higher temperatures in the more boreal regions and by the changed ecosystems of their traditional staging and wintering locations.

6 . 6 .

Impacts on agriculture and fisheries

Weather fluctuations (temperature, heat waves, availability of water in the plants growing stages, hail or heavy rains in the ripening stages) will affect several Mediterranean crops (wheat, soya beans, sugar beets, tomatoes, tobacco, citrus and other fruit trees).

Change in winter temperature would have a very significant impact in areas where this factor limits plant growth, that is in most of the Mediterranean Europe highlands, and in mountain and continental areas of Northern Africa and the Near East. It would, for instance, increase the areas of cultivation of cold-sensitive crops such as olive, citruses, winter cereals, vegetables. Agriculture is likely to change towards even more intensive irrigation and use of greenhouses, at least in many areas.

Nevertheless, warmer winters and severe water deficits will threaten the existence of tree cultivations (e.g. olives, nuts) that require a dormant period at relatively low temperatures. Crop plants will be adapted by selection of different strains (Le Houérou, 1989).

Soil fertility should tend to decrease, fewer nutrients being available to the plants due to increased soil salinity. Irrigation would become increasingly necessary, but also more difficult and expensive, requiring better soil drainage. Cultivated areas in floodplains could be affected by a greater incidence of floods and by changes in channel morphology.

In a globally warmer climate, some tropical and subtropical plant diseases will move north, and the distribution of insects and pests will be altered. There will be a need for new biological and/or chemical controls of pests and pathogens.

6 . 7 .

Impacts on society

Climatic changes should not affect the distribution and dynamics of human population in the littoral zones, because the natural growth of the population will continue to follow the present trends in the individual countries. They are slowly growing (perhaps static and locally decreasing) population size on the north Mediterranean coasts, or large increases in the countries of the southern coast. Migration to coastal areas could accelerate in the south due to increased desertification in the interior (Baric and Gasparovic, 1989).

At the present time approximately 133 million people (37% of total population of Mediterranean countries) live in the littoral zone (only 17% of the total area of these countries). 60% of them live in the urban zones. According to the five Blue Plan scenarios, in the year 2025 there will be between 200 and 220 million inhabitants in the coastal zones, 75% of which in cities.

Any foreseeable change in temperature would have an almost negligible impact on the environment compared to the demographic explosion. Nevertheless, sea level rise will affect considerably the economy and well being of many countries, especially because many low coasts will increasingly experience physical instability due to sub-residence and river sediment starvation. A major risk is represented by an increase in frequency and intensity of storms and of storm surge flooding. Major expenditures will be required to control longshore drift and beach erosion. The main concerns include greater wave attack on harbour structures, retreat of headlands, and the management of lagoons.

Expected demographic and economic changes in Mediterranean coastal zones vary considerably. In the Ebro delta, a temperature increase of 1.5^{o}C and a sea level rise in the range of 20 cm, will have much lower effects on the system than the man-induced modifications. Nevertheless, these changes will increase actual erosion processes and lead to more frequent flooding of the wetlands, increasing their salinity and destroying the present flora and the nesting grounds for migratory birds. As the coastline retreats, the bays and lagoons gradually will be closed, affecting the area's marine productivity (Marino, 1989).

In NW Italy and in the Gulf of Lion settlement patterns should change little because of low population growth. The main concerns for regional management would be the availability of water resources. In France, most of the large urban centers (Perpignan, Narbonne, Béziers, Montpellier, Nîmes, Arles) are built back from the shore, thus are protected from any serious impact of sea level rise. On the other hand, the coast, with its tourist resorts and harbours, is particularly vulnerable due to the narrow strip of sand and the low altitude of the dunes ridges (Corre, 1989).

In Italy, the main threats will be to the survival of Venice (and other towns of artistic-historical importance), to the tourist industry, to the activities of important harbours, and to specialized agricultural productions. It might be more economical to turn at least parts of the reclaimed sub-zero level lands back to their original lagoonal state, in favour of fishing, which is at present a more efficient and remunerative activity than agriculture. Lagoons and marshes also could act as buffer zones between the open sea and higher land, as well as nature reserves. Industrial and other activities in the areas less than 1 m would probably move gradually inland without excessive disruption (Sestini, 1989).

In Greece, large scale radical consequences could affect the greater Thessaloniki area. The damming and isolation of the Thessaloniki Bay may become a necessary "buffer zone" in order to diminish the impacts of sea level rise on the low lying urban and industrial coastal area. The Bay would be transformed into a controlled lagoon, with essential navigation outlets, and would not negatively affect the greater Thermaikos Gulf marine environment, as seawater circulation and sewage output regime would remain almost unaffected. Otherwise, sea level rise and sea surges will cause significant damage along the whole coastline, as waves will easily overtop the present sea barriers fronting the reclaimed agricultural land, and the cement seawall along the city of Thessaloniki. The beaches at the eastern end of the bay might gradually disappear due to high erosion, producing significant economic effects on recreational land use (Georgas and Perissoratis, 1989).

In the Nile delta, the nature and extent of climatic impact will depend largely on the degree of coastal development during the next 2-3 decades. Intensified land-use in the coastal zone is inevitable, due to the continued growth of population and the consequent need to augment food production through the further extension of land reclamation and of lagoonal fishing. These developments will place an increasing stress on water supplies. The most serious negative effect of sea level rise could be on ports, lagoonal fishing and lowland agriculture, and thus, indirectly, on population centers, which are tied to port and agriculture-related industries. Therefore, the main impacts of economic significance are those that impair the efficiency of harbours and the proper management of lagoonal fisheries and lowland agriculture. Alexandria will lose its attraction as a summer resort city, but the recreational use of beaches is not threatened elsewhere (Sestini, 1989a).

In North Tunisia the whole area is presently adjusting to a period of accelerating change. Canalization, deforestation and agricultural improvements have all had demonstrable effects on the Ichkeul-Bizerte Lake. A scheme to construct more dams on the rivers flowing into Ichkeul between 1983 and 2000 could even more dramatically change the hydrology and ecology in this area. Overall, existing environmental problems are likely to be exacerbated; agriculture will suffer, inland and lagoon fisheries may have already disappeared through the impact of the dam scheme; sea fisheries may benefit slightly, industry will be largely unaffected, water resources will decline in both quantity and quality; settlements will suffer through their foundations and sewers; the quality of urban life may decline through an accelerated influx of farmers abandoning the countryside (Hollis, 1989).

To mitigate the adverse effects throughout the Mediterranean it will certainly be necessary to increase expenditure for:

- the protection of the low coastal areas from sea level rise;
- the protection of fresh water resources;
- the (re)construction of waste water systems;
- the production of food and other agricultural products

The cost of alleviating the consequences of climatic changes might be easily met in the countries with higher national incomes. Poorer developing countries may experience great difficulties in funding the necessary projects to alleviate (or at least temporize) the expected impacts.

7. SOME BLUE PLAN AND PRIORITY ACTIONS PROGRAMME INFORMATION RELEVANT TO THE IMPLICATIONS OF CLIMATIC CHANGES IN THE MEDITERRANEAN

In addition to information from Blue Plan and Priority Actions Programme utilized in the above consideration, following are some considerations which are of interest for the subject.

7.1. Energy consumption

Blue Plan carried out a study concerning projections of energy consumption in the Mediterranean countries for the 2000 and 2025 horizons. This study is at world level one of the very few prospection studies on energy for the next 30 years; it follows closely the analysis of resources, economic development and the environment. For instance the study, which takes into consideration several global Mediterranean scenarios and several energy scenarios, shows in the framework of the probabilistic scenarios, an increase of hydrocarbon consumption (with an increasing role for natural gas which has less negative effects than CO_2), a relative stabilization - at least until 2000-2010 - of nuclear energy (which is interesting in this connection since $CO_2 = 0$), a marked increase, unfortunately, of coal consumption (with a concomitant increase of the CO_2) which in any event would make necessary a costly treatment to mitigate the negative effects (but not CO_2 production) (Annex V).

Il is possible, according to the Blue Plan, that in 2025 the ships carrying coal and travelling through the Mediterranean will be more numerous than petroleum tankers.

CO_2 increase will be felt in the Mediterranean Basin in the next 30 years: the picture looks different depending on the scenario applied, the "all coal" scenario being of course the worst.

This increase is mostly linked to an increase of energy needs (approximately multiplied by 3) and especially to the demands for electricity (multiplied by 4 or 5 in the Northern Mediterranean countries and by 7 in the Southern Mediterranean countries) in the higher growth scenarios (Annex V).

Renewable sources of energy will increase in the next 30 years but not enough to have a decisive effect. Hydroelectric energy still offers some untapped resources (e.g. in Turkey); as far as solar energy is concerned it could find useful applications especially in the housing (hot water/heating) and agriculture sectors (irrigation). A policy of encouraging such applications should be pursued especially for solar heating in sparsely inhabited areas.

Blue Plan could prepare a synthesis of the results of the Blue Plan study to be submitted to the international organizations involved in prospective studies on energy/environment in the context of global climate warming.

Renewable sources of energy is one of the 10 priority topics of the Priority Actions Programme. The work has so far resulted in 10 working meetings and training sessions. Spain (Madrid and Almeria) has made an important contribution in this connection. The studies which were carried out (1986-1989) are listed in Annex VI.

7.2. Emission of CO_2 in the Mediterranean Basin

The objective of this text is to give a quick estimate of the possible range of CO_2 emissions in the Mediterranean basin, on the basis of the results of the Blue Plan (sub-scenarios "Energy"). Thus, this text illustrates the various uses of these scenarios.

CO_2 comes from the combustion of fossile combustibles (coal, oil and derivatives, natural gas) used for domestic and industrial purposes, for transport or for the production of electricity. We have limited ourselves here to the production of electricity, a topic more suitable for comparative studies, since in this field the substitution among combustibles can be easier (whereas substitution is about zero for transports and rather poor for the other energy uses).

The following calculations are based on a number of assumptions:

1) the highest (without being unrealistic) energy and electricity consumption scenarios were used for the period between now and the year 2025; this was done in order to have the greatest contrast in the results obtained. In other words we used the "T-3 moderate trend scenarios" of the Blue Plan; a recent updating of these scenarios on the basis of the latest available data showed the applicability of the results.

2) the calculations concerning increases in electricity consumption between 1985 and 2025, without taking into consideration production installations existing in 1985 (assumed to remain unchanged during that period);

3) we used the CO_2 emission coefficients given by UNEP for a TCE (tonne coal equivalent), i.e.:

   - coal: 0 to 73 (which means that when one burns or consumes one TCE in the form of coal, there is 0.73 tonne of carbon emission (see remark below);

   - oil: 0 to 53 (or 0.53 tonne of carbon emitted per TCE in the form of oil burnt or consumed);

   - natural gas: 0 to 39 (or 0.39 tonne of carbon emitted per TCE in the form of natural gas burnt or consumed).

   Regardless of any quantification at a later stage, we can already see the intrinsic advantage of natural gas vis-à-vis oil and even more vis-à-vis coal.

   Note: It should be pointed out that the results are given in tonnes of carbon and not in tonnes of CO_2. Generally, scientists give results in tonnes of carbon emitted, each tonne of carbon corresponding in effect to 3.66 tonnes of carbonic gas (coefficient 44/12 of molecular weights).

   Let us also remember that today on a world level 5 billion tonnes of carbon are emitted yearly in the atmosphere.

Scenarios concerning electricity consumption:

Table I (Annex V) is a review of production of electricity figures by source in 1985 in Millions of tonnes coal equivalent (basic unit for the calculation of CO_2). The bottom left gives figures for the corresponding quantities of carbon emitted in the Northern Mediterranean countries (from Spain to Greece), for the Southern and Eastern Mediterranean countries (from Morocco to Turkey) and for the Mediterranean as a whole.

The calculations were based on real figures for production per type of combustible for the Southern EEC countries and extrapolated for the whole of the Mediterranean by assigning a greater role to oil for the production of electricity in the Southern and Eastern Mediterranean countries.

Table II (Annex V) gives estimates for all the Mediterranean countries according to the 3 sub-scenarios of scenario T-3, for which total electricity production was estimated at 2,900 TWh (2889 to be precise which is the sum of the calculations for each country); three hypotheses were made that differ greatly among themselves concerning increase in electricity production between 1985 and 2025:

- all increases would come from power stations burning exclusively coal, which a priori is the least environment-friendly hypothesis (regardless of any economic and/or geopolitical considerations);

- all increases would come from power stations burning exclusively natural gas;

- all increases would come from nuclear power plants, a "theoretical" hypothesis which however would mean that CO_2 emissions would freeze at their present levels;

- a fourth hypothesis was included; this is the "mixed" scenario which corresponds to the initial T-3 scenario, where both fossile combustibles and nuclear energy contribute to electricity production.

Tables III and IV (Annex V) present the results for the Northern Mediterranean and for the Southern and Eastern Mediterranean respectively.

Results:

The bottom of Table II gives a synthesis of the results of the above-mentioned scenarios. If compared with emission levels for 1985 (86.1 million tonnes of carbon), the "all nuclear" scenario does not change emissions (by assumption), then in ascending emission level order, there is the "mixed" scenario (where nuclear energy plays an important role), then the "all gas" scenario and finally the "all coal" scenario.

Two important conclusions can be drawn from these preliminary results:

- the substantial difference between the use of coal and natural gas. This difference became apparent by assuming power stations of the same type (with steam boilers). In fact this difference would be even greater if we assumed for natural gas power stations with a combined cycle (gas turbine followed by a steam turbine); in this case power yields already reach or even exceed 50%.

- in the "all coal" scenario, the increase in emissions - if compared to 1985 - represents for just the Mediterranean electricity slightly more than 10% of the current world-level emissions. This is not a negligible figure.

These figures would be higher if we consider the other uses of fossile combustibles:

- industry, where coal is staging a come-back;

- domestic, which favours fuel oil and natural gas, except for urban heating where coal has certain advantages (but is not widely applied in the Mediterranean region);

- transports, where oil is most important, despite certain inroads of natural gas.

These figures would be even higher if the actual growth in economy, energy and/or electricity needs were greater than that factored in the scenarios T-3. On the other hand, the figures should be revised downward if things went in the opposite direction, as for instance in the case of the T-2 scenario of the Blue Plan which forecasts low economic growth, or in the case of the A scenarios with highly voluntaristic policies of energy savings and recourse to new forms and renewable sources of energy.

In any event, the figures give us a first indication of both the values at stake and especially of the choices that will have to be made concerning the development of electricity production in the Mediterranean basin.

REFERENCES

Baric, A. and F. Gasparovic (1989), Implications of climatic changes on the socio-economic activities in the Mediterranean coastal zone. In: Implications of Climatic Changes in the Mediterranean, G. Sestini, L. Jeftic, J.D. Milliman (Eds.) (in preparation).

Bolin, B., B.R. Doos, J. Jager and R.A. Warrick (Eds) (1986), The greenhouse effect, climate change and ecosystems, Scope 29, J. Wiley and Sons, Chichester.

Corre, J.J. (1989), Implications des changements climatiques dans le Golfe du Lion. In: Implications of Climatic Changes in the Mediterranean, G. Sestini, L. Jeftic, J.D. Milliman (Eds.) (in preparation).

Emery, K.O. (1980), Relative sea levels from tide-gauge records, Proc.Nat.Ac.Sci., 77, pp.6968-6972.

Gacic, M., A. Hecht, T. Hopkins, A. Lascaratos, (1989), Physical oceanography aspects and changes in circulation and stratification. In: Implications of Climatic Changes in the Mediterranean, G. Sestini, L. Jeftic, J.D. Milliman (Eds.) (in preparation).

Georgas, D. and C. Perissoratis, (1989), Imlications of future climatic changes on the inner Thermaikos Gulf. In: Implications of Climatic Changes in the Mediterranean, G. Sestini, L. Jeftic, J.D. Milliman (Eds.) (in preparation).

GESAMP (1980), Interchange of pollutants between the atmosphere and the oceans. Rep.Stud.GESAMP,(13):55 p.

GESAMP (1985), Interchange of pollutants between the atmosphere and the oceans (part II). Rep.Stud.GESAMP,(23):55 p.

Gornitz, V., S. Lebedeff, J. Hansen (1982), Global sea level trend in the past century, Science, 215, pp.1611-1614.

Hekstra, G.P. (1986), Will climatic changes flood the Netherlands? Effects on agriculture, land use and well-being, Ambio, 15(6), pp.316-326.

Hoffman, J.S. (1984), Estimates of future sea level rise. In: Greenhouse effect and sea level rise. A challenge for this generation, M.C. Barth, J.G. Titus (Eds.), Van Nostrand Reinhold, New York, pp.79-103.

Hollis, G.E. (1989), Implications of climatic changes on the Garaet el Ichkeul and Lac de Bizerte, Tunisia. In: Implications of Climatic Changes in the Mediterranean, G. Sestini, L. Jeftic, J.D. Milliman (Eds.) (in preparation).

Imeson, A.C., I.M. Immer (1989), Implications of climatic change on land degradation in the Mediterranean. In: Implications of Climatic Changes in the Mediterranean, G. Sestini, L. Jeftic, J.D. Milliman (Eds.) (in preparation).

Kwadijk, J. and H. de Boois (Eds) (1989), European Workshop on Interrelated Bioblimatic and Land-use Changes, October 17-21 1987, Noordwijkerhout, The Netherlands, National Institute of Public Health and Environmental Protection, Bilthoven.

Le Houérou, H.N. (1989), Change in vegetation and land-use by the year 2050; a prospective study. In: Implications of Climatic Changes in the Mediterranean, G. Sestini, L. Jeftic, J.D. Milliman (Eds.) (in preparation).

Marino, M.G. (1989), Implications of climatic changes on the Ebro delta. In: Implications of Climatic Changes in the Mediterranean, G. Sestini, L. Jeftic, J.D. Milliman (Eds.) (in preparation).

Robin, G. de Q. (1986), Changing the sea level - The greenhouse effect, climate change and ecosystems. Bolin B., et al (Eds.), Scope 29.

Sestini, G. (1989), Implications of climatic changes on the Po delta and Venice Lagoon. In: Implications of Climatic Changes in the Mediterranean, G. Sestini, L. Jeftic, J.D. Milliman (Eds.) (in preparation).

Sestini, G. (1989a), Implications of climatic changes on the Nile delta. In: Implications of Climatic Changes in the Mediterranean, G. Sestini, L. Jeftic, J.D. Milliman (Eds.) (in preparation).

STC/UNEP/ASPEI (1989), Intergovernmental Meeting on Climatic Change and Sea Level Rise inthe South Pacific, Majuro, Marshall Island, 17-20 July 1989.

UNEP (1988), Report of the Joint meeting of the Task Team on the Implications of Climatic Changes in the Mediterranean and the Co-ordinators of Task Teams for the Caribbean, South-East Pacific, South Pacific, East Asian Seas and South Asian Seas Regions, Split, 3-8 October 1988 (UNEP(OCA)/WG.2/25)

UNEP (1989a), J. Pernetta and G. Sestini: The Maldives and the impact of expected climatic changes. UNEP Regional Seas Reports and Studies No. 104.

UNEP (1989b), G. Sestini, L. Jeftic and J.D. Milliman: Implications of expected climate changes in the Mediterranean region: an overview. UNEP Regional Seas Reports and Studies No. 103.

UNEP (1989c), G. Sestini, L. Jeftic and J.D. Milliman: Implications of expected climate changes in the Mediterranean region: an overview. MAP Technical Reports Series No. 27.

UNEP (1989d), High and Dry, Mediterranean Climate in the Twenty-first Century, MAP and OCA/PAC.

UNEP (1989e), Bibliography on effects of climatic change and related topics. MAP Technical Reports Series No. 29.

Wigley, T.M.L. (1989), Future climate of the Mediterranean Basin, with particular emphasis on changes in precipitation. In: Implications of Climatic Changes in the Mediterranean, G. Sestini, L. Jeftic, J.D. Milliman (Eds) (in preparation).

Wigley, T.M.L. (1989a), Predicted changes in sea level. In: Implications of Climatic Changes in the Mediterranean, G. Sestini, L. Jeftic, J.D. Milliman (Eds.) (in preparation).

ANNEX I

A. DECISION OF THE FOURTEENTH SESSION OF THE UNEP GOVERNING COUNCIL ON "GLOBAL CLIMATE CHANGE"
(Nairobi, 18 June 1987)

UNEP/GC/DEC/14/20. Global climate change

The Governing Council,

Aware that national and international studies continue to conclude that a global climate change will result from increases in the concentration of greenhouse gases from human activities,

Concerned that such change would have potentially serious consequences for human welfare and the natural environment,

Mindful of the need to improve expeditiously scientific understanding of climate change, its causes and its consequences, as a basis for formulating appropriate policy responses at the global, regional and national level,

Recognizing the importance of initiating international consideration of possible policy responses,

Recognizing that the United Nations Environment Programme, by effective implementation of its lead responsibility within the World Climate Programme for climate impact studies, as well as through the Global Environmental Monitoring System and its Global Resource Information Data Base, can make important contributions in this area,

Considering that the recently concluded Tenth Congress of the World Meteorological Organization has stressed the importance of close co-operation with the United Nations Environment Programme and the International Council of Scientific Unions on global climate change, in particular to improve scientific assessments, including impact assessments,

1. Notes with satisfaction the importance being attached by the United Nations Environment Programme to the global climate change problem, including efforts to raise public awareness and to assess climate impacts;

2. Urges the Executive Director to ensure that the United Nations Environment Programme, working in close co-operation with the World Meteorological Organization and the International Council of Scientific Unions, in particular, the Special Committee on Global Change of the International Council of Scientific Unions, maintains an active, influential role within the World Climate Programme through the fulfillment of its central responsibility for climate impact studies and by ensuring that the World Climate research programme includes studies on the causes and effects of atmospheric changes, taking account of social and economic aspects;

3. Welcomes the Executive Director's plans to join with the World Meteorological Organization and the International Council of Scientific Unions in convening a second World Climate Conference in late 1989 or early 1990, and to support the World Conference on the Changing Atmosphere: Implications for Global Security, being convened by the Government of Canada in June 1988;

4. Urges the Executive Director to respond positively to the decision by the Tenth Congress of the World Meteorological Organization requesting its Secretary-General, in co-operation with the Executive Director of the United Nations Environment Programme to explore and, after appropriate consultation with Governments, to establish an ad hoc intergovernmental mechanism to carry out internationally co-ordinated scientific assessments of the magnitude, timing, and potential impact of climate change*;

5. Requests the Executive Director to report to the next regular session of the Governing Council on:

(a) Progress with climate impact studies;

(b) The work of the ad hoc intergovernmental mechanism;

(c) The full range of possible responses by Governments and international agencies to anticipated climate changes, including possibilities for reducing the rate of climate change, taking into account, inter alia, the findings of the World Meteorological Organization/International Council of Scientific Unions/United Nations Environment Programme Advisory Group on Greenhouse Gases and those of other relevant agencies.

15th meeting
18 June 1987

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* Resolution 3.20/1 (Cg-X) of the Tenth Congress of the World Meteorological Organization.

B. DECISION OF THE FIFTEENTH SESSION OF THE UNEP GOVERNING COUNCIL ON "GLOBAL CLIMATE CHANGE" (Nairobi, 25 May 1989)

UNEP/GC/DEC/15/36. Global climate change

The Governing Council,

Recalling its decision 14/20 of June 1987 on global climate change

Recognizing that while further scientific studies are important, the knowledge and awareness of global climatic change and its possible consequences are developing rapidly,

Emphasizing that the scientific participation of developing countries and therefore the development of their intellectual resources is essential to understanding the state of the atmosphere and climate change for the world as a whole,

Emphasizing further the importance of discussing the whole range of climate-related measures on a broad international basis,

Recognizing also the expressions and readiness on the part of a growing number of States to act decisively to protect the global climate,

Conscious of General Assembly resolution 43/53 of 6 December 1988, entitled "Protection of global climates for present and future generations of mankind", which recognized that climate change is a common concern of mankind and determined that necessary and timely action should be taken to deal with climate change within a global framework, and requested the Executive Director of the United Nations Environment Programme and the Secretary-General of the World Meteorological Organization to utilize the Intergovernmental Panel on Climate Change to initiate that action,

Noting that the heads of State or of Government of States members of the European Communities, meeting at Rhodes in December 1988, underlined the need for an effective international response to global environment problems such as climate change,

Noting the report of the International Meeting of Legal and Policy Experts on the Protection of the Atmosphere, held in Ottawa in February 1989, in which and international convention or conventions with appropriate protocols was recommended as a means to ensure rapid international action to protect the atmosphere and limit the rate of climate change, [1/]

[1/] See Protection of the Atmosphere: International Meeting of Legal and Policy Experts, 20-22 February 1989, Ottawa, Ontario, Canada, "Statement of the Meeting of Legal and Policy Experts; introduction.

Recalling the Chairman's message from the London Conference or Saving the Ozone Layer, which met from 5 to 7 March 1989 and was attended by one hundred and twenty-three countries, which, inter alia, noted that action to protect the ozone layer will at the same time reduce the impact of global warming, which poses particularly serious threats to certain low-lying developing countries, [2/]

Noting that representatives of twenty-four States at the highest political level adopted in The Hague on 11 March 1989 a declaration on the threats to the atmosphere, particularly the warming of the atmosphere and the deterioration of the ozone layer,

Noting the initiatives of the Governments of the Netherlands and of Norway with regard to the establishment of a world climate fund and their willingness to contribute to such a fund,

Also noting the ongoing work of the Intergovernmental Panel on Climate Change on financial measures to implement strategies to respond to climate change,

Encouraging Governments and relevant international organizations to further the development of international funding mechanisms, not excluding a possible climate fund, for additional assistance, in particular to developing countries, for the implementation of national and international policies to protect the environment from climate change,

Noting further the Declaration by eighty-two countries and the European Communities in Helsinki on 2 May 1989 [3/] in which they, mindful that some ozone-depleting substances are powerful greenhouse gases leading to global warming, agree to phase out the production and the consumption of chlorofuorocarbons controlled by the Montreal Protocol as soon as possible but not later than the year 2000, taking due account of the special situation of developing countries,

Emphasizing that the Montreal Protocol, as amended from time to time, is the legal instrument available to its parties by which the production and consumption of ozone-depleting substances are to be controlled,

Emphasizing that, within the perspective of protection of the atmosphere, new measures to counteract global warming are required,

1. Notes with satisfaction the establishment of the Intergovernmental Panel on Climate Change by the Secretary-General of the World Meteorological Organization and the Executive Director of the United Nations Environment Programme upon appropriate decisions by the Executive Council of the World Meteorological Organization and the Governing Council of the United Nations Environment Programme as an ad hoc intergovernmental working group;

[2/] UNEP/Ozl.Pro.1/5, para.11

[3/] Ibid., appendix I

2. Requests the Executive Director of the United Nations Environment Programme in full collaboration with the Secretary-General of the World Meteorological Organization, to consult with the Intergovernmental Panel on Climate Change with respect to the determination of its internal organization and procedures, its budget and means of financing such budget;

3. Authorizes the Executive Director of the United Nations Environment Programme to continue to give strong support to the work of the Intergovernmental Panel on Climate Change;

4. Urges all Member States of the United Nations, its specialized agencies and international organizations, including the International Atomic Energy Agency, as well as relevant intergovernmental and non-governmental organizations, to support fully and participate actively in the work of the Intergovernmental Panel on Climate Change;

5. Urges the Intergovernmental Panel on Climate Change to take the necessary steps to ensure the scientific and policy participation of developing countries in its work and recommends the international community to provide assistance in this respect;

6. Notes the agreement within the Intergovernmental Panel on Climate Change, as reflected in paragraph 10 of General Assembly resolution 43/53, that its work include the following main tasks, each to be accomplished by a Working Group;

(a) Assessment of available scientific information on climate change;

(b) Assessment of the environmental and socio-economic impacts of climate change;

(c) The formulation of response strategies; [4/]

7. Further notes the intention of the Intergovernmental Panel on Climate Change to adopt an interim report not later than October 1990;[5/]

8. Notes the agreement of the Response Strategies Working Group of the Intergovernmental Panel on Climate Change at a meeting held in Geneva from 10 to 12 May 1989, that its workplan includes the identification and evaluation of a range of measures to implement response strategies, namely legal measures, including the elements of a possible future framework convention on climate change, technological measures, financial measures, economic measures and educational measures;

4/ Report of the First Session of the Intergovernmental Panel on Climate Change, (World Meteorological Organization/United Nations Environment Programme, World Climate Programme Publications Series, No. IPCC-1/TD-No.267) paras. 3.2 and 3.3.

5/ Ibid., paras. 3.12 and 4.3.

9. Requests the Executive Director of United Nations Environment Programme,in co-operation with the Secretary-General of the World Meteorological Organization, to begin preparations for negotiations on a framework of the Intergovernmental Panel on Climate Change, as well as the outcome of recent and forthcoming international meetings on the subject;

10. Recommends that such negotiations should be initiated as soon as possible immediately after the adoption of the interim report of the Intergovernmental Panel on Climate Change;

11. Recommends that the Governments and competent regional integration economic organizations consider, while awaiting the outcome of the negotiations, the range of possible options for averting the potentially damaging impacts of climate change, for removing the causes of the phenomenon, and for developing programmes for implementing those more appropriate to the national needs, including, inter alia, to:

(a) Accede to the Montreal Protocol on Substances the Deplete the Ozone Layer, if they have not yet done so, and comply with its regulatory measures with its utmost speed, adopting and applying, where possible, more stringent controls than those specified in the Protocol in the shortest possible time with an ultimate objective of, as far as possible, completely eliminating the emission of controlled substances to better protect the ozone layer and the global climate from change, consistent with the Helsinki Declaration on the Protection of the Ozone Layer;

(b) Combat deforestation and accelerate reforestation and afforestation programmes to provide a natural bank for atmospheric carbon in terrestrial ecosystems;

(c) Promote programmes to improve energy efficiency and energy conservation in both the supply and use sectors of national economies, setting goals and objectives as appropriate;

(d) Adopt in industrialized countries strategies for actions, including use of regulations and technologies as appropriate, designed to control, stabilize and reduce national emissions of greenhouse gases through more efficient use of energy in both the production and consumption sectors of national economies, setting goals and objectives as appropriate, with, as a first step, the goal of stabilization of emissions of carbon dioxide and other greenhouse gases, and the development of energy sources that do not emit greenhouse gases which threaten global climate;

(e) Adopt in developing countries similar strategies for actions which, while not impeding in impetus of their development, make optimal use of energy production and consumption systems that are safe, affordable and efficient and that minimize emissions of greenhouse gases, which threaten global climate;

(f) Identify and possibly strengthen relevant existing international legal instruments having a bearing on global climate change;

12. Recommends the institution of programmes and measures of assistance, including technology transfer, that will make it possible for developing countries to avoid risk to global climate;

13. Recommends that Governments, taking note of the need for scientific knowledge of global, regional and local climates and their impacts, continue and, whenever possible, increase their activities in support of the World Climate Programme and International Geosphere-Biosphere Programme including the monitoring of atmospheric composition and climate conditions, and further recommends that the international community support efforts by the developing countries to participate in these scientific activities.

12th meeting
25 May 1989

ANNEX II

DECLARATION OF THE HAGUE

10 MARCH 1989

The right to life is the right from which all other rights stem. Guaranteeing this right is the paramount duty of those in charge of all states throughout the world.

Today, the very conditions of life on our planet are threatened by the severe attacks to which the earth's atmosphere is subjected.

Authoritative scientific studies have shown the existence and scope of considerable dangers linked in particular to the warming of the atmosphere and to the deterioration of the ozone layer. The latter has already led to action, under the 1985 Vienna Convention for the protection of the ozone layer and the 1987 Montreal Protocol, while the former is being addressed by the Intergovernmental Panel on Climate Change established by UNEP and WMO, which has just begun its work. In addition the UN General Assembly adopted in 1988 resolution 43/53 on the protection of the global climate, a resolution which recognizes climate development as a concern for humanity as a whole.

According to present scientific knowledge, the consequences of these phenomena may well jeopardize ecological systems as well as the most vital interests of mankind at large.

Because the problem is planet-wide in scope, solutions can only be devised on a global level. Because of the nature of the dangers involved, remedies to be sought involve not only the fundamental duty to preserve the terrestrial ecosystem, but also man's right to a viable environment, and the consequent duty of the community of nations vis-à-vis present and future generations to do all that can be done to preserve the quality of the atmosphere.

We consider, therefore, that, faced with a problem the solution to which has three salient features, namely that it is vital, urgent and perforce global, we are in a situation that calls not only for the application of existing principles but also for a new approach, through the development of new principles of international law, and unprecedented and more effective decision-making and enforcement mechanisms.

What will be needed here are regulatory measures and mechanisms of support and adjustment that take into account the participation and contribution potential of countries which have reached different levels of development. Most of the emissions that affect the atmosphere currently originate in the industrialized nations. And it is in these same nations that the room for change is greatest, and these nations are also those which have the greatest resources to deal with this problem effectively.

The international community and especially the industrialized nations have particular obligation to help the developing countries which will be very negatively affected by changes in the atmosphere although the responsibility of many of them for the process will have been only marginal.

Financial institutions and development agencies, be they international or domestic, must coordinate their activities in order to promote sustainable development.

Each state, within the framework of its international commitments, by endorsing this declaration shall acknowledge the commitment to the following principles:

a) the principle of establishing, within the framework of the United Nations, a new authority, either through the strengthening of existing institutions, or through the creation of a new one, which, in the context of the preservation of the earth's atmosphere, shall be responsible for combating any further warming of the atmosphere, by having recourse to all effective decision taking procedures, even if on occasion consensus cannot be reached;

b) the principle that this authority undertake or commission the necessary studies, be granted appropriate information upon request, ensure the circulation and exchange of scientific and technological information, which implies furthering access to the necessary technologies, develop the instruments and define standards to enhance or guarantee the protection of the atmosphere and monitor compliance therewith;

c) the principle of appropriate measures in order to promote the effective implementation and the respect of the authority's decisions, subject to the jurisdiction of the international court of justice;

d) the principle of fair compensation to those countries to which decisions taken to protect the atmosphere shall prove to be an abnormal or special burden, in view, inter alia, of the level of development and their actual responsibility for the deterioration of the atmosphere. To this end mechanisms will have to be developed;

e) the determination to give the aforementioned principles effective and consistent grounding, not only institutionally but also financially through the necessary legal instruments to be negotiated.

The heads of state and government or their representatives who have expressed their endorsement of this declaration by placing their signatures under it:

- stress their resolve to implement the principles thus defined;

- state their intent to further the development of their initiative within the United Nations and in close coordination and collaboration with existing agencies set up under the auspices of the United Nations;

- invite all nations of the world and the relevant international organizations, by taking into consideration the studies carried out by GIEC to join in developing the framework conventions and other legal instruments necessary to establish the institutional authority and to implement the other principles stated above to protect the atmosphere and to prevent climatic change, especially the warming of the atmosphere;

- urge all nations of the world and the relevant international organizations to sign and ratify conventions relating to the protection of nature and the environment;

- call upon all nations of the world to endorse the present declaration.

ANNEX III

RESOLUTION OF THE EUROPEAN PARLIAMENT ON THE CONSEQUENCES OF A RAPID RISE IN THE SEA LEVEL ALONG THE COASTLINE OF EUROPE, 26 May 1989

The European Parliament:

- having regard to the motion for a resolution by Mrs Maij-Weggen on the consequences for European coastal areas of a rapid rise in the sea-level (Doc. B2/1382/87);

- having delegated the power of decision to its Committee on the Environment, Public Health and Consumer Protection, pursuant to Rule 37 of the Rules of Procedure;

- having regard to the report of the Committee on the Environment, Public Health and Consumer Protection (Doc. A2-0087/89);

A. whereas an overall rise in the sea level is an inescapable phenomenon, but whereas the international community must address the problem seriously - and hence act in time - bearing in mind that it will worsen rapidly and is a consequence of human activity;

B. whereas a number of scientific meetings have confirmed that the sea level is likely to rise by 10 to 20 cm by 2025 and by 50 to 200 cm by 2100, but whereas even worse forecasts have been made;

C. whereas the rise in the sea level is likely to have many disastrous repercussions, including:

   - a higher risk of flooding
   - increased beach and coastal erosion
   - the disappearance of some islands and coastal strips
   - increased demand for drainage
   - the salinization of water
   - loss of agricultural land
   - changes in agricultural production
   - the disappearance of fish-farming
   - the disappearance of wetlands
   - damage to port and coastal infrastructures, etc;

D. whereas almost one-third of the world's population lives less than 60 km from a shore;

E. whereas the expected rise in the sea level is closely linked to the overall rises in temperature resulting from the accumulation of CO_2 and other "greenhouse effect" gases in the atmosphere;

F. whereas the increase in temperature to be expected within the next thirty years is between 1.5 and 4.5EC;

G. whereas the greenhouse effect is expected substantially to increase the force of cyclones and hence the amount of damage they cause;

H. whereas measures to combat coastal erosion, for which the greenhouse effect will have been largely responsible, will have to be accompanied by other legislative measures to control the extractive industries and the excavation of materials from river beds;

GENERAL MEASURES

1. Recalls its resolution on the "greenhouse effect" (1) of 12 September 1986, stressing the need to allocate more financial resources to climatology research;

2. recalls its resolution of 14 June 1988 (2) on the protection of the ozone layer and reiterates the need for drastic restrictions on the use of CFCs - which account for almost 30% of the greenhouse effect;

3. recalls its resolution of 8 July 1988 (3) on combating deforestation and stresses that it is vital to develop a common forestry policy as part of an overall European strategy against the rise in temperature;

4. calls on the Commission to check that the International Convention on Transboundary Air Pollution is being applied in the Member States and to establish as a matter of urgency a Community strategy geared to the various objectives set out in the Final Declaration of Toronto in June 1988 and including in particular:

    - the finalization, by 1992, of a world framework convention on the protection of the atmosphere;

    - the setting up of a World Fund for the atmosphere, financed by a tax on the use of fossil fuels in the industrialized nations.

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(1) OJ No C 255, 13.10.1986, p.273
(2) OJ No C 187, 18.07.1988, p.53
(3) Minutes of the sitting of 08.07.1988

SPECIFIC MEASURES AGAINST THE RISE IN THE SEA LEVEL

5. Calls for specific measures against the rise in the sea level to be included in the European strategy against the rise in temperature;

6. calls on the Commission to prepare without delay possible scenarios for rises in the sea-level up to different heights. These scenarios should include data on:

(a) the extent of flooding at each height;

(b) the population directly affected (local inhabitants) and indirectly affected (workers);

(c) possible danger points: dangerous industrial plants, nuclear power stations, storage sites for radioactive materials, special waste disposal sites, etc.; and

(d) exposed nature reserves and the flora and fauna therein which would be particularly at risk;

7. calls on the Commission to propose a series of measures on:

- observation of sea patterns;
- greater protection of natural sea defenses;
- control of sediments brought to the coasts by watercourses;
- the extractive industries;
- the various means of combating coastal erosion;
- the hazards that would be created by the release of dangerous substances in flood areas;

8. insists that work on ecological cartography being carried out at Community level be directed towards producing maps of coastal areas threatened by a rise in the sea level;

9. calls for increased effort in scientific research, particularly into:

- hydrological cycles
- ocean dynamics
- the dynamics of the polar ice-caps;

10. advocates a review of regional planning policies so that they take account of the risk of a rise in sea level;

11. calls for the EEC's development aid policy to include specific measures for the transfer of information and technology relating to the protection of coastal areas against the rise in sea level.

MEASURES AGAINST ATMOSPHERIC POLLUTION

12. Emphasizes that mankind has already reached certain points of no return regarding atmospheric pollution, the main effects of which will be an overall rise in temperature and a rise in the sea level;

13. stresses that the more atmospheric pollution increases, the more it will cost to "repair" the damage, in so far as that is still possible - the cost of the necessary measures having been put at more than 115 ECUs for every person on earth for 50 years;

14. advocates political action based on the principle that atmospheric change must be limited as far as possible;

15. calls on the Commission to carry out a through investigation of the measures which would enable the EEC to achieve the objective (set by the Toronto Conference) or reducing CO_2 emissions by 20% by 2005 and by 50% by 2050;

16. calls on the Commission to propose, within a year, a first series of European measures designed to achieve a substantial reduction in CO_2 emissions;

17. advocates the reallocation of EEC budget appropriations towards research and development on the change in the climate and its consequences for the environment, in particular the sea level (such R + D being linked to that of the USA-USSR climatology research programme) and towards research and development on techniques for the effective use of energy and renewable energy sources;

18. stresses that it is vital to promote the transfer of the relevant technology to the developing countries and, consequently, to redirect certain financial aid and certain loans to the developing countries;

19. emphasizes that Community policies as a whole, including the policy on production processes and transport policy, must be reassessed in the light of their contribution towards reducing emissions off CO_2 and other "greenhouse effect" gases;

20. instructs its President to forward this resolution to the Council and the Commission of the European Communities, the United Nations and the Council of Europe.

ANNEX IV

LIST OF PAPERS PRESENTED AT THE SPLIT MEETING

(Joint Meeting of the Task Team on Implications of Climatic Changes in the Mediterranean and the Co-ordinators or Task Teams for the Caribbean, South-East Pacific, South Pacific, East Asian Seas and South Asian Seas Regions
Split, 3-8 October 1988)

Bach, W., Isopleth maps on mean monthly and annual data of the GISS-GCM programme for the Mediterranean (UNEP(OCA)/WG.2/17).

Baric, A. and F. Gasparovic, Implications of climatic changes on the socio-economic activities in the Mediterranean coastal zone (UNEP(OCA)/WG.2/12).

Corre, J.J., Implications des changements climatiques dans le Golfe du Lion (UNEP(OCA)/WG.2/4 F).

Elder, D., A. Jeudy de Grissac, Effects of the sea-level rise on coastal ecosystems including those under special protection and threatened and migratory species (UNEP(OCA)/WG.2/5).

Flemming, N., Predictions of relative coastal sea-level change in the Mediterranean based on archaeological, historical and tide gauge data (UNEP(OCA)/WG.2/13).

Gacic, M., T. Hopkins, A. Lascaratos, Physical oceanography aspects and changes in circulation and stratification (UNEP(OCA)/WG.2/16).

Georgas, D. and C. Perissoratis, Implications of future climatic changes on the Inner Thermaikos Gulf (UNEP(OCA)/WG.2/9).

Hollis, G.E., Implications of climatic changes on the Garaet el Ichkeul and Lac de Bizerte, Tunisia (UNEP(OCA)/WG.2/2).

Imeson, A.C., I.M. Immer, Implications of climatic change on land degradation in the Mediterranean (UNEP(OCA)/WG.2/7).

IOC/CPPS/UNEP Task Team, Implications of climatic changes in the South-East Pacific region (UNEP(OCA)/WG.2/22).

IOC/UNEP Task Team, Implications of climatic changes in the South Asian Seas region (UNEP(OCA)/WG.2/23).

Jelgersma, S. and G. Sestini, Impact of a future rise in sea level on the coastal lowlands of the Mediterranean (UNEP(OCA)/WG.2/10).

Le Houérou, H.N., Change in vegetation and land-use by the year 2050; a prospective study (UNEP(OCA)/WG.2/15).

Marino, M.G., Implications of climatic changes on the Ebro delta (UNEP(OCA)/WG.2/3).

Sestini, G., Implications of climatic changes on the Po delta and Venice Lagoon (UNEP(OCA)/WG.2/11).

Sestini, G., Implications of climatic changes on the Nile delta (UNEP(OCA)/WG.2/14).

Shröder, P.C., The impact of sea-level rise on society: a management approach (UNEP(OCA)/WG.2/19).

Simonett, O., Preliminary report on the GRID Mediterranean case studies (UNEP(OCA)/WG.2/8).

Task Team for South Asian Seas region, Report of the Co-ordinator (UNEP(OCA)/WG.2/23 Add.1).

Task Team of the Association of South Pacific Environmental Institutions, Interim report on Potential impacts of greenhouse gas generated climatic change and projected sea-level rise on Pacific Island States of the SPREP region (UNEP(OCA)/WG.2/20).

Task Team of the Caribbean Environment Programme, Implications of climatic changes in the Wider Caribbean region (UNEP(OCA)/WG.2/21).

UNEP/MEDU, Bibliography on effects of climatic change and related topics (UNEP(OCA)/WG.2/18).

Wigley, T.M.L., Future climate of the Mediterranean Basin, with particular emphasis on changes in precipitation (UNEP(OCA)/WG.2/6).

ANNEX V

TABLE I

ELECTRICITY PRODUCTION (MTCE combustibles) (1985)

	COAL	OIL	GAS	TOTAL FOSSILE
SPAIN	11	0.8	0.6	12.4
FRANCE	8.7	1.2	1.5	11.4
ITALY	5.9	16.5	6.2	28.6
GREECE	4.8	1.6	0	6.4
YUGOSLAVIA	8.9	0.9	0.5	10.3
MED/NORTH	39.3	21.0	8.8	69.1

ELECTRICITY PRODUCTION (Twh) (1985)

	COAL	OIL	GAS	TOTAL FOSSILE	NUCLEAR	HYDRO	TOTAL
SPAIN	49.6	3.6	2.9	56.1	26.7	31.7	114.5
FRANCE	38.5	5.3	6.7	50.5	213.1	63.4	327
ITALY	25	71.3	26.6	122.9	6.7	44.1	173.7
GREECE	22.2	6.8	0	29	0	2.8	31.8
YUGOSLAVIA	40	4.1	2.4	46.5	4.1	24.3	74.9
MED/NORTH	175.3	91.1	38.6	305	250.6	166.3	721.9
	(57%)	(30%)	(13%)	(100%)			
				(42%)	(35%)	(23%)	(100%)

(Source: UNIPETE and PB)

ELECTRICITY PRODUCTION (MTCE combustibles) (1985)

	COAL	OIL	GAS	TOTAL FOSSILE
MED/NORTH	56.1	30.0	12.6	98.8
	(57%)	(30%)	(13%)	
MED/SOUTH	4.7	33.7	7.7	46.1
	(10%)	(73%)	(17%)	
MED	60.9	63.8	20.3	144.9
	(42%)	(44%)	(14%)	

(Percentages taking into account petroleum producing countries)

CO_2 EMISSION (C in millions of tonnes) (1985)

	COAL	OIL	GAS	TOTAL FOSSILE
MED/NORTH	41.0	15.9	4.9	61.8
MED/SOUTH	3.5	17.9	3.0	24.3
MED	44.4	33.8	7.9	86.1

TABLE II

ELECTRICITY PRODUCTION IN THE MEDITERRANEAN (TWh)

	THERMAL	NUCLEAR	HYDRO	TOTAL
SITUATION 1985	450.8 (50%)	250.6 (28%)	193 (22%)	894.4
SCENARIO T3				
(2025 "ALL COAL")	2445.4 (85%)	250.6 (9%)	193 (7%)	2889
(2025 "ALL GAS")	2445.4 (85%)	250.6 (9%)	193 (7%)	2889
(2025 "MIXED)	1523.6 (53%)	1115.4 (39%)	250 (9%)	2889

SITUATION 1985

	COAL	OIL	GAS	TOTAL
PRODUCTION OF FOSSILE ELECTR. (MTCE combustibles)	60.9 (42%)	63.8 (44%)	20.3 (14%)	144.9 (100%)
CO_2 EMISSION (C in millions of tonnes)	44.4	33.8	7.9	86.1

SCENARIO T3

	COAL	OIL	GAS	TOTAL
SCENARIO "ALL COAL"				
PRODUCTION OF FOSSILE ELECTR. (MTCE combustibles)	702.0 (89%)	63.8 (8%)	20.3 (3%)	786.0 (100%)
CO_2 EMISSION (C in millions of tonnes)	512.4	33.8	7.9	554.1
SCENARIO "ALL GAS"				
PRODUCTION OF FOSSILE ELECTR. (MTCE combustibles)	60.9 (8%)	63.8 (8%)	661.4 (84%)	786.0 (100%)
CO_2 EMISSION (C in millions of tonnes)	44.4	33.8	257.9	336.2
SCENARIO "MIXED"				
PRODUCTION OF FOSSILE ELECTR. (MTCE combustibles)	205.7 (42%)	215.5 (44%)	68.6 (14%)	489.7 (100%)
CO_2 EMISSION (C in millions of tonnes)	150.2	114.2	26.7	291.1

TABLE II
(continued)

SCENARIO T3	(1985)	"ALL COAL"	"ALL GAS"	"MIXED"	"ALL NUCLEAR"
PRODUCTION OF FOSSILE ELECTR. (MTCE combustibles)	144.9	786.0	786.0	498.7	144.9
CO_2 EMISSION (C in millions of tonnes)	86.1	554.1	336.2	291.1	86.1

Scenario "ALL COAL" = The total increase of electricity comes from thermal electricity "Coal"

Scenario "ALL GAS" = The total increase of electricity comes from thermal electricity "Gas"

Scenario "MIXED" = Identical distribution for coal, oil, gas as in 1985; increase of nuclear and hydroelectric power identical to the increase of primary electricity of Scenario 3

TABLE III

ELECTRICITY PRODUCTION IN THE MEDITERRANEAN/NORTH (TWh)

	THERMAL	NUCLEAR	HYDRO	TOTAL
SITUATION 1985	305 (42%)	250.6 (35%)	166.3 (23%)	721.9
SCENARIO T3				
(2025 "ALL COAL")	1464.1 (78%)	250.6 (13%)	166.3 (9%)	1881
(2025 "ALL GAS")	1464.1 (78%)	250.6 (13%)	166.3 (9%)	1881
(2025 "MIXED)	736.6 (39%)	978.1 (52%)	166.3 (9%)	1881

SITUATION 1985

	COAL	OIL	GAS	TOTAL
PRODUCTION OF FOSSILE ELECTR. (MTCE combustibles)	55.4 (57%)	30.0 (31%)	12.6 (13%)	98.0 (100%)
CO_2 EMISSION (C in millions of tonnes)	40.4	15.9	4.9	61.3

SCENARIO T3

	COAL	OIL	GAS	TOTAL
SCENARIO "ALL COAL"				
PRODUCTION OF FOSSILE ELECTR. (MTCE combustibles)	428.0 (91%)	30.0 (6%)	12.6 (3%)	470.6 (100%)
CO_2 EMISSION (C in millions of tonnes)	312.4	15.9	4.9	333.2
SCENARIO "ALL GAS"				
PRODUCTION OF FOSSILE ELECTR. (MTCE combustibles)	55.4 (12%)	30.0 (6%)	385.2 (82%)	470.6 (100%)
CO_2 EMISSION (C in millions of tonnes)	40.4	15.9	150.2	206.6
SCENARIO "MIXED"				
PRODUCTION OF FOSSILE ELECTR. (MTCE combustibles)	133.8 (57%)	72.5 (31%)	30.5 (13%)	236.8 (100%)
CO_2 EMISSION (C in millions of tonnes)	97.7	38.4	11.9	148.0

TABLE III
(continued)

SCENARIO T3	(1985)	"ALL COAL"	"ALL GAS"	"MIXED"	"ALL NUCLEAR"
PRODUCTION OF FOSSILE ELECTR. (MTCE combustibles)	98.0	470.6	470.6	236.8	98.0
CO_2 EMISSION (C in millions of tonnes)	61.3	333.2	206.6	148.0	61.3

Scenario "ALL COAL" = The total increase of electricity comes from thermal electricity "Coal"

Scenario "ALL GAS" = The total increase of electricity comes from thermal electricity "Gas"

Scenario "MIXED" = Identical distribution for coal, oil, gas as in 1985; increase of nuclear and hydroelectric power identical to the increase of primary electricity of Scenario 3

TABLE IV

ELECTRICITY PRODUCTION IN THE MEDITERRANEAN/SOUTH (TWh)

	THERMAL	NUCLEAR	HYDRO	TOTAL
SITUATION 1985	145.8 (85%)	0 (0%)	26.7 (15%)	172.5
SCENARIO T3				
(2025 "ALL COAL")	981.3 (97%)	0 (0%)	26.7 (3%)	1008
(2025 "ALL GAS")	981.3 (97%)	0 (0%)	26.7 (3%)	1008
(2025 "MIXED)	787 (78%)	137.3 (14%)	83.7 (8%)	1008

SITUATION 1985

	COAL	OIL	GAS	TOTAL
PRODUCTION OF FOSSILE ELECTR. (MTCE combustibles)	5.5 (12%)	33.7 (72%)	7.7 (16%)	46.9 (100%)
CO_2 EMISSION (C in millions of tonnes)	4.0	17.9	3.0	24.9

SCENARIO T3

	COAL	OIL	GAS	TOTAL
SCENARIO "ALL COAL" PRODUCTION OF FOSSILE ELECTR. (MTCE combustibles)	274.0 (87%)	33.7 (11%)	7.7 (2%)	315.4 (100%)
CO_2 EMISSION (C in millions of tonnes)	200.0	17.9	3.0	220.9
SCENARIO "ALL GAS" PRODUCTION OF FOSSILE ELECTR. (MTCE combustibles)	5.5 (2%)	33.7 (11%)	276.2 (88%)	315.4 (100%)
CO_2 EMISSION (C in millions of tonnes)	4.0	17.9	107.7	129.6
SCENARIO "MIXED" PRODUCTION OF FOSSILE ELECTR. (MTCE combustibles)	71.9 (12%)	143.0 (72%)	38.1 (16%)	253.0 (100%)
CO_2 EMISSION (C in millions of tonnes)	52.5	75.8	14.9	143.1

TABLE IV
(continued)

SCENARIO T3	(1985)	"ALL COAL"	"ALL GAS"	"MIXED"	"ALL NUCLEAR"
PRODUCTION OF FOSSILE ELECTR. (MTCE combustibles)	46.9	315.4	315.4	253.0	46.9
CO_2 EMISSION (C in millions of tonnes)	24.9	220.9	129.6	143.1	24.9

Scenario "ALL COAL" = The total increase of electricity comes from thermal electricity "Coal"

Scenario "ALL GAS" = The total increase of electricity comes from thermal electricity "Gas"

Scenario "MIXED" = Identical distribution for coal, oil, gas as in 1985; increase of nuclear and hydroelectric power identical to the increase of primary electricity of Scenario 3

ANNEX VI

STUDIES ON RENEWABLE SOURCES OF ENERGY CARRIED OUT IN 1986-1989

1. Report of the Seminar on Renewable Energies Utilization in Mediterranean Coastal Zones (Almeria, 20-22 May 1987)*

   Documents presented at the seminar:

   - Introductory report: "Mediterranean Network in the Renewable Sources of Energy" (by N.B. Urly);
   - L'expérience algérienne de développement des énergies renouvelables (par Haut commissariat à la Recherche);
   - Solar Energy Utilization in Cyprus (by I. Papadopoulos);
   - Solar Crop Drying - Egypt (by A. Hegazi, M. El-shiaty, E. El-Sharkawi, T. El-Tablawi and M.S. Abd El-Salam);
   - Etablissement d'une méthodologie de recherche systématique du potentiel solaire d'un espace urbain - France (par D. Drocourt);
   - Application of Solar Energy in Greenhouses and Solar Crop Drying - Italy (by R. Floris and G. Parodi);
   - Austrian-Maltese Research Centre (AMRC) 1981-1985 Research Programme on solar heating and cooling systems - Malta (by E. Scicluna);
   - Greenhouse Irrigations and Habitation Electrification with Photovoltaic Solar Energy - Spain (by A. Luque and E. Lorenzo);
   - Renewable Energy Assessment and some Application of Solar Energy in Croatia - Yugoslavia (by N. Urli, U. Desnica and B.G. Pegrovic);
   - Thermal Solar Energy Application in Tourism - Yugoslavia (by J. Grabovac, P. Novak and M. Bosanac);
   - FAO's Approach to Energy for Rural and Agricultural Development with Special Reference to Solar Energy Activities.
   - Renewable Energy in the Arab States - A Regional Outlook (by ALECSO);
   - Proposal for the preparation of a training course on the applicability of solar energy in Mediterranean countries (by A. Sevilla);
   - Progress Report on the Activity of the Ministry of Electricity and Energy in the Field of Development and Use of New and Renewable Energy - Egypt (by Ministry of Electricity and Energy);
   - A Note on the Renewable Energy Activities in Turkey.

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* In English and French

2. Notes of the Meeting of Representatives of Spanish Institutions and PAP/RAC Related to Preparatory Activities for Training Course on Renewable Energy Sources (Split, 11-12 May 1988)**.

3. Report of the Training Course on Practical Application of Renewable Sources of Energy in the Mediterranean Region (Almeria, 21 November - 1 December 1988)*.

   Training documents:

   - Simulation methods (by S. Alvarez Dominguez);
   - Fundamentals of wind energy conversion (by F. Avia);
   - Fundamentals of low-temperature conversion (by M. Bosanac);
   - Fundamentals and technology of PV conversion (by L. Delgado Martinez);
   - Bioclimatic architecture (by M. Gerber);
   - Conversion efficiencies of solar energy systems (C. Gomez Camacho);
   - Economic analysis of renewable energy sources (by H. Klaiss and J. Meyer);
   - Feasibility and reliability of PV systems (by E. Lorenzo);
   - Availability of wind energy (by F. Martin Morillas);
   - Design of PV systems (by S. McCarthy);
   - Practical considerations on solar system design (by E. Mezquida);
   - Potential of renewable energy sources in the Mediterranean countries (by P. Novak);
   - Environmental approach to renewable energy sources (by J. Pasztor);
   - Operation and maintenance of wind turbines (by J.P. Mustaros);
   - Passive solar architecture fundamentals (by R.S. Florenza);
   - Availability of solar energy (by M. Sidrach);
   - Wind energy systems (by E. Soria);
   - Medium-temperature conversion (by E. Zarza Moya).

4. Notes of the Meeting on the Follow-up of the Priority Action on the Mediterranean Network in Renewable Sources of Energy (Madrid, 15 March 1989**.

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* in English and French

** only in English