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CYPRUS AND THE CLIMATE CHANGE ISSUE AS ENVISAGED IN THE BROADER MEDITERRANEAN REGION

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FORWARD

It is more than true that we depend on weather for food and water, for health and pleasure, for economic well-being and even for survival.

One very prominent theory about the weather is that the Earth is in the process of getting warmer in an unprecedented way. Human beings by burning fossil fuels, clearing rain forests, raising domestic animals and manufacturing certain chemicals are causing carbon dioxide and other gases to build up in the atmosphere where they prevent radiated sunlight from escaping. Heat is trapped in the Earth's surface, causing a rise in temperature known as the "greenhouse effect".

But do we really know how much or how fast the climate will change, and can we say with absolute confidence that it will take place at all? There is a consensus in the scientific community that there is already enough evidence for the coming change and to wait another decade for certainly would be irresponsible. It is more than likely that we will see important changes in 30 to 40 years, and that these will have serious implications for economies and human well-being in many vulnerable regions of the world, including the Mediterranean.

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PART I

INTRODUCTION

Cyprus is the third largest island in the Mediterranean Sea with an area of 9,251 sq.km. It has a maximum length of 224 km from east to west and a maximum width of 96 km from north to south and is situated at the north-eastern end of the west Mediterranean basin.

The country has a population of approximately 660,000. Population distribution by ethnic group in 1960, when the last official census was held, was as follows: out of 527,707 inhabitants, 441,568 or 77.1% were Greek Cypriots, 103,822 or 18.1% were Turkish Cypriots and 27,317 or 4.8% were other minorities i.e Maronites, Armenians, Latins and others.

Cyprus has an intense Mediterranean climate with the typical seasonal rhythm strongly marked in respect of temperature, rainfall and weather generally. Hot dry summers from mid-May to mid-September and rainy, rather changeable winters from November to mid-March are separated by short autumn and spring seasons. The average annual total precipitation for the island as a whole is 500mm. Snow occurs rarely in the lowlands and on the northern range but falls frequently every winter on ground above 1000 meters. Although snow cover is not continuous, during the coldest months it may lie to considerable depths for several weeks. Temperatures are high in summer while winters are mild. Sunshine is abundant all year round and particularly from April to September when the average duration of bright sunshine exceeds 11 hours per day.

The island's unique shape is due, geologically, to the occurrence of two ridges. The north coastal plain covered with olive and carob trees is backed by a steep narrow mountain range of limestone, the Pentadactylos Range, rising to a high of 1010 meters. In the south the extensive massif of Troodos, covered with pine, dwarf oak (quercus), cypress and cedar, culminates in the peak of Mount Olympus, 1951 meters above sea level. Between the two ranges lies the fertile plain of Mesaoria open to the sea at east and west.

Of the total area of the country 46,8% is arable land while the total forest land is 19%. Roughly 12% of the total cultivated land is irrigated, about 4% is perennially irrigated, while in a normal year a further 13% can be watered from spate floods.

The principal crops in the lowlands are cereals (wheat, and barley), vegetables, potatoes and citrus. The olive-tree grows everywhere but flourishes particularly on the southern and western slopes. Vinyards occupy a large area on the southern and western slopes of the Troodos mountains. Deciduous fruit trees are grown in the fertile mountain valleys. The most valuable export crops are mainly potatoes, citrus, vegetables and table grapes. Sheep and goats are mainly reared in sheds or tethered, but the semi-nomadic traditional system of grazing is still exercised although not on a significant scale.

Cyprus has a remarkable variety of landscapes and scenery. Its coastline alternates between rocky shores, promontories and sandy bays. The Pentadactylos Range stretches for about 100kms along the north coast. Rocky peaks stand out against clear skies while the Troodos mountain massif in the south-western part is a maze of ridges and valleys. The central plain of mesaoria is studded with a number of "mesas" and a variety of soils. This variety of landscapes makes Cyprus a country of outstanding scenic beauty, with many features which are unique; and it is precisely this "uniqueness" that makes a great number of areas priceless and justifies their protection and preservation in their natural state.

PART 2

CLIMATIC CHANGES AND THE GREENHOUSE EFFECT

It has been known since late 19th century that a manmade or anthropogenic warming of the earth's climate was possible due to the atmospheric emissions and radiative properties of industrial and agricultural "greenhouse gases" (carbon dioxide, methane, nitrous oxide, ozone, chlorofluorocarbons). The greenhouse effect is, in fact, normal to earth and essential to life. Without its effect the earth would be more than 30 degrees celsius cooler and life as we know it would not exist. It is the additional greenhouse effect, underway since the industrial revolution began, that poses the threat of climate change.

There is a consensus in the scientific community that if industrial activity is continued at present time rates, a doubling of the greenhouse gases concentration will occur sometime in the 21st century, possibly around 2030 AD and a corresponding global increase of temperature between 1.5° - 4° C is predicted to be come effective 2-3 decades later. Not since the down of civilization, 10,000 years ago, has the earth been 1° C warmer than it is today and only during the oscillations associated with Pleistocene glacial advance and retreat, did temperature change would have profound effects on global ecosystems, water resources and agriculture.

For the Mediterranean Basin, General Circulation Models point to a warming similar in magnitude to the global-mean value and although the magnitude of this warming is uncertain we can be fairly confident that, as a prediction, it is qualitatively correct.

As far as precipitation is concerned, projected changes vary so much from model to model that one cannot say, on the basis of model results only, whether precipitation will increase or decrease. Much of the precipitation in the Mediterranean region 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.

Another main consequence of a warmer atmosphere is an accelerated rise of sea level, due to melting of alpine glaciers and polar ice caps and due to the thermal expansion of oceanic waters. Sea-level has been rising since the last glacial maximum (120m rise in the last 16,000 years at rates of 8 to 12 mm/year) while in recent historical times the rate has been 0.5 to 1.5 mm/year.

Depending on the extent of oceanic thermal expansion and the behavior of the polar ice caps, conservative moderate estimates of sea level rise range between 13-39 cm (by 2025), 24-52 cm (by 2050) and 38-91 cm (by 2075). However there will be a significant lag in sea level rise, coupled with oceanic thermal inertia. If for example, 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.

PART 3

PREDICTED IMPACTS OF CLIMATE CHANGE ON THE MEDITERRANEAN ENVIRONMENT

Various marine parameters will be affected by the likely general northward shift of the atmospheric circulation pattern which will influence also the path and frequency of passage of midlatitude cyclones over some parts of the Mediterranean area.

The impact of large scale climatic variations, 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 established stratification of the sea water 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 affect 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.

As far as the impact of climatic changes on the coastal zone is concerned, 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 same lagoons into bays, the flooding of reclaimed lands and coastal wetlands, salt wedges to move further inland in rivers, as well as direct damage to harbors, towns and roads.

In terms of physical impacts, increases of more than 30cm should be considered to be moderate, because they could be coped with by gradual adjustments to existing coastal defenses and by accepting modest losses. The beaches in most countries will continue to retreat, while greater increases (more than 50cm), at least locally, would have catastrophic consequences. Main concerns would be wave attack on harbor structures, the retreat of the headlands, the flooding of the residential and industrial quarters and the management of lagoons and coastal wetlands.

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 more erratic rainfall, drier summers, higher evapo-transpiration rates while air circulation to the mountain masses would remain the same. The areas of lesser reliable rainfall

might increase and shift northward and overall, rainfall is expected to decrease in the south. Lesser and more erratic precipitation would cause reduced groundwater recharge and therefore lesser groundwater levels.

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. The average storage in the reservoirs will fall by up to 25% due to decreased river flow and precipitation and increase evapo-transpiration. Reservoirs will be nearly empty up to 19% of the time with serious siltation and storage capacity problems.

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. The expected climatic changes should not result in a major shift in the boundaries of the main soil types. 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 region. Forested areas will also be adversely affected by the increase frequency of fire. Evapo-transpiration and any decreases in the rainfall duration and intensity would increase salt accumulation which would particularly affect areas with an annual rainfall of less than 600mm.

Aquatic ecosystems is likely to be affected profoundly by temperature rise. Shallow onshore marine areas would become warmer and more saline, locally hypersaline. In some areas even a 1° C rise might have a marked adverse effect on fish life because of changes of oxygen concentration and changed water chemistry.

Significant changes in the amount of mean annual rainfall or in its seasonal distribution pattern would have dramatic effects on natural vegetation. A general 2 C warming would lead to a shift of the natural range of species by 300-500km northward and 300m in altitude. Forest are likely to suffer from the increased temperature and aridity. The coastal plantations will suffer from salinization and, probably, remobilized sand dunes and the Mediterranean maquis cover could be affected by desertification. Finally, forest fires will become more frequent, also involving higher areas than at present.

Regarding the impact of climate change on agriculture it is almost certain that weather fluctuations will affect several Mediterranean crops. 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. Soil fertility should tend to decrease, fewer nutrients being available to the plants due to increase soil salinity. Irrigation would become increasingly necessary while cultivated areas in floodplains could be affected by a greater incidence of floods.

Climatic changes should not affect the distribution and dynamics of human societies in the littoral zones, because the natural growth of the population will continue to follow the present trends in the individual countries. Nevertheless migration to coastal areas could accelerate in the south due to increased desertification in the interior. 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. A major risk is represented by an increase in frequency and intensity of storms and of storm surge flooding.

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 and
- 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 the expected impacts.

PART 4

SOME ISSUES RELEVANT TO CLIMATE CHANCE AND ITS IMPACT ON THE ENVIRONMENT OF CYPRUS

4.1 Climatic Trends

In the past, the Mediterranean region has experienced climatic changes with significant fluctuations of temperature and precipitation, although less intense than those experienced in the northern latitudes, at least as regards temperature.

In Cyprus instrumental meteorological records, which go back to 1881, reveal a decreasing trend in precipitation amounts and an increasing trend in temperature. As regards precipitation there is a remarkable uniformity in the precipitation trend in the coastal areas, in the central plain and on the high mountains with highest elevation upto about 2km.

For Cyprus as a whole the average annual precipitation for the period 1951-1980 is 477mm. This average value is 2.5% less than the average for the period 1941-1970 and 5% less than the average for the period 1916-1950. The variability is even higher if different averaging periods are chosen. Moreover, the annual variability of the precipitation in the last 30 years is greater than in the preceding period.

The records of air temperature for Nicosia, in the central plain of Cyprus, show a slight variation in temperature from year to year and a slight increase in temperature as from the early 1920's. The average annual temperature for the period after 1920 is about 0.5°C higher than in the preceding period.

The conclusion drawn from the instrumental meteorological records is that in this century the climate of Cyprus is experiencing a decreasing trend in precipitation and an increasing trend in temperature.

4.2 Sea-water Intrusion

Although sea-water intrusion problems in Cyprus are not attributed to climatic changes nevertheless the end result is identical. The intensive exploitation of the groundwater led to the development of extensive depressions of the groundwater table in all major coastal aquifers of the Island. As a result of the lowering of the groundwater table in the coastal aquifers the rate of freshwater outflow to the sea was reduced, the hydrodynamic balance was disturbed and seawater has moved inland, thus deteriorating the quality of the groundwater and limiting drastically its use, both for irrigation and domestic purposes.

The phenomenon of seawater intrusion is present in almost all coastal aquifers of the Island. Typical examples of important aquifers which have been affected by seawater intrusion are those of Western and South-Eastern Mesaoria.

The coastal aquifer of Western Mesaoria has been intruded by seawater about 6km inland (pre-1974 situation) with a maximum lowering of groundwater table of about 8 metres below sea-level. This intrusion started in 1964-1965.

The coastal aquifer of South-Eastern Mesaoria is being overxploited and has undergone depletion during the last 30 years at a very high rate, with a mean annual lowering of the water table of about 2 metres. It was estimated that this intrusion is about 3km inland and the amount of seawater which has intruded the aquifer is about 10 million cubic metres.

4.3 Sea Level Rise

Though much work needs to be done on models to predict the likely effects of global warming it is generally agreed that some increases in sea level are to be expected. Figures of about 20cm are quoted as likely for the year 2025.

The impact of such a rise is not, by itself, likely to have a significant direct impact on the coast of Cyprus in that time period except in local situations such as on coastal lagoons (Akrotiri lake etc.) and perhaps on some beaches. Local subsidence and other factors may, however, make the relative sea level rise much greater. The impact of even a 20cm rise is likely to lead to increased coastal erosion which is likely to be also adversely affected by the stopping of the transfer of material to the sea by the construction of dams. Increased exposure to waves of certain areas (e.g. Larnaca front) may also have catastrophic results. The impact of a larger sea level rise would no doubt have much more disasterous effect on coastal towns, hotel installations, aquaculture installations etc. There may also be impacts on central sewage schemes and an intensification to the already existing problems of sea-water intrusion in coastal aquifers.

PART 5

STEPS TOWARDS THE RIGHT DIRECTION

5.1 Energy Efficiency and Conservation

Cyprus is almost totally dependant on imported energy for satisfying its needs and hence energy is of vital importance to the island's economy. The main measures which have been taken or planned by the Government in order to achieve greater energy efficiency and less polluting energy production are the following:

- Energy Planning and Data Base Study
- Energy Audits in Industry and Commerce
- Energy Conservation Programme for the Electricity Authority
- Energy Conservation Programme for the Petroleum Refinery
- Reduction of Energy Consumption and Pollution in the Transport Section
- Energy Conservation Campaigns/Information and
- Participation in Regional and International Energy Programmes.

At the same time a number of measures have been introduced for limiting the rate of increase or reducing the present level of energy consumption on the Island.

In Cyprus, renewable energy resources constitute the only indigenous source of energy and their contribution in meeting the total energy requirements of the country is about 3.5%, from which almost 3% is from solar energy. In this field Cyprus is one of the leading countries as regards the utilization of solar water heating systems for the production of hot water. 90% of individual houses, 15% of flats and 50% of hotel and hotel appartments are equipped with solar water heating systems. In 1987 the total installed area of solar collectors was 455,673 m2 resulting in a ration of 0.82m2 per capita, which is among the highest in the world.

Regarding energy consumption in building, a mandatory code of practice on designing energy efficient buildings has been prepared but not yet enforced.

Finally among the basic energy objectives of the 1989-1993 Development Plan are:

- Measures for Conserving Energy
- Measures for Changing the Balance of Energy Sources
- Institutional Measures and
- Measures for Further Development of Renewable Energy Sources.

5.2 Recycling of Raw Materials

Local industries are actively engaged at different stages of recycling activity. This includes recycling of used products to manufacture similar new products or recycling to provide either raw materials for other industries or materials for export. Programmes to encourage recycling activity include import and export licencing control, protection offered to local recycling units. Examples of recycling activity in Cyprus include recycling of car batteries, glass bottles, scrap metals, used lubicating oils while Municipalities are studying the feasibility of the more systematic recycling of refuse.

5.3 Carbon Dioxide and CFC's Emissions

Reduction of CO2 emissions can be achieved through energy conservation and the use, where possible, of clean resources of energy like solar, wind and hydo as well as fuels other than coal and oil. Despite the efforts made to reduce energy consumption through the above measures, developing countries like Cyprus will unavoidably continue to consume more and more energy resulting in higher CO2 emissions. Cyprus will follow and adopt any appropriate technology that may be available and suitable in the future, to reduce CO2 emissions from power plants and other boiler installations. Within this context Cyprus is considering for signing the Convention on Long Range Transboundary Air Pollution.

Cyprus although a non producing country of chlorofluorocarbons and a marginal user of these substances, nevertheless is taking serious steps towards the reduction and eventual subtitution of CFC's by other "ozone safe" products, in the various manufacturing processes. We are also at an advance stage for ratifying the Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Susbstances that Deplete the Ozone Layer.

5.4 Environmental Impact Assessment Studies

In making political decisions compatible with sustainable development the Government of Cyprus has taken decisive steps for the substantive incorporation of the environmental dimension in the overall socioeconomic development strategy of the island. Among others, the institutional framework for environmental planning has been strengthened and environmental impact assessment of new projects has become a necessary preconditon for their approval.

5.5 Public Awareness

The new environmental approach of the Government is based on the principle that the task of protecting the environment is not, solely, the concern of a number of governmental departments or organizations but the concern of every single active force of the society.

In an effort to increase public awareness, concerns and participation in the country's socio-economic development and environmental planning and management, the Government of Cyprus has recently materialized the participation of Non-Governmental Organizations (NGO's) in the Council for the Protection of the Environment, an advisory body chaired by the Minister of Agriculture and Natural Resources, and the District Environment Committees. A special Government Fund for granting of subsidies, on special grounds, to NGO's, has been initiated and a programme for the proper information of the public on environmental issues, of general concern, is presently at an advanced stage of preparation.

In concluding it should be stressed out that the Government of Cyprus regognizes and adopts the general principle that the building of environmental awareness through proper education and the appropriate dissemination of information is of paramount importance in sensitizing and shaping peoples (especially of the youth) values and attitudes towards safequarding the environment in which they now live in and which they are going to hand over to the generations to come.

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