MAB report series No. 43

Montpellier
26 September-2 October
1976

Programme on Man and the Biosphere (MAB)

MAB-Mediterranean Scientific Conference: Regional meeting for MAB National Committees of countries bordering the Mediterranean Sea

Final Report

Unesco 1978

Previous reports in this series:

1. *International Co-ordinating Council of the Programme on Man and the Biosphere. First session. Paris, 9-19 November, 1971.*

2. *Expert panel on the rôle of systems analysis and modelling approaches in the Programme on Man and the Biosphere (MAB). Paris, 18-20 April, 1972.*

3. *Expert panel on Project 1: Ecological effects of increasing human activities on tropical and subtropical forest ecosystems. Paris, 16-18 May, 1972.*

4. *Expert panel on Project 12: Interactions between environmental transformations and genetic and demographic changes. Paris, 23-25 May, 1972.*

5. *Expert panel on Project 5: Ecological effects of human activities on the value and resources of lakes, marshes, rivers, deltas, estuaries and coastal zones. London, 19-22 September, 1972.*

6. *Expert panel on Project 3: Impact of human activities and land use practices on grazing lands: savanna, grassland (from temperate to arid areas), tundra. Montpellier, 2-7 October, 1972.*

7. *Expert panel on educational activities under the Man and the Biosphere Programme (MAB). Paris, 5-8 December, 1972.*

8. *Expert panel on Project 6: Impact of human activities on mountain ecosystems. Salzburg, 29 January-4 February, 1973.*

9. *Expert panel on Project 13: Perception of environmental quality. Paris, 26-29 March, 1973.*

10. *International Co-ordinating Council of the Programme on Man and the Biosphere. Second session. Paris, 10-19 April, 1973.*

11. *Expert panel on Project 7: Ecology and rational use of island ecosystems. Paris, 26-28 June, 1973.*

12. *Expert panel on Project 8: Conservation of natural areas and of the genetic material they contain. Morges, 25-27 September, 1973.*

13. *Expert panel on Project 11: Ecological aspects of energy utilization in urban and industrial systems. Bad Nauheim, 16-19 October, 1973.*

14. *Working group on Project 6: Impact of human activities on mountain and tundra ecosystems. Lillehammer, 20-23 November, 1973.*

15. *Consultative group on Project 9: Ecological assessment of pest management and fertilizer use on terrestrial and aquatic ecosystems (Part on fertilizers). Rome, 7-9 January, 1974.*

16. *International working group on Project 1: Ecological effects of increasing human activities on tropical and subtropical forest ecosystems. Rio de Janeiro, 11-15 February, 1974.*

17. *Task force on the contribution of the social sciences to the MAB Programme. Paris, 28 February-2 March, 1974.*

18. *Regional meeting on integrated ecological research and training needs in the Sahelian region. Niamey, 9-15 March, 1974.*

19. *Expert panel on Project 2: Ecological effects of different land use and management practices on temperate and mediterranean forest landscapes. Paris, 16-19 April, 1974.*

20. *Task force on pollution monitoring and research in the framework of the MAB Programme. Moscow, 23-26 April, 1974.*

21. *International working group on Project 5: Ecological effects of human activities on the value and resources of lakes, marshes, rivers, deltas, estuaries and coastal zones. Paris, 13-17 May, 1974.*

22. *Task force on criteria and guidelines for the choice and establishment of biosphere reserves. Paris, 20-24 May, 1974.*

23. *Regional meeting on integrated ecological research and training needs in the Andean region. La Paz, 10-15 June, 1974.*

24. *Expert consultations on Project 9: Ecological assessment of pest management and fertilizer use on terrestrial and aquatic ecosystems (Part on pesticides).*

25. *International working group on Project 3: Impact of human activities and land use practices on grazing lands: savanna and grassland (from temperate to arid areas). Hurley, 2-5 July, 1974.*

26. *Regional meeting on integrated ecological research and training needs in the South East Asian region. Kuala Lumpur, 19-22 August, 1974.*

27. *International Co-ordinating Council of the Programme on Man and the Biosphere. Third session. Washington, D.C., 17-29 September, 1974.*

28. *Regional meeting on integrated ecological research and training needs in Latin America, with emphasis on tropical and subtropical forest ecosystems. Mexico City, 30 September-5 October, 1974.*

29. *Expert panel on Project 4: Impact of human activities on the dynamics of arid and semi-arid zones' ecosystems, with particular attention to the effects of irrigation. Paris, 18-20 March, 1975.*

30. *Regional meeting on the establishment of co-operative programmes of interdisciplinary ecological research, training and rangeland management for arid and semi-arid zones of Northern Africa. Sfax, 3-12 April, 1975.*

31. *Task force on integrated ecological studies on human settlements, within the framework of Project 11. Paris 2-6 June, 1975.*

32. *Task force on Project 14: Research on environmental pollution and its effects on the biosphere. Ottawa, 5-8 August, 1975.*

33. *Regional meeting on integrated ecological research and training needs in the humid tropics of West and Central Africa. Kinshasa, 29 August-5 September, 1975.*

34. *Regional meeting on integrated ecological research and training needs in the Southern Asian mountain systems, particularly the Hindu Kush-Himalayas. Kathmandu, 26 September-2 October, 1975.*

35. *Regional meeting on integrated ecological research and training needs in tropical deciduous and semi-deciduous forest ecosystems of South Asia. Varanasi, 5-11 October, 1975.*

36. *Regional meeting on integrated ecological research and conservation activities in the northern Mediterranean countries. Potenza, 27-31 October, 1975.*

37. *Expert consultations on Project 10: Effects on man and his environment of major engineering works.*

38. *International Co-ordinating Council of the Programme on Man and the Biosphere. Fourth session. Paris, 18-26 November, 1975.*

39. *Regional planning meeting of the MAB National Committees of Andean countries, with particular attention to Project 6. Lima, 2-5 December, 1975.*

40. *Regional meeting on integrated ecological research and training needs in North East Africa and in the Near and Middle East, with emphasis on the ecological effects of irrigation derived from large river basins. Alexandria, 24-27 February, 1976.*

41. *Regional meeting on integrated ecological research in temperate zones of the northern hemisphere, in the framework of Project 2. Brno, 24-29 April, 1976.*

42. *Planning meeting for Project 11, with emphasis on industrialized settlements. Amsterdam, 8-12 June, 1976.*

TABLE OF CONTENTS

S Y N O P S I S

Following the recommendation of the International Co-ordinating Council at its fourth session in November 1975, the MAB National Committee of France and the Unesco National Commission of France organized, with the help of Unesco, a MAB-Mediterranean Scientific Conference which was held from 27 September to 2 October 1976 at the Regional Centre for Pedagogical Information (RCPI) at Montpellier.

One hundred and twenty participants from fifteen countries bordering the Mediterranean Sea attended the Conference: Algeria, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Morocco, Monaco, Spain, Syria, Tunisia, Turkey, Yugoslavia, as well as representatives from the United Nations Educational, Scientific and Cultural Organization (Unesco), the United Nations Environment Programme (UNEP), the Food and Agriculture Organization (FAO), the World Meteorological Organization (WMO), the Organization of Economic Co-operation and Development (OECD), the Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée (CIESM), the Centre International des Hautes Etudes Agronomiques Méditerranéennes (CIHEAM), and the Institut Agronomique Méditerranéen (IAM). Observers from countries outside the region were also present at the meeting.

Recommendations for each of the eleven themes discussed by the delegates were sent to the International Co-ordinating Council of the MAB Programme for final approval during its next session in 1977. These recommendations included important perspectives for bilateral and multilateral co-operation in the Mediterranean region. Some recommendations of general interest are given below.

Concerning Conference theme 1 on "Fire and forest ecosystems and those resulting from forest degradation (garrigue, maquis, matorrales)", the delegates emphasized amongst other things, the importance of two meetings planned for 1977 for the future development of this sub-theme of MAB Project 2. A Technical Consultation on forest fires was planned at Saint-Maximin (France) for May 1977, to be jointly organized by FAO, Unesco and IUFRO (International Union of Forestry Research Organizations) in collaboration with UNEP, and an International Symposium on the consequences and use of fire in mediterranean climate ecosystems, to be held in California in August 1977 at the invitation of the MAB National Committee of the United States. The delegates also hoped that the Mediterranean MAB National Committees would draw up for their respective countries a list of organizations carrying out research or studies relating to fire with a view to the subsequent setting up of a regional information centre on forest and forest-derived ecosystems.

Concerning theme 2 on "Grazing in forests and marginal areas", the Conference recommended that the Sardinian project be retained as a MAB pilot project for the Mediterranean region, considering the progress that had been made and the variety of ecological situations that were represented. The delegates also felt that a Mediterranean working group be established for this project. This group would be responsible on the one hand for organizing an annual meeting for information and planning in Sardinia and, on the other hand, for ensuring exchanges of information between the different national teams.

A large number of recommendations were made for theme 3 on "Rangelands in Mediterranean arid and semi-arid areas", amongst others requesting the speeding up of the establishment of a regional centre in Tunisia for recycling and continuous training in grazing management. The delegates, noting the existence in the Mediterranean region of an institution, the Ecothèque méditerranéenne, whose aims would likely meet needs of efficient circulation of information, recommended that Unesco

study the possibility of developing the Ecothèque méditerranéenne into a regional-type body which would depend on an information network made up of small working core groups in the interested countries. The countries belonging to such a network would contribute to managing the system according to a procedure yet to be elaborated. The participants noted the necessity of disseminating scientific information, the existence of a considerable mass of information that could be circulated, and wished to encourage the Co-ordinating Committee for North African countries created during the Sfax meeting. It was also noted that a working group should be created for the arid and semi-arid mediterranean areas in which all countries bordering the Mediterranean should be represented. This group's rôle would be to assess scientific results from various projects and to ensure concordance in directions for research, methodology and perspectives.

In dealing with theme 4 on "Deltas, irrigation and water management", amongst other things the Conference asked for the assembly and diffusion of data on water contamination diseases, notably with the collaboration of WHO. The participants noted with satisfaction Egypt's proposal to establish an information centre for ecopathological matters. Concerning the epidemiology of transmissible diseases and the toxic processes linked with the use of pesticides in irrigated areas, the participants gave priority to problems relating to schistosomiasis transmitted by aquatic molluscs, malaria, and more generally diseases and illnesses carried by blood-sucking insects, and also the prevention of bacterial and toxic (pesticides) pollution. The Conference also noted that the development through irrigation of deltaic zones and of agricultural areas in analogous situations presents great difficulties because of the multiple ecological and socio-economic factors involved. The recent experience of the Nile delta and the creation of new irrigated zones next to the delta (Nubareya Project) make apparent the necessity of studies that take into account the integrated management of the entire river basin.

Concerning theme 5 on "Problems concerning drainage basins and protection against erosion", the Conference noted that FAO, Unesco and UNEP would be willing to study the possibility of including a joint meeting in their working programmes and their 1978 budget. This meeting would concern integrated applied research on conservation and development of the natural resources of drainage basins. It noted with satisfaction the MAB National Committee of Morocco's proposition to host such a meeting in 1978.

After discussion on theme 6 on "The impact of pollutants on mediterranean natural areas", a number of recommendations were made, notably with reference to the preparation and dispatch of a questionnaire to the MAB National Committees of mediterranean countries. The aim of this questionnaire would be to evaluate the "pollution and contaminants" situation for each country, including research undertaken in this field. The creation of an ad hoc *working group was also requested.*

Conference theme 7 dealt with "Man's impact on the mediterranean coast, especially tourism". Amongst the recommendations formulated on this subject was the request for the organization of a workshop in Tunisia in 1977 to include experts from mediterranean countries on perception of landscapes and landscape transformations. In the light of this workshop's conclusions, the MAB Secretariat was asked to propose a master plan designed to give directions for research.

After having re-examined the priorities of theme 8 on "Biosphere reserves and preservation of genetic material" in the context of the particularities of the mediterranean region, each country was requested to rapidly prepare a pre-inventory of major mediterranean ecosystems and to draw up an inventory of endangered plant and animal species. The delegates gratefully acknowledged the proposition of ICONA (Instituto para la Conservacion de la Naturaleza, Spain) to conduct activities to set up a network of biosphere reserves representative of the region. Each country was asked to designate a representative to ensure liaisons with ICONA to this effect. The Conference appreciated the generous offer of the MAB National Committee of Turkey to organize a meeting at Side in 1977 for further discussion on scientific aspects of this question.

Studying theme 9 on "Methodology, systems analysis and modelling", the Conference recommended that training and teaching activities be planned at different levels, particularly for young researchers, by making them take a practical course in a modelling centre. The delegates considered that it was important to plan for exchanges of knowledge and local experience in modelling between neighbouring countries. The delegates emphasized that a group of specialists made up of representatives of each mediterranean country should try to standardize the design and the data base of ecological models of the MAB-Mediterranean programme in order to facilitate their transition and use in other modelling systems. It was requested that efforts be made to improve co-ordination between ecologists and socio-economists in the field of modelling so that the models could be successfully used within the framework of management and development, and that the MAB National Committees for all the mediterranean countries encourage the undertaking of research in collaboration with researchers experienced in modelling for each of the fourteen MAB projects.

Theme 10 provided matter for discussion on the problems of training technicians responsible for carrying out field work. The delegates specified that it would be necessary to organize and develop courses in field training centres and in the research laboratories contributing to the MAB Programme in the mediterranean region. These courses should teach researchers and technicians to work with an interdisciplinary approach. They also said that a particular effort should be made in heightening the awareness of decision-makers to environmental problems. There was also a request to organize a working meeting in order to harmonize and co-ordinate training programmes and to establish an exchange network between institutions specializing in training of researchers and technicians.

The Conference finally dealt with theme 11 on "Information". After having noted the urgent need to improve information exchange between the MAB National Committees, the Conference favourably accepted the proposal of the MAB National Committee of Egypt to prepare with Unesco's support a MAB information bulletin for countries bordering the Mediterranean Sea.

PREFACE[1]

In Mediterranean countries, the geographic and ecological diversity as much as that of social and technical traditions are at the origin of a great complexity of agro-ecological systems and ways of life which nevertheless have not altered the remarkable mark of time on the unity and universality of the Mediterranean world.

Agricultural change and more generally the changes in productive activities related to biological resources result from new trends in Mediterranean agriculture: transformation of small-scale traditional agriculture into more intensive holdings; research for resources coming from the exportation of products; development of certain privileged productions such as animal raising, forestry or arboriculture.

This evolution, linked also to social change stemming from a prodigious increase in industry, has given rise to both a regression of the traditional agrarian society and to variations in edaphic and climatic processes which should be noted, by altering water regimes, a consequence of sometimes huge development schemes which upset age-old ecological equilibria and increase the fragility of already vulnerable zones ravaged by man's ancient practices, and finally to an increased degradation of natural environments afflicted by various forms of pollution.

The effects of acceleration and the differential rhythms of evolution should be taken into account. If the trends shown in the Mediterranean region correspond to an overall rule, and if the direction of the evolution has been everywhere the same, its rapidity has however been irregular. The stage of evolution attained by such and such a region is a direct function of the general economic level of each Mediterranean country and of the standard of living of its populations resulting from a confrontation of past culture and aspirations for a new economic order.

The Mediterranean coast has become one of the most popular poles of attraction for tourism and it is without doubt one of the most frequented in Europe. The frequentation has risen from 20 million tourists in 1960 to 61 million in 1973: what will it be in a decade or two? In creating a source of wealth through the development of the tourist industry, there has perhaps been certain profits but the harmful effects of the environmental changes it has engendered are beginning to be realized.

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[1] *Prepared by P. Grison, Scientific Chairman of the French MAB National Committee and President of the MAB Mediterranean Scientific Conference.*

Many things have therefore changed in a few decades, and even more rapidly in the last ten years. In posing the world problem of gradual transformation of all human communities, one evokes all at once the historical evolution of means of production, of agrarian and land-ownership patterns, of demographic disequilibrium ... and the consequences of this transformation on the irregularities of different forms of land use, the changes in plant environment and unfortunately also in the mineral environment. This historical approach relating the characterization and extension of present non-cultivated land and their potential evolution to past socio-economic situations, symbolizes perfectly Unesco's humanist ethic and the realism with which the Man and the Biosphere Programme was conceived and approved at the 16th session of the Unesco General Conference in 1970.

The Conference took note of the inventories established during preceding meetings of experts organized either by Unesco or by other international organizations.

The Conference discussed the means of implementing and the progress of the pilot projects retained by the MAB International Co-ordinating Council whose main objectives, if not their scientific content, are common to all countries of the Mediterranean Basin in spite of the diversity of ecological conditions and social structures.

The Conference objectively noted certain gaps in both the elaboration of the projects' scientific contents and in their means of implementation, advising the enlargement of their field of action and a better methodological approach both submitted for the diligent appreciation of the *ad hoc* working groups.

Some well known gaps appeared concerning the participation of the human sciences without which there could be no integrated research and planning of the management of renewable natural resources.

The Conference, in considering methodology, highlighted the similarity between human impacts on natural environments and on human life styles and the rapid transformation of all kinds of communities, regardless of the research project; socio-economic factors make it impossible to dissociate the effects of fire, over-grazing, tourism, erosion, pollution, or to study interface zones such as the coastal areas, without including the hinterland or the larger maritime zone.

These different problems have already been taken up in a piecemeal fashion in several Mediterranean countries, but it seems, and such is Unesco's motivation,

that the efficiency of their implementation would be considerably improved if it could proceed from a large international consultation in a regional biogeographical framework: the Conference desired that the consultation be facilitated by decentralization and wider diffusion of information on MAB projects in the Mediterranean Basin.

If Unesco and the MAB International Co-ordinating Council have obtained appreciable results in promoting national and international planning organizations to increasingly consult top-level scientific experts, it seems however that insufficient efforts have been made in training executive personnel for which all Mediterranean countries have a pressing need for field work.

Without being a futile ambition, the multitude of Mediterranean 'terroirs' can be the seat for restoring a balanced and diversified development of all activities, human, agricultural, pastoral, industrial, cultural and those relating to crafts, by recreating a 'way of life' which restores to 250 million Mediterranean men and women the lawful pride to open the doors of their future and contribute to a new world humanism, as their ancestors had done so brilliantly in the past.

1. INTRODUCTION

Conforming to the recommendation of the International Co-ordinating Council at its IV session in Paris in 1975, a MAB Mediterranean Scientific Conference for the countries of the Mediterranean Basin was held at Montpellier from 27 September to 2 October 1976. This Conference was organized by the MAB National Committee of France and the Unesco National Commission of France and deals with eleven main themes connected with various MAB projects.

(1) fire in forest and non-forest ecosystems;
(2) impact of grazing on forest and marginal areas;
(3) rangeland in arid and semi-arid zones;
(4) deltaic zones and irrigation problems;
(5) problems concerning drainage basins and protection against erosion;
(6) impacts of pollution on different natural environments;
(7) impacts of tourism on coastal regions;
(8) conservation of biological resources and creation of biosphere reserves;
(9) methodology and modelling;
(10) problems of scientific training;
(11) information.

The Conference is the follow-up of three regional meetings on specific themes of the MAB programme organized in 1975 and 1976 in different localities of the Mediterranean Basin.

Regional meeting on the establishment of co-operative programmes of interdisciplinary ecological research, training and rangeland management in arid and semi-arid zones of North Africa. Sfax/Tunisia, 3-12 April 1975. This meeting concerned five North African countries (Algeria, Egypt, Libya, Morocco, Tunisia) parts of whose territories lie in the arid and semi-arid Mediterranean climatic zone (see MAB report series No. 30). This meeting aimed at formulating co-operative programmes of interdisciplinary ecological research, training and management of the region's rangelands (MAB Project 3).

Regional meeting on integrated ecological research and conservation activities in the Northern Mediterranean countries. Potenza/Italy, 27-31 October 1975. Organized in relation to MAB Projects 2, 4 and 8, the meeting (see MAB report series No. 36) brought together experts from Mediterranean countries situated on the North side of the Mediterranean (France, Greece, Italy, Portugal, Spain, Turkey and

Yugoslavia). The meeting's objective was to establish a regional network of pilot projects with a view to carry out ecological research of Mediterranean forest ecosystems and to set up biosphere reserves in the European part of the Mediterranean region.

Regional meeting on integrated ecological research and training needs in North East Africa and in the Near and Middle East, with emphasis on the ecological effects of irrigation derived from large river basins. Alexandria/Egypt, 24-27 February 1976. The main objectives of this meeting were: to identify priorities for countries where there are already large-scale irrigation projects in river basins; to elaborate integrated demonstration projects and training activities linked to these irrigation projects; and to review the ways and means to implement these activities within the framework of the MAB Programme, with the collaboration and financial assistance of concerned national, regional and international organizations and institutions.

The MAB Mediterranean Scientific Conference at Montpellier assembled 120 participants from 15 countries bordering the Mediterranean Sea: Algeria, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Morocco, Monaco, Spain, Syria, Tunisia, Turkey, Yugoslavia as well as representatives from various international organizations: Unesco, UNEP, FAO, WMO, OECD, CIESM, CIHEAM, IAM. Observers from countries outside the region (but having areas with a mediterranean climate such as Chile and the United States of America) also attended the meeting (see Annex I for list of participants).

The Conference was opened on Tuesday 28 September by the French Minister of the Quality of Life (text of address in Annex 2). There were addresses from Mr. Batisse, Deputy Assistant Director General for Natural Resources and Environmental Sciences of Unesco; Mr. Richard, Rector of the University of Montpellier, University Chancellor and Mr. di Castri, Secretary of the International Co-ordinating Council for the MAB Programme. Mr. P. Grison, France, was elected president of the Conference, Mrs. S. Nasser, Egypt and Mr. O. Weber, Yugoslavia, vice-presidents, and Mr. S. Djebaili, Algeria, rapporteur.

Mr. Thatcher, Director of the UNEP Office at Geneva, presented UNEP's activities in the Mediterranean region and introduced the projection of a film on the Blue Plan.

The Montpellier meeting was preceded on the 27th of September by three field study excursions aimed at teaching the participants about the concrete

problems posed by all of these themes and representing numerous socio-economic aspects and ecological transformations of natural environments.

The 'Montpellier garrigues' excursion presented the main types of plant communities particularly concerned by wildfire factors: combustibility, inflammability, spread, risks, damage, pyrophytic ecological succession.

The 'Larzac Causses' (limestone plateau) excursion was aimed at getting to know in the field, ecosystems that are related to MAB Project 3 (rangeland ecosystems).

During the excursion centred on the Languedoc Coast and the Camargue, the main themes discussed concerned MAB Projects 2 (mediterranean forest ecosystems), 3 (rangeland ecosystems: herds of Camargue horses and bulls), 4 (irrigation problems), 5 (ecological effects of human activities on the value of marshes, deltas and coastal zones), 8 (biosphere reserves), 9 and 14 (pollution), 11 (town planning) and 13 (perception of environmental quality).

Unesco would like to express its thanks to the MAB Committee of France and to the Unesco Commission of France who took the initiative to organize the Montpellier Scientific Conference. It also thanks the Regional Prefect of Montpellier, Mr. Blanc, as well as all the French authorities who gave their generous support to facilitate the running of the meeting.

As was agreed at the MAB Mediterranean Scientific Conference, a consultation was held afterwards at Unesco Headquarters (28 and 29 April 1977), at which members of the Bureau of the Montpellier Conference participated. The aim of this consultation was to revise in detail, and to give a definite form to, the specific recommendations pronounced at the Montpellier Conference and which appear at the end of each chapter.

2. FIRE IN MEDITERRANEAN FORESTED AREAS

2.1 Introduction

Fire has at all times strongly affected plant evolution in mediterranean climates. Fire has long been the simplest, quickest and most economic means to destroy undesirable natural vegetation and clear space for pastures and crops. It is nearly certain that since the Paleolithic, the shepherds and farmers of the Mediterranean Basin periodically burned the forests to make pasture or crop land. Later on at the beginning of the historical era, for example in Sardinia during the Carthaginian occupation, the standing natural vegetation was burnt to create new agricultural land.

This technique is less and less used today but fire remains an important factor, since the mediterranean environment, windswept and dry in summer, especially near the coast, carries fire very easily. Thus every year fire sweeps thousands of hectares of natural vegetation.

2.2 Climatic summary

The reason for the high susceptibility of the mediterranean vegetation is mainly due to the climate, characterized by a long dry summer season with high temperatures and low relative humidity, which is particularly propitious to wildfires.

Total rainfall, which determines a wet or dry year, is not the most important phenomenon influencing fire occurrence. It is rather the quantity and especially the distribution of summer rainfall which has an important effect on the rhythm of wildfire occurrence.

Strong drying winds coming from the North (mistral, tramontane) or the South (sirocco) and air humidity are also important factors governing ignition, spread and surface area.

In addition, the mediterranean vegetation (maquis, garrigue, etc.) is highly combustible, with its species that contain resins and essential oils. The rough terrain of the entire region also could facilitate the spread of wildfires.

It must be added that the presence of millions of people (permanent residents or summer visitors) living in this region creates an 'explosive' situation. A spark alone can start a fire under these conditions. Destruction is often caused by negligence, or unfortunately often from the deliberate setting of a fire.

2.3 Burned areas

The size of areas burned varies greatly from year to year and, in spite of technological progress in fire fighting, the number of fires increases.

In 1970 in Spain and Southern France alone, wildfires swept over 160,000 ha, causing human casualties. In 1974, 140,000 ha were affected by fires. The tendency in South-Eastern France is towards an increase in the number of fires, but a decrease in burned areas, whereas in 1976, in the whole of France, about 120,000 ha were devastated by flames. In Italy, more than 100,000 ha of maquis and forests were burnt in 1974. What is the ecological significance of this problem?

The situation in France has been most thoroughly studied. In a zone covering more than 500,000 ha - Provence, Riviera and Corsica - called the 'Red Zone', average annual areas reach 4%. This means that each forest area in this zone burns once every 25 years.

In many places of South-Eastern France, Corsica, Sardinia, Sicily and North-East Algeria, 10% of the forested area is burnt every year. Since many Near East countries and Portugal are not considered, it can be estimated that fire destroys about 200,000 ha of natural vegetation each year. The cost amounts to a minimum of 50 million dollars per year, including prevention and fire fighting, not counting damage resulting from the erosion, decreased soil fertility, infilling of lakes and dams, etc. Approximately three quarters of this damage is localized in the Western part of the Mediterranean where the afforestation rate is ten times higher than in the Eastern part (excepting Turkey and Greece).

2.4 Causes

Wildfires are rarely due to natural causes, such as lightning. Fires are most often lit directly or indirectly by man; through the negligence of passers-by who throw away cigarettes or non-extinguished matches, or who light fires for fun or for cooking, leaving the smouldering embers in the wind.

Wildfire is often caused by fires set to destroy brush or to clear ditches. Unfortunately it is a method that is still used by peasants and roadmen. In addition, it is becoming increasingly common in certain touristic regions for fires to be deliberately set in order to destroy the vegetation and thereby to depreciate a piece of land so that it can be used for building or for other purposes that normally would not be permitted.

The burning of rangeland is an important cause of wildfire in developing countries or in certain European countries, such as, for example, in Corsica, certain parts of Algeria, Italy, Greece, Spain, Tunisia and Turkey.

In Europe (France, Italy, Greece, Spain), negligence corresponds most of the time to tourist-connected activities. The majority of wildfires occur during the summer months, and more than a third of them start at roadsides. Abandoned bottles, acting as lenses on plant litter, are also a significant cause of fires.

2.5 The vegetation that burns

Mediterranean vegetation is particularly combustible. Pine forests are amongst the most vulnerable to fire. The forests of *Pinus halepensis* cover vast areas of France, Italy, Greece, Turkey, Algeria and Spain; they are the most seriously affected by fire. In Greece, the *P. halepensis* forests represent one-third of the burned area. There is about the same proportion in Spain, France and Italy. Other coniferous species such as *P. pinea, P. pinaster, P. laricio* are very combustible. Next come the woods or coppices of evergreen oaks: *Quercus ilex, Q. suber, Q. coccifera* and *Q. calliprinos* which often make up degraded stands called 'garrigues' or 'matorrales'. The forests least susceptible to fire are those made up of deciduous oaks or beech forests (*Quercus lanuginosa, Q. pyrenaica, Q. faginea, Fagus silvatica, F. orientalis*) and fir forests (*Abies pinsapo, A. cilicia, A. cephalonica*). These least vulnerable stands are not typically mediterranean vegetation but belong to transition zones where the summer rainfall is relatively high.

2.6 The effects of fire

The effects of fire can be grouped in four categories: loss of products, loss of services, socio-economic impacts and ecological effects.

The loss of products can be loss of merchantable timber or other wood, cork, forage, fish or game. Thus in 1974, Spain lost a capital greater than 40 million US dollars through forest fires. As for loss of services, these are measured in terms of fresh water and touristic values. Loss of human life can be considered as a socio-economic impact. However, fire can also damage buildings. Thus in Spain every year forest fires cause damage which can be expressed in monetary terms. Finally, ecological effects of forest fires concern not only the vegetation but also the fauna. There is little data available on the impact of fire on plant communities of the Mediterranean Basin, even less on animal communities.

In sclerophyllous plant communities like the garrigue and the maquis, fire destroys the above-ground shoots except the main stems of the largest woody species; the litter is also entirely burnt away. Fire considerably weakens the vigor and the trend in succession towards the climax. Wildfires damage or completely destroy the plant biomass, but also affect the root stocks, seeds and litter. Erosion generally follows. The microflora and microfauna of the upper soil horizon are also destroyed.

Wildfire is a very important limiting factor from a plant evolution point of view, for when it occurs each year at the same season, the vegetation is obliged to always remain at the same stage or to regress, and therefore cannot evolve towards the climax, which seems to be confirmed by the following examples from around the Mediterranean Basin.

Near Gerona (Spain) in 1973, wildfire ravaged a forest of *Quercus suber, Pinus pinea* and *P. halepensis*: this site became a highly inflammable area of brush dominated by *Quercus coccifera, Rosmarinus officinalis, Genista* spp. In the same way near Valencia (Spain) a forest of *Pinus pinaster* and *P. halepensis* destroyed by fire shows signs of being recolonized mainly by *P. halepensis* because of the numerous seedlings, but this latter species is less useful than *P. pinaster* for wood production.

Another example can be taken in Italy, in Sardinia next to Nuoro, where the fire of 1934 destroyed a forest of *Quercus ilex* and *Juniperus oxycedrus*; forty years later there are only a few sprouts of *Juniperus* and no sprouts nor seedlings of *Quercus*. In the same way certain garrigues of *Cistus* or *Erica* or *Calycotome* in the South of Italy never reach the point of developing into the real maquis stage.

In Tunisia, because of repeated wildfires and grazing, the *Quercus ilex* and *Q. suber* forests are becoming rarer and rarer.

Of course not all mediterranean plant species show the same degree of sensitivity to fire; there are numerous species which, being resistant, manage to regrow and bit by bit recolonize the area. Amongst the species which resist fire better than others and which can regenerate include: *Quercus ilex, Q. coccifera, Pistacia lentiscus, Phillyrea angustifolia, Erica arborea, Chamaerops humilis. Pinus halepensis, Rosmarinus officinalis, Cistus* spp., *Calycotome spinosa, C. villosa* only reproduce from seed. Germination is even stimulated by fire for the last two species.

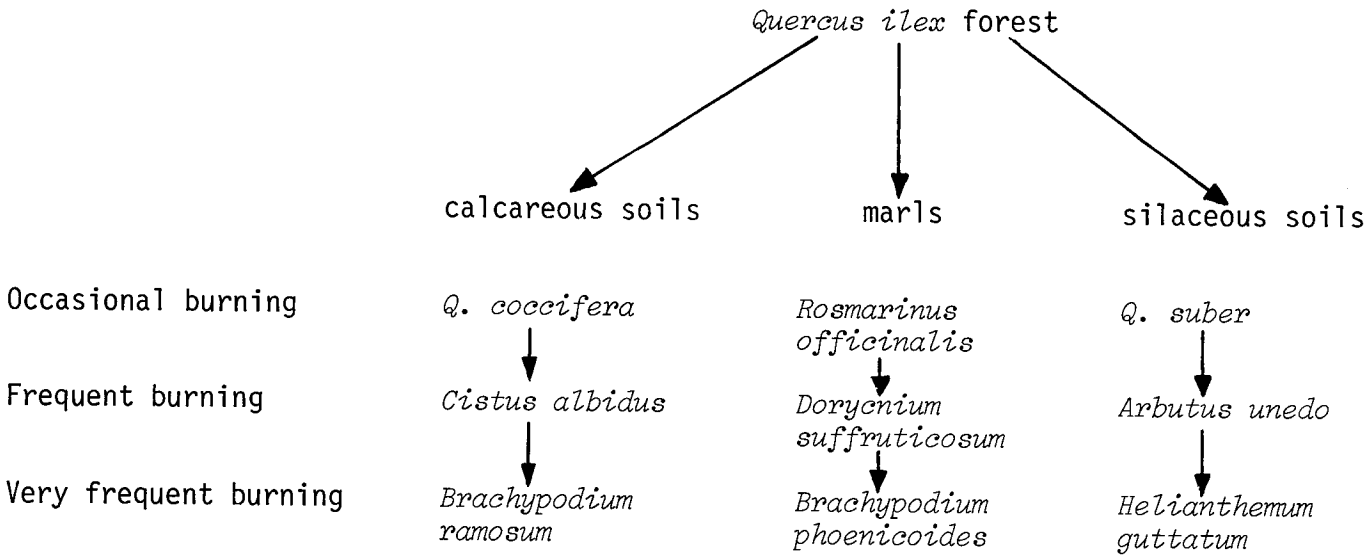
The case of the Kermes oak (*Quercus coccifera*) merits special attention. This oak is a typical pyrophyte, evergreen and sclerophyllous, covering vast areas,

probably more than 2 million ha in the South of France, Spain, Italy, North Africa and the sub-species *Calliprinos* in Libya, Crete, Cyprus, Greece and the Near East. Although it can sometimes grow into a small tree (3-5 m) in natural conditions, it rarely reaches this size because of repeated wildfires. It is generally found in brush form 0.5 to 1.5 m high with prickly leaves. *Quercus coccifera* has a two-fold capacity for regenerating after fire, both from ground shoots and root suckers. It has a very strong although superficial root system which forces its way through cracks and fractures in the rock. Seedlings are rarely found because this species spreads mainly by vegetative reproduction stimulated by fire. The Kermes oak has been for centuries in equilibrium with periodic fires caused mainly by shepherds. However, when fires occur too frequently, the oak can be killed leaving gaps in which appears *Brachypodium ramosum*.

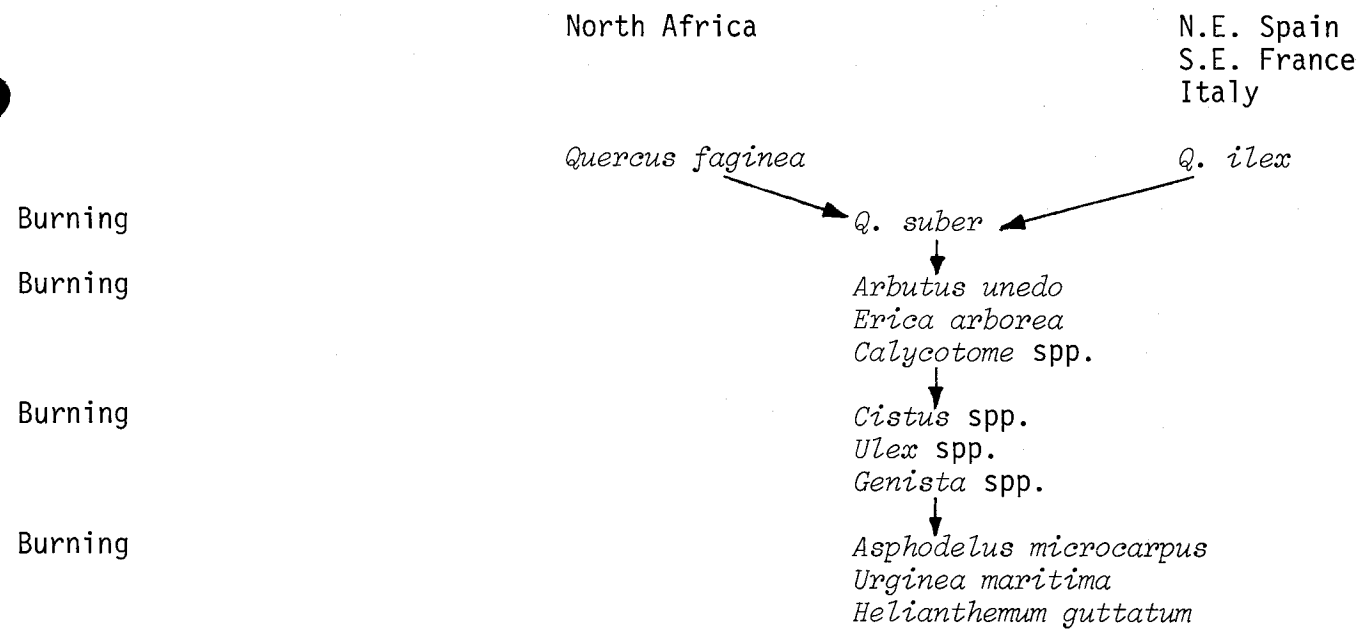
2.7 Pyrophytic sequences

Various authors have assembled the changes in plant cover which appear after wildfire into pyrophytic sequences.

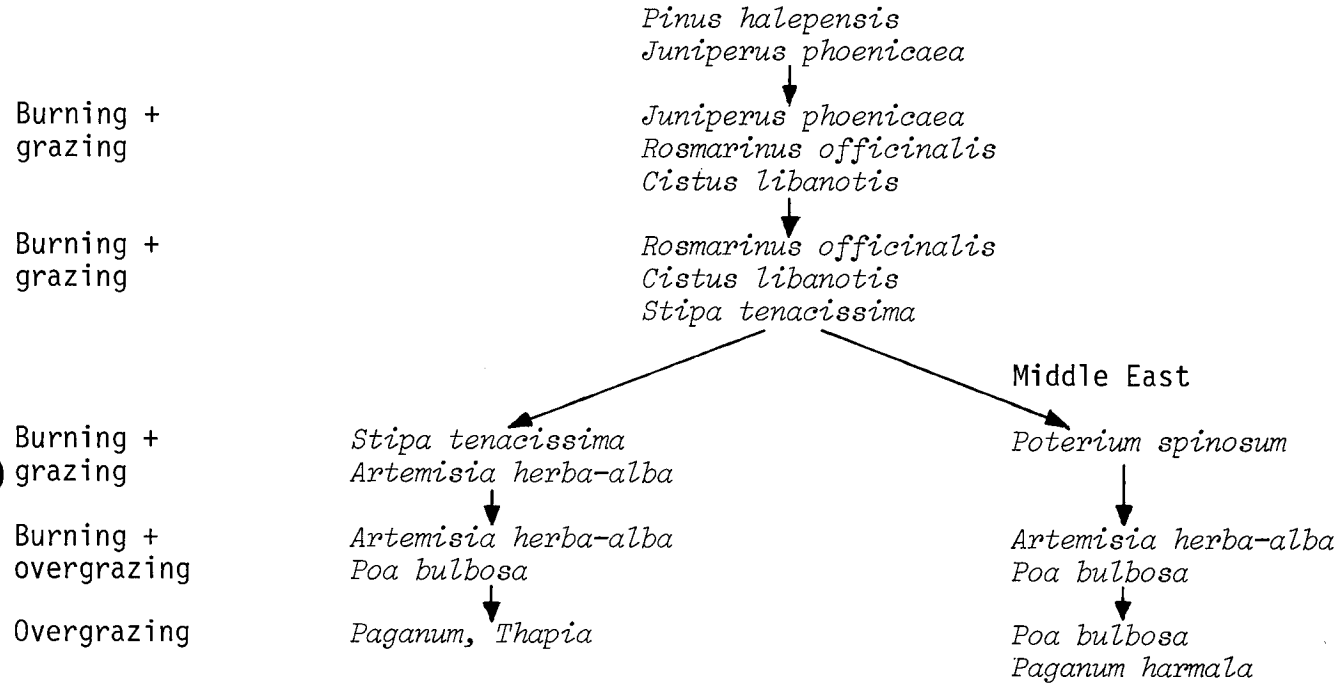
In the South of France and probably in certain regions of Spain and Italy, regressive succession can be summarized as follows. However, immediately following fire in the Kermes oak coppices, the soil is colonized by species which existed before the fire, accompanied by some nitrophilous annuals and apparently in spite of regular burning, the floristic composition of these plant communities is quite stable.



In North Africa (N.W. Tunisia, N.E. Algeria, Morocco), in Spain, and in the South of France, the pyrophytic regression can be outlined as follows:



In the Southern and Eastern part of the Mediterranean Basin, the regressive pyrophytic series are the following:



2.8 Conclusions

Mainly because of the nature of the climate, mediterranean vegetation is swept every year by numerous fires. In addition, Man has burnt the forests for thousands of years to obtain better pasture or arable land.

Fire affects the vegetation structure, composition and productivity. The forests not affected by fire, at least those which have not been burnt for 50 or 100 years or

more, have a simple structure only with trees, creepers and some herbaceous plants. With occasional fire, the structure becomes more complex and includes herbaceous plants, trees and bushes of different sizes. When fire is too frequent, however, the structure becomes simple again, with only low shrubs and annual or perennial herbaceous plants. The most degraded stages are very simple with only a herbaceous stratum.

There are very few studies on the use of fire as a practical tool for fuel management. It must be hoped that the causes of fire and its effects on mediterranean vegetation will rapidly become topics for research in order to better understand and master the ecological force that fire represents.

2.9 Recommendations

The evolution and the actual physionomy of mediterranean forest and non-forest ecosystems result from the combined action of inseparable natural and human factors. No study can lose sight of these two aspects (thus certain questions relating to the use of fire must be linked with the grazing problem in forested and marginal zones).

On the other hand, very little is known about mediterranean ecosystems, and many questions about their structure, functioning and management still remain unanswered. It is therefore necessary to increase fundamental research, but, in waiting for results, it is indispensable to manage these ecosystems with great care in order to avoid irreversible evolutions which would decrease their potential for use in the future.

These considerations lead the participants to formulate several requests. Research should be undertaken on fire behaviour and ecosystem evolution under the influence of fire. This research could rely on field observation (statistical data), and on the use of experimental material in the laboratory (fire tunnel) and in the field (experimental burning of garrigue in France and prescribed burning in Greece). Prevention should consider socio-economic studies on causes of wildfires and the damage they cause. Forecasts of fire danger should rely more on studies of the weather factors governing ignition and fire spread, studies conducted with the support of the World Meteorological Organization. The different national delegations should draw up for their respective countries a list of institutions and other bodies undertaking research or studies relative to the theme of 'fire', with a view to the subsequent establishment of a regional information centre for forest ecosystems and those derived from forests (maquis, garrigues, matorrales, etc.).

The participants of the working group on fire expressed the wish that within the framework of MAB Project 2, scientific discussions should take place at the

Conference organized in collaboration with IUFRO, FAO, Unesco and probably UNEP at Saint-Maximin in May 1977. They also requested to be informed on the results of the first phase of the joint FAO/UNEP project on forest fires and to receive the report that had already been published so that decisions on recommendations therein could be made at the Saint-Maximin Conference.

Finally the participants noted the initiative of the MAB Committee of the United States of America to organize an International Symposium on the Environmental Consequences of Fire and Fuel Management in Mediterranean-climate Ecosystems (forests and scrublands) planned for August 1977 in California, and hoped for active participation of Mediterranean countries.

3. ANIMALS AND GRAZING IN FORESTED AND MARGINAL AREAS

3.1 Introduction

When confronting the problem of the relationship between forests and grazing in the Mediterranean area, there is always a situation of conflict. However, all through their long history and even up to the present time in certain local areas, Mediterranean societies have depended for subsistence on systems of animal raising which are closely linked to the Mediterranean forest. The facts show that the forested areas have regressed more through population expansion with its increasing needs for construction material and energy, than through the action of grazing animals.

In the following chapter, firstly there is an attempt to look at and consider the different levels of analysis of the Mediterranean forest-grazing problem; next the needs for scientific research are identified. An example of integrated research concerning grazing in forests is given in Annex 3 (Sardinian Project).

3.2 The relations between animal-raising and Mediterranean ecosystems

The highly complex problem of forest and animal-raising relations in the Mediterranean area comes into the more general framework of relations between grazing and Mediterranean plant formations. Three levels of analysis can be noted:

(1) land use problems and the relations between social classes (socio-economic approach);

(2) the relations between an animal and the ecosystems in which it lives (ecological and behavioural approach);

(3) the relations between production systems (zootechnical and sylvicultural approach).

The problem of land use and society. The animal-raising-forest conflict can be considered in terms of competition for land use. The men wishing to use the same piece of land do not have the same interests in mind and neither use the same scale of space or time. In the Mediterranean region, the forester is the land owner or represents central authority, whereas the herdsman has only his flocks as heritage and means of subsistence. The forester envisages long-term production and represents a guarantee for long-term protection of a fragile ecosystem. The herdsman acts in view of a subsistence economy and the search for immediate production.

It is likely that certain ecological or technical arguments put forward by such and such a party only find their strength in a certain historical context. Is there always necessarily conflict or can there be complementarity of these activities?

Animal-ecosystem relations. In the 'herdsman-forester' conflict, the argument constantly expressed is that of damage caused by the animals, essentially damage to young shoots and to the soil, which in the mind of those who condemn grazing in forests, upsets or prevents regeneration and could lower forest productivity. Inversely however, can not grazing also protect the forest by clearing up the forest floor and thus ensure a better protection against wildfires than the most perfected systems of surveillance and fire control? While for the Mediterranean herdsman the forest is potential pastureland, for the forester the rangeland is 'naturally' an unknown forest! The use of certain terms characterizing the environment is ambiguous: the degradation of rangeland through the growth of thorny or woody species is considered a positive evolution by the forester. Do not these terms convey a Manichean concept which reverts to transposing a conflict which has deep socio-economic origins in the ecological context?

To what extent can pastureland and forest co-exist in the same area?

Systems of ecosystem production. The dissociation of productive activities is a logical aspect of the evolution of economically developed societies. In ignorance of the real and possible relationships, animal and ecosystem, it has probably contributed to the evolution of respectively sylvicultural and zootechnical techniques in more or less divergent directions. Developed independently of each other and without integrating ideas other than those of their 'sector', they lead to the training of technicians who are increasingly preoccupied with obtaining a given production rather than managing the resources of an area. It is therefore not surprising that even the idea of introducing grazing animals into forests causes conflicts. It is not surprising either that animal-raising techniques developed for well-managed farming areas giving high productivity per animal are having difficulty in being accepted in range areas where the main need is to use the land.

In the Mediterranean region, this type of conflict is all the more apparent because there is a tendency to transpose sylvicultural and zootechnical technology and management techniques developed for the particular environmental conditions and installations of northern Europe.

In the Mediterranean region, the surface area strictly devoted to animal raising and more or less productive forestry in relation to the irrigated or cereal growing

areas renders the development of production systems quite fundamental, taking into account the specific capacities of different natural land units. The problem of intelligent valorization of the use of possible Mediterranean ecosystem resources implies an important, well-planned, decisive research effort.

3.3 Methodology and aspects of research into relations between grazing and Mediterranean ecosystems

Studies on animal-ecosystem relationships. The consideration by research of a problem as complex as the animal-ecosystem relations necessitates the involvement of researchers from several disciplines, especially ecologists, foresters and zootechnicians. However, it is important that the step taken by each one of them escapes from past traditional dogmas which tend to be imposed by officialdom as a matter of course. Only under this condition can the measure succeed and help to show the possibilities of useful exploitation of plant formations in both a new and rational way. Here, as elsewhere, the researcher must shrug off the dialectic of 'all black' or 'all white'. This is already what we have tried to do by expressing, in what many would say is a non-conformist way, the problems of animal-raising in non-agricultural environments.

In making an 'enlightened' scientific step forward, the research forester must admit that a timber stand can also produce forage; it is necessary to evaluate the type and the quantity of forest production which can be given over to animals and the conditions of this concession without hindering the subsequent growth of the forest. As for the zootechnician, he must consider that rangeland is not necessarily a permanent natural feature: here it is necessary to envisage the way in which herds of animals can control environmental evolution either by themselves or accompanied by other means.

Finally, the fundamental factor to be studied is the behaviour of different animal species: trampling, rhythm of activities, delimitation of territories, choice of plant species in different stages of vegetation, and especially the study of differential behaviour regarding the herbaceous stratum, brush, seedlings and woody plants. This study on domesticated animals is to be associated with similar studies on wild species. The food niche of each species should be identified throughout the different seasons of the year in different types of environment.

Although some observations of this type are beginning to be available for the forests of Northern or temperate regions, this kind of study is practically non-existant in Mediterranean environments.

Studies on production systems. Studies on ecosystem use by animals or on ecosystem evolution must culminate in the construction of production systems integrating environmental protection concerns and natural ecosystem dynamics together with the requirements for animal-raising and agricultural and forestry productions.

The demands for plant primary products (wood, cereals, forage) as well as the limitations due to soil, relief and elevation, create a fundamental organization of land area (cultivated land and non-cultivated areas, forested areas and rangelands). There are also differences between areas according to the moment that natural forage resources are at the peak of availability. In Mediterranean environments, this compartmentation of the landscape is a constant feature which is seen on different levels, village and farm as well as the inter-regional level (mountain ranges and agricultural plains for example).

Up till the present time, research has followed sectoral lines so that the development of certain techniques has been carried out in the context of a society which has increased the productivity of its cultivated land, abandoned areas with important limiting factors, orientated forested zones and abandoned rangeland only towards the production of timber. Natural land organization has only been exploited in one way: the zoning of activities. Now it is necessary to study the cultural, economic, technical and ecological conditions of a type of integrated development of these different zones.

On a conceptual level, it can already be said that this development can only be effected through exchanges between the different zones. These exchanges can be of different types (energy, animals, genes). They can be measured by flow rates. Up till now, only the economist has been interested in some of these flows but only where they represent commercial transactions. Now, in the economic context with energy becoming increasingly expensive, greater attention should be paid to the energy balance of production systems. The problem posed here is therefore one of optimum energy return from a highly organized land area while ensuring the indispensable production of wood, cereals and meat.

Forms of research. Faced with these questions, research must take complementary forms: research in a specially designed experimental framework; and analysis of traditional practices and systems. The experimental framework is necessary insofar as certain questions require detailed measurements and observations of animals to analyse animal-plant formation relations.

Not the least important is the drawing up of a list of solutions adopted by the herdsmen integrating the socio-economic dimension for a very wide range of Mediterranean environments. These two types of study must also be done on an interdisciplinary basis.

3.4 Recommendations

Considering the proposals made by the meeting of experts held at Potenza in October 1975, the participants expressed the wish to increase research efforts to appraise, define and describe the possibilities of grazing in forest ecosystems or in marginal areas and to include in this research a project on the 'non-timber tree-herbaceous vegetation' ecosystem such as the 'Dehesa' type in semi-arid areas.

Characteristics of this research:

(1) to bring together within the framework of the same programme zootechnicians, foresters, ecologists and socio-economists;

(2) to undertake observations using the experimental material specially designed for this type of study but also taking into account the solutions adopted as fact by the herdsmen.

Aims:

(1) to study and record traditional practices in the context of different natural land units in relation with the historical evolution and the cultural and socio-economic conditions;

(2) to identify for each ecosystem the grazing impact of different species and races of animals on the ecological equilibrium, and the possibilities of harvesting forage resources using animals while ensuring the perpetuation of these ecosystems;

(3) to define the best-adapted forest and range production systems in function of the criteria of production and conservation.

Conceptual means:

(1) to make use of techniques to assess their effectiveness according to different criteria (economics, energy, significance of long-term demands in relation to short-term needs);

(2) to envisage modelling of workable systems which would allow the subsequent use of a general type of reasoning for very varied situations.

Information. This research must rely on a network for the circulation and communication of information which should be generally done by: the dissemination of publications and results which because of their interdisciplinary character are set aside from the usual, essentially sectorial ways of distribution; the strengthening of collaboration between MAB Project 2 and the FAO so as to co-ordinate research, training and resource management activities concerned with Mediterranean forest and range ecosystems.

Sardinian Project. From an operational point of view, the Sardinian Project (see Annex 3) should be retained as pilot project, considering the progress made and the variety of situations represented. This especially means that:

(1) the necessary means for continuing this programme should be made available;

(2) the work should be done in collaboration with researchers from different countries;

(3) a working group for the Mediterranean region should be set up alongside this Project which would be responsible on the one hand for the organization of an annual meeting in Sardinia for information and planning, on the other hand to ensure exchange of information coming from the different national teams.

4. RANGELANDS IN MEDITERRANEAN ARID AND SEMI-ARID ZONES

4.1 Introduction

Rangelands in Mediterranean arid and semi-arid zones, a theme for which discussion was proposed during a special session of the MAB Mediterranean Scientific Conference, is included within the MAB Programme under MAB Project 3. The general objectives of Project 3 have been defined in MAB Report Series No. 6.

It was recognized in MAB Report Series No. 25 that the regionalization of Project 3 was to permit better planning of research in each of the great ecological zones of the world. Thus for the Mediterranean zone, it was proposed to consider separately the sub-zones with essential climatic differences, which condition the level of ecosystem productivity and the nature of social practices and management of land and resources. Emphasis is placed on fragile zones with marginal agriculture for which an irreversible threshold of degradation must not be reached and where the possibilities of multi-purpose use of resources must be kept in mind.

Several proposals have been made for the formulation and implementation of a regional project on Mediterranean arid and semi-arid zones. A preliminary outline of this regional project was presented at the Sfax meeting (MAB Report Series No. 30) which brought together the five countries North of the Sahara. Scientists from the countries concerned gathered information on the possibilities offered by regional and international co-operation and showed its willingness to plan research activities which follow the aims of MAB Project 3. They also strongly insisted on the necessity to integrate research, resource management and training activities, a condition *sine qua non* which guarantees the success of development projects based on the principles of ecological management.

In order to better understand the importance of certain proposals and recommendations, it seemed imperative to describe in more detail the nature of the problems to be resolved which confront the whole scientific community of the ecological area considered.

4.2 Climatic conditions

The rangelands of Mediterranean arid and semi-arid zones lie in the Mediterranean ecological sub-zone with relatively low average annual precipitation, according to the following definitions:

(1) arid: a zone which receives 100 to 400 mm (the highest seasonal maximum is in autumn) or 75 to 300 mm (highest seasonal maximum shifts to winter and spring, the case of the Near East where precipitation is compensated by the maritime influence as in Atlantic Morocco);

(2) semi-arid: a zone which receives 300-400 mm to 500-600 mm according to the seasonal effectiveness of precipitation.

Another fundamental distinction can be made by considering the values of average minimal temperatures of the coldest month, which vary from -10 °C (plateau of Anatolia) to +12 °C (Wadi Araba and Jordan Valley), and which give rise to very important distinctions regarding the distribution of plant species and the length of growing season, which in turn conditions grazing and crop-growing practices in the zones under consideration.

4.3 The geographic area concerned and the magnitude of the problem

All the countries bordering the Mediterranean Sea with the obvious exception of Yugoslavia and Albania, are concerned. Some are concerned for only limited areas: Greece, France, Italy; others for vast areas: Cyprus, Spain, Turkey, the West and North of the Mediterranean Sea; Algeria, Egypt, Israel, Lebanon, Libya, Morocco, Syria and Tunisia.

The group of arid and semi-arid territories of the countries indicated above - and according to climatic criteria proposed in Section 2 - covers a total surface area of about 150 million ha (1.5 million km^2) of which approximately two-thirds, i.e. 100 million ha are primarily more or less permanent rangelands. This means that the plant communities which produce above-ground biomass are essentially used for grazing purposes on a cycle of several consecutive years; this biomass serves as the almost exclusive food resource for large quantities of livestock, sheep, goats, cattle, donkeys, dromedaries, and sometimes pigs (Spain). The total numbers of livestock, expressed in equivalent sheep units[1], correspond to some 50 to 70 million units, which means an average stocking rate between 0.5-1 equivalent sheep unit per hectare per year. When it is known that in arid zones, rangeland does not produce more than 200 to 250 kg of edible dry plant matter per hectare per year, one realizes immediately

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1. *After Le Houérou (1976). In: Le Houérou and Coste,* Relationships between rangeland production and average annual rainfall. *(In press).*

1 adult sheep (40 kg) = 0.20 cattle = 0.10 camels = 1.20 goats = 0.15 horses = 0.30 donkeys = 300 forage units/yr = 495,000 kcal/yr

1 sheep unit = 1 ewe + 1 lamb up to 3 months + 1/5 ewe lamb + 1/25 ram = 450 FU/yr = 1.5 sheep

the relative lack of meaning in giving such high stocking rates for such low carrying capacities. It must be noted that this fact no doubt accounts for extreme local variations in the numbers of sheep, etc., in the zone under consideration, and the precarious existence of the populations.

In the Mediterranean context, this notion of "rangeland" must be understood - as has just been defined - as referring to relatively permanent grazing and also bearing in mind the diversified uses of the renewable resources coming from these ecosystems. These multiple uses are governed by the land at a given time and *a fortiori* by the temporal variations of the major uses.

Thus, for example, the majority of *Artemisia campestris* communities on sandy soils in Tunisia and Libya, are in fact at present rangelands resulting from fairly recently abandoned cropland whose cultivation used quite rudimentary ploughing techniques, i.e. light, shallow singleshare ploughing accompanied by hand removal of certain woody species, which were avoided if they were too big an obstacle. Such practices were used only in the years considered favourable for cereal culture in arid climates. In the same way, the North African *Stipa tenacissima* steppe is most of the time both rangeland (sheep, goats) and a source of fibrous raw material (for wood pulp or esparto goods); on the other hand, the steppe often develops from the degradation of open forests of *Juniperus phoenicaea*, *Pinus halepensis* and *Quercus ilex*, also exploited for other uses.

Another example demonstrating the multiple use of pastoral ecosystems in Mediterranean arid zones is given, as Emberger (1938) has already noted, by the argan forests (*Argania spinosa*) of Morocco. This is typically a complex structured ecosystem of "trees + herbaceous plants" in which the tree alone, here the argan, has a multiple function, whereas the herbaceous layer is predominantly used for grazing. As well as providing timber, firewood and wood for charcoal, the argan tree also provides "hanging forage" with its leaves, and excellent animal food with its fruit. In addition, the seeds bear edible oil, oil of argan, which was one of the basic foods of the local population and also an article for commercial transactions.

It is surprising that in the last forty years such observations did not give rise to integrated studies on the diversified productions of this ecosystem. Of course, priority has rarely been given to arid zone research, since under the current economic systems priority is accorded to zones with high precipitation or to zones where, at the lowest cost, the so-called advanced technologies (with high energy input) can be used, which in turn create new needs which stimulate, by chain reaction, the different sectors of the economy.

4.4 Present productivity and potential productivity

The biological productivity of pastoral ecosystems in Mediterranean arid and semi-arid zones can be considered - apart from noteworthy exceptions - relatively low, considering the length of the growing season, the diversity of ecosystems present within the same area and the standard of efficiency of the use of water and nutrients.

By low levels, it is meant that the majority of ecosystems under consideration, managed by traditional methods, only produce some hundreds of kilogrammes of edible dry matter (for man or animals) per hectare per year. Briefly, let it be said that in the 200-300 mm zone, annual plant production usually amounts to about 500 to 800 kg of dry matter/ha/yr, whether for rangelands or for fields of cereals (rain-fed agriculture). There are some cases where the amount of precipitation could allow the production of 2,000 kg DM/ha/yr, for example in the case of *Cynodon dactylon* meadows, zones with *Zizyphus lotus* and *Artemisia campestris* in the South of Tunisia . These yields could be doubled for plant communities dominated by annual grasses and legumes, resulting from the transformation of the *Artemisia herba-alba* steppe through reasonable management of grazing with restoration of soil fertility and appropriate handling of the flocks of sheep, such as that which has been demonstrated at Migda-Tadmor in the North of the Negev .

4.5 Summary of the causes of under-production

The main reasons for the malfunctioning of biological production of the ecosystems under consideration are the following:

(1) past soil impoverishment not only of total organic matter but also of mineral salts (essentially nutrients of phosphorous and nitrogen) through hundreds and thousands of years of cropping and grazing practices;

(2) malfunctions affecting the water cycle: degradation of hydro-dynamic conditions of surface and sub-soils; present inefficiency of small-scale systems of water management which nevertheless worked in the past;

(3) losses through wind and water erosion affecting the living fraction (arable) of soil resulting from the recent use of powerful mechanical means (e.g. tractor-drawn multi-disc ploughing) which helps to totally destroy low-growing woody species and crush surface horizons, leaving the soil bare for long periods, without, however, a reduction in uncontrolled grazing pressure over the whole rural area;

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1. *cf. works of CEPE/ORSTOM/INRAT on the Zerkine zone, South of Gabès (arid Tunisia).*

2. *Van Keulen, H. 1975.* Simulation of water use and herbage growth in arid regions. *Wageningen.*

(4) removal of all woody species for many different uses: crafts, esparto goods, heating, cooking, extraction of volatile oils, drugs, etc.

It is not surprising therefore, that vast areas characterized at the beginning of the century by diversified plant communities with over 50% total cover providing multiple uses and resources, are today characterized by plant communities with low total cover (0-25%), often dominated by annual species of low palatability (e.g. *Stipa retorta*) or by perennial herbaceous species with very short growing cycles (e.g. *Brachypodium ramosum, Poa sinaica, Carex pachystylis,...*), and even by perennial species supposedly inedible for animals (*Asphodelus* spp., *Peganum harmala, Arthrophytum scoparium, Hammada scoparia,...*) and post-harvest species (*Artemisia campestris, Prosopis farcta,...*).

In extreme cases, the degradation of pastoral ecosystems is shown by permanent soil denudation and by surface exposure of raw mineral layers (beds of limestone and sandstone); crusts of calcium carbonate and calcium sulphate; crumbly limestones and gypsums...) unsuitable for plant life except in special circumstances.

4.6 Biological up-grading, management of resources and rural areas

The recovery and biological up-grading of such degraded areas are often very problematical because of the absence or the scarcity of seed-bearing plants and viable seed of the right natural species. Managers imagine that they can deal with these problems by using high-energy, costly techniques. Nevertheless, the use of sophisticated techniques of reconstituting plant cover, with increasingly sophisticated methods of artificialization (re-sowing and planting of species on prepared ground; fertilization, appropriate treatments using pesticides; expensive maintenance over many years...), is not justified in numerous cases where the natural potentials can be defined through careful study of natural plant communities and can be activated if only decisions were taken for managing such areas which are utilized alternately for grazing or left at rest. Examples are numerous from Morocco to Tunisia, Egypt to Syria, which show the exceptional vigor of the naturally-occurring flora and fauna of these territories. Thus it is reasonable to say along with many experts from the countries considered that what is most important is the research on the conditions in which new standards of management could be applied. This idea should bring in research workers from the human sciences which have as yet been little involved in such discussions.

4.7 General information on the major pastoral ecosystems

Has one the right to say that research on pastoral ecosystems of the Mediterranean arid and semi-arid ecological sub-zone is representative at the present time

of major pastoral ecosystems of the area under consideration? Whilst praiseworthy efforts were made through the Sfax meeting (MAB Report Series No. 30), and whilst the MAB Mediterranean Scientific Conference drew up a list of the ecosystems studied ("dehesa" in Spain), a rapid examination of the list which follows shows how much ground has still to be covered.

Europe. For the "France, Greece, Italy and Spain" area, and principally in Spain, arid and semi-arid rangeland covers some 10 million ha. Arid rangeland is only present in Spain, shown by the presence of steppes of *Artemisia herba-alba*, of *Stipa tenacissima*, often derived from forest communities (*Quercus ilex*, *Juniperus thurifera*,...). The particularity of this European area of arid and semi-arid rangelands is no doubt due to the existence (S.W. Spain, Sardinia...) of pastoral ecosystems associating scattered trees with herbaceous plant formations (meadows) or with a low woody plant stratum (matorrales, garrigues and low maquis, phrygana, tomillares,...). The "dehesa" system of the semi-arid Extremadura region is very representative in this respect: trees cover between 10 and 30%, mainly *Quercus ilex* and *Q. suber* over meadows of annual grasses and legumes; the grazing resources of the "dehesa" are used by two or three categories of domestic animals; this multi-strata pastoral ecosystem is in dynamic equilibrium because of human intervention, often through several centuries of ecological-type management.

Other trees should be considered: *Olea europea*, *Ceratonia siliqua*, *Juniperus oxycedrus*, or even *Pinus pinea*, one of the rare pines which, in open stands, does not exclude herbaceous growth.

Area North of the Sahara. For all the five countries North of the Sahara: Algeria, Egypt, Libya, Morocco, Tunisia, arid and semi-arid rangelands cover some 50 million ha, the majority with an arid climate. Excluded from this estimation are the 15 to 20 million ha of dry-farmland which, as stubble-fields, become grazed fallow and wasteland, range based mainly, but not always, on annual grass species.

For about the last ten years, the traditional rangelands have tended to serve as reserve land for the irresistible extension of rain-fed cereal culture (wheat, barley) or dry-farmed tree crops (olive, almond, pistachio, cactus in Tunisia; figs, olives in Egypt...).

Amongst the most extensive pastoral ecosystems, those that are derived from *Artemisia herba-alba* steppes on silty soils are to be noted. They are present in all five countries under highly various forms which would justify comparative studies.

Ecosystems derived from *Stipa tenacissima* steppes are still very extensive in Algeria and Morocco, but to disappear in Tunisia and especially Libya. Several other types of ecosystems should be noted: the steppe ecosystems on sandy soils of *Artemisia campestris* (Tunisia), *A. monosperma* (Egypt), *Rhantherium suaveolens* (Tunisia), *Arthrophytum schmittianum* (Algeria, Tunisia, Libya), *Aristida pungens* (all countries); the argan tree (*Argania spinosa*) ecosystems and the *Acacia gummifera* area of Morocco, the ecosystems of *Lygeum spartium*, most often on gypsiferous soils; the ecosystems with dominant halophytes (*Suaeda* spp., *Salsola* spp., *Atriplex halimus*, etc.); and, finally, the degraded ecosystems where the dominant plants are *Peganum harmala, Arthrophytum scoparium, Stipa retorta* and many other extremely ephemeral annual species incapable of holding the surface soil layer and avoiding the speeding up desertification processes.

Some of these ecosystems lie within the ecological range of sparse forests of *Juniperus phoenicaea, Pinus halepensis, Zizyphus lotus, Pistacia atlantica, Olea europea-Pistacia lentiscus* and, less frequently, *Quercus ilex, Callitris quadrivalvis* and *Ceratonia siliqua*. In the last 100 years, the trees of all these forests have been disappearing through man's actions. Because of this, the "deforestation-steppification-desertification" process is a relatively recent phenomena in the Magreb, whereas it dates back more than 2,000 years on the coastal zone of the Western Egyptian desert, where an ecosystem of *Thymelaea hirsuta* and *Asphodelus microcarpus* is found (SAMDENE Project, Omayad station in the non-saline depressions attesting that in the past it belonged to a forest ecosystem).

As for the European area, the semi-arid rangelands North of the Sahara are almost all plant communities dominated by low woody plants (*Rosmarinus, Cistus, Cytisus, Ericacea, Rhamnus, Adenocarpus, Thumus,...*) and whose valuable forage species are often the same as in wetter zones (*Dactylis glomerata* spp., *Oryzopsis miliacea, Phalaris tuberosa, Ph. truncata, Festuca elatior* subsp. *arundinacea...*). Such ecosystems result from the degradation of semi-arid forests of *Callitris quadrivalvis* (Morocco, Tunisia), of *Juniperus phoenicaea* (Magreb, Libya), of *J. thurifera* (Morocco), of *Olea-pistacia Lentiscus-chamaerops* (Magreb), of *Pinus halepensis* (Magreb), of *Quercus ilex* and *Q. suber* (especially Morocco) and of semi-arid argan woods (Morocco).

It is interesting to note some significant figures quoted by Le Houérou (1975)[1]:

50% of Morocco lies in arid and semi-arid zones
46.7% of Tunisia lies in arid and semi-arid zones

1. *Le Houérou, H.N. 1975. La situation pastorale dans le nord de l'Afrique: Etat d'avancement des données et des travaux.* Options méditerranéennes, *28, p. 17-20.*

12.2% of Algeria lies in arid and semi-arid zones
5.3% of Libya lies in arid and semi-arid zones
3% of Egypt lies in arid and semi-arid zones

These figures on their full significance when one realizes that the "hyper-arid" areas under Mediterranean climates represent, for example, 97% of the country in Egypt and 94% in Libya. Hence the overall strategic importance of arid and semi-arid zones in these countries. This fact alone justifies the recommendations which were made at the Sfax meeting and the tremendous amount of scientific knowledge which is urgently needed to solve the specific problems of such zones.

Near East area (Israel, Lebanon, Syria) of Cyprus and Turkey. This area is characterized by about 40 million ha of mainly arid rangelands. As in the North of the Sahara, these rangelands tend to give way to cereal-growing practices which have been present for several thousands of years. It should be noted of course that, with the exception of Cyprus and Turkey, the most common pastoral ecosystems are those belonging to the ecological range of *Artemisia herba-alba*, and here, even more than to the North of the Sahara, degraded forms of these ecosystems are most frequent, such as the steppes of *Hammada scoparia* (= *Arthrophytum scoparium*), of *Peganum harmala*, or short meadows of *Poa sinaica* and *Carex pachystylis*, or even ephemeral meadows of *Stipa retorta*.

In Turkey, the arid pastoral ecosystems are on the one hand represented on the central highlands by the ecological range of the *Artemisia fragans* steppe (numerous plant communities), itself originating partly from steppes of *Stipa lagascae* and *Bromus arvensis* or from open forests of *Quercus pubescens* subsp. *anatolica* and, on the other hand, on the mountains, by the steppes of *Astragalus* spp. (*A. microcephalus*, *A. micropterus*...).

The forest ancestry of all these steppes of the Near East and Turkey is less obvious than in the Magreb. Indeed it is only at the limits of the areas in the arid and semi-arid stages that what remains of forests appear with: *Pinus halepensis*, *Cupressus sempervirens*, *Quercus ithaburensis*, *Q. calliprinos*, *Q. pubescens* subsp. *anatolica*, *Juniperus phoenicaea*, *Pistacia atlantica*, and the group *Ceratonia siliqua-Olea europea-Pistacia* spp. The extreme degradation of arid and semi-arid zone soils in the Near East sometimes results in the baring of large surfaces of hard rock and an appreciable change in water balance of the fraction of fine earth which is trapped between the outcrops of rock in such a way that meso- and xerophilous forage species (*Dactylis glomerata*, *Oryzopsis holciformis*, *Hordeum bulbosum*, etc...) can co-exist

with more xerophilous species. A large part of the *Sarcopoterium spinosum* "bathas" and the better plant communities in the zones receiving between 400 and 800 mm show an ecological azonality due to thousands of years of man-caused degradation of the forest environments of this region.

4.8 Current evolutionary tendencies and the conditions for improvement

In the present stage of evolution - and if human and animal pressure follows the trends that are noted at the present time - the general physionomy of arid rangelands will be that of a complex steppe of "chamaephytes, grasses and herbs" opening up more and more and giving way to plant communities dominated by highly ephemeral annual species, or, finally, to areas devoid of vegetation for several years on end. On the other hand, the rangelands of the semi-arid zone are currently being completely deforested; they are then invaded by species of very low forage value. However, it is certain that all the potential area of rangeland receiving between 200 and 600 mm average annual precipitation could support complex structured plant communities of tall woody species of varying density (general cover between 10-25%), low woody plants and especially valuable herbaceous forage species.

This "trees + herbaceous plants" structure is more or less that of the semi-arid "dehesa" system of the Spanish Extremadura region (Badajoz); it also corresponds to certain very open forest stands of Algeria (Djelfa), Morocco (Mamora, Souss), Tunisia (Southern part of the Dorsale, Bled Thala), Near East (edge of Anatolian plateau, open rich oakwoods of *Quercus ithaburensis* of Israel, Lebanon and Syria). Even in the most arid part (between 100 and 250 mm) of the whole area, open woody stands of this type are still well mixed with pastoral plant communities, for example, the open stands of *Acacia tortilis, A. raddiana, A. gummifera, Argania spinosa, Pistacia atlantica, Zizyphus lotus*. Trees are therefore not excluded from this immense zone. Their disappearance is not due to climate, at least if one considers the last five thousand years or so. Their persistance in certain places (Spanish dehesa, Bled Thala in Tunisia...) is due to traditional social practices and the tendency of present social institutions to preserve these practices without necessarily seeking scientific justifications. Nevertheless it is easy to demonstrate the synergetic effect on rangeland production, and even on the range of diverse resource uses, which is related to the co-existence of trees and herbaceous plants. Of course, this is true only as long as the forest species do not wholly compete with the herbaceous layer (case of softwoods, especially in general *Pinus halepensis*). The following example illustrates this analysis. In the open forest zone of *P. halepensis* and *Quercus ilex* undergoing "steppification" (*Stipa tenacissima*) in the Djelfa region of Algeria with 300 mm average

annual precipitation, the most valuable forage herbaceous plant community exists under the direct cover of *Quercus ilex*. Indeed, an almost continuous cover of *Dactylis glomerata* develops under the trees. In contrast, good forage species are totally absent underneath *Pinus halepensis* and quite rare in the steppes of *Stipa tenacissima* and *Artemisia herba-alba*. This fact suggests that much still needs to be done.

Today, researchers can hypothesize that an area of rangeland with 10 to 25% woody plant cover made up preferably of trees providing forage with their fruits or leaves (*Argania spinosa*, *Acacia* spp., *Ceratonia siliqua*, *Quercus* spp.) and with careful development and management of the use of herbaceous plant production, could constitute an area whose rangeland productivity could be expressed in carrying capacities between 1 equivalent sheep unit/ha/yr in the most arid zones (100 mm) and 10 equivalent sheep units/ha/yr in particularly favourable zones (effective available water equivalent about 250-500 mm). The diagnostic for efficient water use for plant needs implies consideration on the one hand of the installation of systems for capturing, conserving and distributing water runoff (development of micro-catchment management) in arid and semi-arid rangelands, and on the other hand of the correction of nutrient levels of the majority of environments (N and P deficiencies).

Interesting results have been obtained at Migda-Tadmor (Negev) with efficient use of 250 mm of water and careful correction of the nutrient levels of the iso-humic loess soils:

(1) if the spatial and temporal rainfall distribution patterns are ideal from a biological point of view and if there are sufficient amounts of N, as was the case in 1972-73 at Migda-Tadmor, the 250 mm of precipitation received by a herbaceous plant community dominated by annual grasses and legumes can give a production of 7,000 kg DM/ha;

(2) with 250 mm average annual precipitation and sufficient N, the average yield over 12 years is calculated at 4,450 kg/ha/yr;

(3) with the same quantity of water, two to three times more dry matter are obtained with sufficient N (adding fertilizer) than with naturally occurring N;

(4) maximum growth calculated for the spring seasonal peak in optimum conditions is 170 kg DM/ha/day.

These figures are interesting only in that they clearly show that although the most important factor limiting growth and productivity is really the maximisation of water use, it must be remembered, however, that another limiting factor is the quantity of nitrogen available at the most crucial moments of plant growth. The debate

remains open concerning the theoretical and practical means which would have to be implemented to either successively or simultaneously get past these two bottle-necks. Integrated research thus becomes even more necessary to provide pertinent answers to such questions. The constant concern of researchers should be the economy of means and the most thorough use of adaptation strategies of existing biotypes in the zones concerned. Is it sufficiently known, for example, that certain non-leguminous species such as *Plantago albicans, Echiochilon fruticosum* can fix in their organs (leaves and inflorescences) higher quantities of nitrogen and plant proteins than have been detected for other species, including the usual leguminous plants considered as the only ones capable of fulfilling this rôle? There is a need for research planning on plant and animal biotypes, research which is capable of solving the problems posed by the regeneration of the arid and semi-arid rangeland of the Mediterranean region and also of ensuring a high level of productivity.

All of the foregoing observations emphasize how urgent the acquisition and communication of knowledge is, or, more simply, the circulation of information among researchers, projects and countries. A critical assessment of available information would already save time and money and would orient research in the most promising priority directions. It would also facilitate co-ordination of the various projects.

4.9 Recommendations

After having noted the studies already undertaken in several areas, notably North of the Sahara, and the conclusions of previous expert conferences held, often jointly, by Unesco, FAO and with assistance from UNEP, the participants emphasized that several governments are very concerned about arid and semi-arid zone rangelands and made the following proposals:

(1) to seek complementary activities of two or more MAB projects and to encourage particularly the implementation of pilot studies within the framework of MAB Projects 3, 4 and 13;

(2) to expedite the establishment of a regional centre in Tunisia for recycling and continuous training in grazing management as noted at the Sfax meeting;

(3) to organize the assembly and diffusion of human sciences literature concerning Project 3 in Mediterranean arid and semi-arid zones;

(4) to provide an efficient and operational organization of the joint Unesco-FAO Secretariat for MAB Project 3 and to strengthen collaboration with the FAO EMASAR Programme for better liaison and integration of research, training and management;

(5) to encourage the publication of an "information and liaison bulletin".

It is hoped that a working group for Mediterranean arid and semi-arid zones be created where all countries bordering the Mediterranean would be represented (MAB Project 3). The rôle of this group would be to assess the scientific results of various research projects and to ensure the concordance of directions for research, methodology and perspectives.

The participants noted the existence of a considerable mass of information that could be circulated, and considered it indispensable to disseminate this information. They expressed the wish to encourage the work of the Co-ordinating Committee for North African countries created at the Sfax meeting.

In view of the existence of an institution in the region under consideration, the Ecothèque méditerranéenne, whose aims would likely meet the needs for efficient circulation of information, and of its recognition by the MAB International Co-ordinating Council, it is recommended that Unesco study the possibility of developing the Ecothèque méditerranéenne into a regional body. However, this could work only if a real information network were created, made up of small working core groups in the interested countries. The countries belonging to such a network would contribute to managing the systems according to a procedure yet to be elaborated.

Given that UNEP financially supports the IPAL Project (International Project on Arid Lands) which is part of MAB Project 3, and given the possibility of extending this programme to other countries, notably these in the Mediterranean region, Unesco is asked to officially distribute information on this project.

5. THE EFFECTS OF MANAGEMENT TECHNIQUES ON THE EVOLUTION OF DELTA ECOSYSTEMS AND ON THE PROBLEMS OF IRRIGATION AND WATER MANAGEMENT

5.1 Introduction

In the biosphere, water resources coexist with other natural resources (land, air, vegetation, animals, etc.), each of which undergo continuous quantitative and qualitative modifications. The dynamics of the relationships between these elements are complex; they are either random, or a function of human activities. Water resources are unequally distributed in time and space over the Earth's surface. In many places there exists a growing disproportion between water availability and water requirements. Water conservation projects can cause operational difficulties or be uneconomical; these conservation systems must include measures of both design and management, notably to minimize water loss and reduce pollution of water resources. The design of irrigation projects can affect the living environment and the natural conditions of the zone concerned; these effects can be positive or negative.

The well-known positive effects are the following: increase in agricultural production; extension of areas "fit for settlement" to the detriment of desert areas; improvement of living conditions and the feeling of security of the population within the project; development of energy resources; and creation of jobs for the local populations and development of tourism.

The negative effects include, amongst others: use of water unsuited to requirements; irrational use of this same water: excessive or insufficient quantities; salinization and waterlogging of soils; loss of organic matter (swamp drainage); deterioration of ecological conditions; degradation of attractive landscapes; and damage caused to aquatic animals.

The choice of a favourable change in the design of a project is closely linked to the economic use of water resources in consideration of present and future water requirements. It is a very good thing that public health scientists have been brought to discuss and assess the economic aspects of the side effects of irrigation on health.

Appropriate planning requires that all necessary data be collected in order to improve the quality of the decision-making process. Up to now, the information given to the designers for evaluation has not been thorough enough to allow for an accurate assessment of the positive and negative effects of these projects on the environment. Because of this, information relating to these effects must be continually brought up to date.

All over the world, irrigation remains a topic of growing interest; much effort is devoted to study and research on irrigation so as to satisfy man's enormous food requirements. This objective could be reached by cultivating new land, or by using more rational methods to transform and improve land that is already cultivated. It is becoming increasingly necessary to take into account the need for optimization of the use of water resources. For this reason, irrigation techniques of maximum efficiency must be selected with the help of research and training. These techniques must also be economically feasible.

Much is known about the importance of the effects that natural phenomena (climate, water, wind) have on the soil, the water circulating in the soil and the plant cover, and the way in which an environment suitable for human habitation can be endangered. The conditions for life and productivity in the Mediterranean region have been ensured through continual human intervention, especially where irrigation and water regulation are concerned.

There have been changes in the original biophysical facies. Their consequences are more noticeable and more important in areas with hot, dry climates than in those with temperate climates (e.g. the Nile Delta). Agriculture does not seriously disturb the environment in temperate climates since the crops grow under agrological and ecological conditions corresponding to their normal requirements.

The aim of the ecological study of deltas is to restore to the deltaic zone an equal or higher productivity than that which existed before man's disturbing interventions.

Understanding all the phenomena which can intervene at the scale of a river basin is essential to the concept of delta ecology. It is essential to have studies devoted to the situation "before and after" major changes in river basins. The absence of silt in water coming from a dam can have adverse consequences, such as disturbance of the geomorphological equilibrium of the deltaic zones. In addition, the productivity of estuaries and deltas is a function of sedimentary deposits and of nutrient transport by rivers and canals. The water discharge acts on the biological productivity and changes in this discharge can disturb fish migration and fishing grounds, thus reducing catches of fish and molluscs.

Also in a hot, dry climatic context, environmental evolution is closely linked to agriculture because the physical and agro-ecological environmental characteristics, by their frequent irregularity, do not meet either the bio-physiological requirements

of crops or the demands of human populations whose demographic growth has been engendered by the realization of large water-management projects.

5.2 Effects of management methods on delta ecosystems

The most successful agriculturally-based human societies have benefited from the potential richness of deltas. Communities have tried to control and manage the supply, distribution and quantity of available water. Irrigation networks, dams, ponds and embankments have long been used to try to increase the capacity of delta production. Many of these attempts have been successful. In other cases, particularly in arid zones, water control techniques have caused salinization, waterlogging, disturbance of fishing grounds, erosion and an increase in water-transmitted diseases.

For the Mediterranean region, studies on delta ecosystems can be divided into two large subject areas: the study of natural modifications of delta ecosystems and the study of man-caused changes in the natural delta environment. The studies devoted to the Rhone Delta are a good illustration of the first type, whereas works on the Po and the Nile are representative of the second.

5.2.1 Sea water intrusion

Sea water intrusion in the Nile Delta. The gradual intrusion of sea water in the fresh water aquifers has created a serious situation in the coastal zones of the Nile Delta, where the partially permeable bed of rock is hydrochemically linked to the sea. Underground fresh water becomes saltier and its chemical quality is lowered. The formation of white crusts made up of alkali accumulation degrades the lands in the North and, if appropriate measures are not taken, it will be impossible to prevent the loss of valuable resources from Egypt's national heritage, i.e. water resources and productive soils.

Through the centuries, annual summer floods composed of muddy fresh water flowed into the sea and retained their identity over a variable distance, whereas the salt water was pushed out to sea, at which point the strata below the land were filled exclusively with fresh water.

The modification of the river system as well as the irrigation and drainage conditions existing after the construction of the Egyptian High Dam have created a regime of great complexity. New static pressures of replenishment have intervened and have caused considerable differences between the levels of fresh and sea water.

Using available information, it is difficult to outline the exact extent of the problem, as it results from many complex relationships (structural, nature of deposits, chemical and hydrological relationships). Surface drainage and replenishment of groundwater through the porous strata have a great influence on the balance between fresh and salt water. The differences in hydraulic pressure affect the flow and direction of groundwater and determine the extent of sea water intrusion. Sea water invades the coastal aquifers by lateral diffusion and a simultaneous rise in level. The two extremes, the Nile and irrigation water on the one hand, and the Mediterranean Sea on the other, affect the chemical quality of underground water to a greater or lesser degree depending on influences due to the source of water. Nevertheless, it is thought that the sea is invading the coastal aquifers to the North of the "40,000 ppm T.D.S. isoline". The ionic ratios of the constituants of groundwater are similar to those of sea water. With the exception of small quantities of fresh water in the coastal dunes, drinking water is limited to the layer that floats on top of fresh, salt or brackish water.

Salt intrusion in the Po Delta. In 1972, the Italian Administration for Electrical Energy (ENEL) decided to construct a high-power thermal station in the Po Delta region. This area was chosen for both technical and social reasons: to contribute towards industrialization and to improve the standard of living of the inhabitants. From a technical point of view, this area was chosen because it receives 24% of Italy's river water, and thus can fulfill the cooling requirements of the station.

In order to study and predict the possible changes in the hydraulic behaviour of currents and saline formations, a homogenous, hydrodynamic numerical model was used at a scale simulating the deltaic network between Pontelagoscuro and the delta.

It was decided to build a model capable of reproducing the physical circulation of water and the penetration of sea water into the river. The purpose was to deal with the main problems related to water quality (salinity and to a lesser extent, temperature) and due to probable changes in the behaviour of saline formations. It is interesting to list the possible consequences of these changes: modification of the marine plant community with destruction of fish and plankton; penetration of salt into aquifers, which is detrimental to agriculture; increase in the rate of sedimentation, necessitating dredging; and recirculation of cooling water, provoking a rise in temperature.

5.2.2 Sedimentation and coastal erosion

Studies devoted to the Nile Delta have shown that it is important to study the effect that the whole river basin has on the delta. In addition, studies on the

historical evolution of the delta and the present processes of formation are closely related and inseparable, constituting the key to predicting future modifications of the coastline.

Man began to control the Nile at the beginning of this century by constructing the Aswan Dam and the Gebel Aulia Dam on the White Nile. In Central Sudan, on the Blue Nile, the construction of the Sennar Dam was undertaken about forty years ago. A dam was erected on the site of the sole exit of Lake Victoria to supply energy for Ugandan industry. The series of projects aimed at controlling the Nile still continue to regulate basin irrigation: the old Delta Dam, the Aswan, Assyut, Esna and Nag-Hammidi dams as well as the new dam on the delta.

The cyclical regime which the river had followed since time immemorial has been completely altered since the diversion of the river-course upriver of the Aswan High Dam (1964). Building the High Dam has given rise to a completely different regime of the Nile between Aswan and the Mediterranean Sea. Because of the enormous capacity of the Dam reservoir, the flood waters are stocked in Lake Nasser and only clear water containing very low quantities of suspended silt is admitted into the channel which feeds the hydro-electric power station, in addition to the water that meets irrigation and navigation needs. The fine silt suspension does not represent more than 1.5 to 4% of the tonnage transported before the construction of this dam (134 million t/yr between 1929 and 1955).

Deprived of its sedimentary drift, the delta will gradually recede until it attains a new state of equilibrium, either naturally by a gradual change in sediment characteristics, artificially by coastal protection measures, or by a combination of the two preceding possibilities. The sediments are a fundamental factor determining the ecosystem characteristics; they have an important rôle in the recycling of nutrients and are the centre of intense microbial activity.

Information available on sediment discharges and rainfall over long periods will provide the basis for a statistical analysis of the Nile sediments. Also, the climatic variations affecting the Nile basin could be reflected in the water discharge and the sedimentary drift. A study of records on the natural discharge of the Nile at Aswan from 1871 to 1971 showed that the subseries 1871-1902 is 27% higher than the average of the second period, 1903-1971. The rainfall showed periodic variations (short-term 5-11 years) occurring with a certain continuity and an alternance of "dry and wet" periods. The last lower-than-average period, 1965-1971, corresponds to the period of persistent drought affecting the Central African savannas, and,

going further back in history, one recalls Joseph's revelation on the seven rainy years followed by seven years of drought.

The majority of sediments come from Ethiopia; there is no doubt that the rainfall pattern in this country strongly influences the sedimentary drift. However, these influences are more or less cancelled out during the long journey of the sediments between Aswan and the Mediterranean Sea. Factors which influence the sediment load are the intensity and frequency of rainfall and the plant cover and moisture content of lands where these rains occur.

It is important to have basic studies on the rivers before they have been disturbed, including studies on the formation of deltas. However, it is difficult to compare data and to extrapolate results from one river basin to another.

5.2.3 Productivity

The productive potential of deltaic soils is determined by the influence of climate, vegetation, relief, parent material, time and human activities. Knowledge about soils, agriculture, financial and economic viability of different methods of farming have a great influence on the productivity of deltas. Accurate determination of soil potential is particularly important in regions of high population density such as the Nile Delta.

Soil-related problems, which are either difficult or expensive to resolve technically, can limit the production of agricultural development projects in terms of both general and specific objectives. There is therefore a direct technical link between agricultural projects and the productive potential of soils; this relationship is expressed in terms of maximum yield in relation to management techniques and to an optimum soil. Productivity is largely a function of the processes related to organic substances coming from fresh water and sea water.

The farmer's ability to increase production depends essentially on innovations resulting in higher yields from soils which, at the present time, barely meet the needs of a single family.

However, plant and animal requirements are not identical. For example, an increase in plant cover does not necessarily mean that animals have abundant and nutritious food. Thus, the deficiency of a soil oligo-element - cobalt for example - can have only very small effects on plant growth. But cattle feeding on these plants

could be seriously affected by this deficiency. This observation underlines the importance of studying the effects of the suppression of Nile sediments on the productivity of the delta.

Important changes have influenced water properties. Detailed studies must be made on several subjects, for example: sedimentation of suspended products rich in nutrients; increase in salt concentration of Nile water, as well as changes affecting the anion/cation equilibrium; increase in water pH and Na concentrations; modification of biological and total microbial activity.

It is thought that there might be deficiencies in the nutrients which were derived from a natural source, namely the mud of the Nile.

5.2.4 Ecological aspects of aquatic plants in deltas

One of the most frequent problems of irrigation systems and of drainage is the spread of noxious aquatic plants, principally the water hyacinth (*Eichornia crassipes*). In the Nile Delta, most of the population lives beside canals and watercourses; consequently, most of the animal and human waste as well as fertilizer remains are dumped into these waters. In addition, the water flowing in the gently sloping waterways is silt-free and has thus favoured the growth and spread of aquatic plants.

The losses caused in the Delta region by aquatic plants are partly due to floating hyacinths which can spread to the point of covering all the area of contact between the water and the atmosphere, causing damage to fishing grounds. These hyacinths appeared in the Delta in 1958 and have spread dangerously. The Ministry of Irrigation has undertaken to control aquatic plants and, in 1975, launched an intensive programme of control by mechanical, chemical and biological means. Since the beginning of 1976, the majority of aquatic plants have been brought under control.

The various losses or damage caused by aquatic plants in their invasion of irrigation systems can even include the complete blockage of canals, preventing irrigation water from reaching the furthest sectors. It has also been noted that the growth of aquatic plants increases at the end of Spring and the beginning of Autumn, in direct opposition to the greatest seasonal water needs of the delta. There are also negative effects from dead plants which fall to the bottom of watercourses, drying and roting in a layer sometimes as thick as 30 cm.

The other harmful effects caused by the plants are:

(1) possible losses from evapotranspiration caused by increased leaf respiration; these losses can attain levels of up to three times the evaporation from a normal surface;

(2) disturbance of navigation on the canals, upsetting nautical activities and fishing;

(3) losses from a health point of view, as these aquatic plants provide a favourable habitat for malaria-carrying mosquitoes and for molluscs carrying other diseases.

5.2.5 Pollution

Pollution of coasts and deltas constitutes a major problem which requires co-ordinated research, administrative and legislative actions. Aerial spraying of pesticides can provoke serious contamination; this technique can be used for programmes of malaria control and for the treatment of agricultural areas situated alongside waterways, ponds and estuaries. The addition of pesticides to irrigation water for paddyfields is a direct source of contamination. The concentrations needed for parasite eradication are lethal for one type of fish, the Tilapia.

It is necessary for further studies be done on the effects of the interactions between different herbicides, pesticides, fertilizers and cultivated plants.

It is obvious that in places where waste water can pollute water for domestic use, it is necessary to have standards of water quality and controls in order to protect the health of the consumers. Other types of pollution, such as the use of persistent biocides to combat mosquitoes, for example, can have serious harmful effects on aquatic ecosystems. Certain contaminants of industrial origin can cause considerable harm and must be eliminated if the aesthetic and touristic value of these regions is to be preserved.

5.2.6 Fishing grounds

Human activity in deltas can cause changes in their salinity or turbidity, or even chemical variations in the estuaries and adjacent marine zones. These changes can have important consequences for fish. The Aswan High Dam is thus accused of having caused great losses for the sardine fishermen. These losses must be compared, however, to the advantages which should arise from the creation of important new fishing grounds at Lake Nasser.

Pisciculture constitutes one of the deltas' resources; its application in the Northern lakes and in the paddyfields of the Nile Delta is of great importance for the country's national economy as it provides the population with relatively inexpensive fish protein. In the Po region, pisciculture in the coastal brackish waters has been the subject of advanced research. The work undertaken by scientists in the fields of plankton ecology, research on fish reproduction in brackish waters, and on other subjects offers good possibilities for regional co-operation.

Propositions have been made to restore the salt lake of Boroles in the Nile Delta area, by introducing fresh water up to a level of one meter above sea level and to reserve these waters for fishing activities. Part of the lake - 18,000 ha of a total area of 81,000 ha - will be allocated as fishing areas. It is thought that the amount fished per hectare should go from 75 kg to 500 kg. The operation affects a total area of 63,000 ha. Filling up the lake with fresh water and the operations of restoring this zone will have new ecological effects which must be considered, and which will give rise to discussions and conflicts between the agriculture and fishing industries such as those which exist in the majority of Mediterranean deltas.

As has already been noted, dangerous substances (pesticides, chemical fertilizers, waste water, industrial pollutants) can affect water quality and the fish population. Legislation which would establish water quality standards and define the conditions for their enforcement and monitoring must be elaborated and brought to conclusion.

5.3 Human and health aspects

The Mediterranean Basin, one of the oldest cultural centres of the world, was influenced by three great civilizations: Egyptian, Greek and Roman. Ever since, this region has been exploited and subjected to man's activities, being considered, *inter alia*, the cradle of irrigated agriculture.

In modern times, this area has undergone industrialization and even more sophisticated exploitation. A huge increase in population has given rise to severe constraints on the regional level. It has also been a centre for activities relating to commerce, transport and tourism.

With respect to health, the Mediterranean Basin has been a place for important epidemics in the past. Due to facility of communication, epidemics of plague, cholera, smallpox and typhus spread throughout the region. It was only after the discovery of

the causes of these diseases and the implementation of means of checking them that man was able to control their spread. Nowadays, this region is affected by other health risks - essentially pollution problems and viral diseases - against which no active steps have been taken.

5.3.1 The health situation in the populated irrigated zones

Certain infectious diseases develop in humid irrigated zones.

Schistosomiasis. There are two types of schistosomiasis, the urinary form (*S. haematobium*), the most widespread in Mediterranean countries, and the intestinal form (*S. mansoni*). These are found in Libya and in epidemic proportions in the Nile Delta from where they are now spreading to other parts of Egypt. The intermediate hosts are *Bulinus truncatus* and *Biomphalaria alexandrina* for urinary and intestinal schistosomiasis respectively.

Schistosomiasis depends on the presence of a host in order to spread. The ecology of the aquatic mollusc depends on the irrigation system and the species which live there. The vectors differ from one irrigation system to another.

In Egypt, this is well-illustrated by the fact that, in the Delta region, agriculture has developed with perennial irrigation. The canals used all year round make a favourable terrain for *B. truncatus* and *Biomphalaria alexandrina*; thus both the urinary and intestinal forms of schistosomiasis are present in the Delta region.

From 1934 to 1937, following the construction of the Aswan Dam and the introduction of perennial irrigation in new areas of Upper Egypt, the incidence of schistosomiasis went from approximately 10% to 60%. A similar change is anticipated in Egypt following the modification of the irrigation system in several provinces of Upper Egypt, which permits the use of water coming from the High Dam.

The control of vectors must be planned from the beginning of the use of new irrigation systems; the conditions favouring their spread such as rate of water flow, currents, aquatic plants, vegetation, canal supply and other factors should be studied. Efforts must be made so that these investigations are undertaken in connection with studies on efficiency or on other economic aspects of the irrigation system.

Prevention of schistosomiasis should include an investigation stage which covers the quantitative ecology of the elements of the cycle (demography, etc.) as well as

the ecology of infestation (ecological habitat of the agent, description of the behaviour of the vector, man-vector relationships). The study should be accompanied by the elaboration of an "epidemiological model" which would allow one to determine the best ways of undertaking co-ordinated control of this disease (see MAB Report Series No. 21).

Diagnosis and mass treatment, as well as the strengthening of all environmental health aspects, are the two pillars on which authorities must stand in the fight against schistosomiasis.

To advise avoidance of contact with water is hardly useful, as such contact, in most countries, is a part of everyday life which could be eliminated only if there were a complete revolution in irrigation and farming methods.

Biological control of aquatic molluscs, the transformation and even the destruction of their habitat, without water pollution, are among the tools and plans for the Bilharzia region. The UNEP and WHO control programmes are also part of this spectrum.

Malaria. This disease has always been endemic to the Mediterranean region. It is transmitted by a vector with an aquatic cycle - the Anopheles mosquito - and its abundance varies from one area to another of the Mediterranean region. In Morocco, the alluvial plain of Gharb is one of the few regions of the Western Mediterranean where malaria is still active. Also in Morocco, in the Oued Seboue, the extension of paddyfields has caused an increase in the vector's population. A sharp increase in malaria was noted during the floods of 1964.

In another connection, the Camargue was a favourable terrain for the endemic malaria right up to the beginning of the 20th century. Afterwards, a regression and even total disappearance of the disease was noted even though its vector was still present. This is a typical case of "anophelism without paludism" (MAB Report Series No. 21).

In Egypt, malaria is under control but has not been eradicated. Nevertheless, the malaria problem is threatening Egypt as a result of the formation of Lake Nasser upriver of the High Dam - a major technological enterprise destined to improve the efficiency of irrigation. In 1942, more than a million cases of malaria and 100,000 deaths were recorded. "If today *An. gambioe* were left to establish itself in the large lake area, the situation would be very serious and the devastation would have incalculable effects" (MAB Report Series No. 21).

Filariasis and onchocerciasis. Filariasis exists in certain countries in isolated pockets right up to the North and in the South of Spain. It has been discovered that the infection is transmitted in Mediterranean countries by *C. fatigans*, *C. pipiens*, *C. molestus* and *Anoph. algeriensis*. The extent of the problem is unknown and more complete information is needed.

Transmitted by the Simulidae, onchocerciasis has not yet been reported in the region. However, because of the development of the artificial lake South of Aswan, the risk of its transmission to Egypt exists as the conditions there are favourable for the Simulidae. Nevertheless, no incidence of onchocerciasis has been detected.

Arboviruses. Arboviruses are the third highest insect-transmitted disease risk in the Mediterranean region. Two arboviruses are important: the West Nile virus and the Tahyna virus, which are transmitted by *Culex* and *Aedes* respectively.

The West Nile virus exists in the majority of Mediterranean countries. Migratory and non-migratory birds play an important rôle as vertebrate vectors.

Leishmaniasis. Three forms of this infection are known at present. Only the infectious Kala-azar and Oriental sore are rampant in the Mediterranean region.

Kala-azar affects essentially young children. Dogs and other members of the Canidae are widely affected and have an important rôle as reservoirs for the disease caused by *L. donovani*, *L. caninum* and *L. infantum*. In Mediterranean areas, Kala-azar is essentially a children's disease; it is transmitted by Phlebotome or even directly by man. Post-transfusion and congenital cases of Kala-azar have been reported.

Oriental sore is transmitted by *Phlebotomus sergenti* and *P. papatasi*, Kala-azar being transmitted by *P. major* and *P. perniciosus*. A bout of Oriental sore during infancy protects against the development of another ulcer at a later stage, but does not immunize against Kala-azar. Leishmaniasis is not truly associated with deltas and irrigated lands; important research undertaken in France shows the endemic nature of the parasite for wild dogs.

Leptospirosis. Known as Weil disease or Mediterranean yellow fever, this disease is caused by *Leptospira icterohoemorragiae*. The natural carriers are wild mice and rats. The extension of paddyfields has caused the outbreak and spread of the disease in several zones. Leptospirosis is considered as a professional disease affecting essentially farmers, miners, fishermen and sewage workers. Dogs can contract this infection and become transmittors.

Ankylostomiasis. Ankylostomiasis constitutes another risk associated with irrigation and cropping. It has a high incidence in Egypt and formally existed in Europe when surrounding conditions favoured its life cycle. In order to develop exterior to the body, it requires a temperature of 24 °C.

The infection is found in irrigated lands and is also considered a professional disease of farmers; it causes great deterioration of health and work capacity.

Cholera, typhoid, dysentery and other gastric affections. These infections spread easily in deltaic zones and irrigated lands. In general, their transmission takes place in the context of aquatic systems. Humid and overpopulated zones constitute a favourable environment for their spread. The propagation of these infections is further favoured by the absence of hygiene and by the use of human excreta as fertilizer.

5.3.2 The health situation in recently colonized or developed zones

Modification of the pathological structure caused by ecological transformations. The development of land and establishment of new irrigation systems are currently being carried out in different countries of the region in order to meet the need for agricultural development and expansion which must be able to cope with strong population pressure. These operations are taking place in Tunisia, Libya, Algeria, Egypt, Syria and in other countries. In Egypt, the realization of the High Dam has allowed the cultivation of new lands and, in the near future, other lands will be developed on the Mediterranean coast. This includes agricultural development and the construction of new villages where new families are then settled. The process is of a multidisciplinary nature; several Ministries are participating. Thanks to these developments, the environment of these regions is changing and there is a transformation in pathological ecology.

The vectors of these diseases - e.g. mosquitoes and molluscs - develop as usual and are either introduced into these new zones, or else undergo increased growth due to the transformation of the environment.

In this respect, the Egyptian experience varies according to the situation and the importance of the environmental transformation to which human beings are exposed. Two big colonization operations have been carried out during the last decade: the Nubian projects and the colonization zones of the Western region of Tahir and Nubareya.

In Upper Egypt, the Nubian autochtones were subjected to important changes. Initially they lived scattered over the vast areas of Nubia. When the colonists were

grouped together in villages, they had difficulties in adapting to their new environment: an increase in mortality of the very young and the very old was noted. The colonists had to change employment and devote themselves to growing sugar-cane. The introduction of new irrigation systems in this region has caused the appearance of molluscs new to the area, in particular *S. mansoni*.

Things happened differently in the Northern Tahrir and Nubareya zone. The colonists were farmers from the delta region; consequently they were subjected to very few changes in their activities and way of life, there being a much less marked environmental impact. Neither was there a mass mobilization of the whole population of an area; the operation was a selective colonization involving the choice of a certain age group, state of health and even of size of family. The colonists could return to visit their villages and the socio-psychological adaptation was much easier.

Nutritional conditions of newly-developed lands. Irrigation projects are launched to increase food production as well as to improve and develop economic conditions of recently-developed zones. This is usually true in arid and semi-arid zones where agriculture and food production are difficult if not impossible without these projects. This does not always involve an improvement in the health and nutrition of the inhabitants, especially in the case of newly-developed lands where soil productivity is not well-established and where, as a result, food shortages can occur.

In this respect, the Egyptian experience is different from the two development projects already mentioned. In the Nubian experiment, the installation of approximately 50,000 people on non-productive lands immediately entailed a food shortage and a big rise in price of basic products; but there was no case of real famine. Resistance to infectious diseases was very low, particularly with the very young and the very old. This resulted from several causes amongst which protein deficiencies played an important rôle. During the two years following the installation of the colonists, a sharp mortality rate increase was noticed: from 13.6 in 1,000 in 1963 to 23.6 in 1,000 in 1965.

In 1965, the government asked the FAO for food aid. The distribution of products lasted 13 months. In 1970, Egypt signed an agreement with the World Food Programme and food products were distributed to farmers in order to incite land development. In the majority of dam constructions and irrigation systems, food aid of local or international origin was found to be essential for colonization operations by population displacement. This was also true in the Volta case, in Ghana.

Use of health services in the newly-developed zones. Again the Egyptian experience had been different for each of the two situations already mentioned. The Nubian people were

not used to utilizing modern pharmaceutical products. Medical supervision was ensured by a doctor who came by boat on the Nile and visited the villages at irregular intervals. In addition, in their original habitat, these people had a great many medicinal plants at their disposal and called upon their traditional medicinal practices which were always linked to the environment.

In studying the situation as it was after the installation of these people in their new villages, it was realized that there was a complete transformation in their conception of health and an almost total disappearance of traditional medicine due to the fact that the plant ingredients did not exist in their new environment; the men used modern pharmaceutical products to cure their ills.

There was minimal use of the health services for the care of children. In the other area of colonization, the use of medical services in North Tahrir did not differ from the practices in the new colonists' former villages in the Delta zone.

The similar pathological conditions of deltaic zones and irrigated lands in the Mediterranean Basin should serve as a basis for regional co-operation in order to obtain the best use of human and scientific resources of these countries.

5.4 Recommendations

The participants presented their requests concerning theme 4 in two distinct parts, the first relative to management of delta ecosystems, and the second to health aspects of irrigation.

In addition, they requested that the Ebro Delta be included in the study programme on Mediterranean deltas undertaken within the framework of MAB Project 5. However, the Algerian delegation expressed reservations on this point.

Management of delta ecosystems. Development through irrigation of deltaic zones and agricultural zones gives rise to great difficulties due to the multiple factors which come into play. Such is the case of the Nile Delta where an important water management scheme (Aswan Dam) and the creation of new irrigated zones next to the Delta (Nubareya Project) revealed the necessity of undertaking studies considering the effects of the entire river basin on the delta.

An expert mission based on this concrete example and on the experience acquired by Egyptian experts could more accurately define the terms for a global approach; this methodological study could then serve as a basis for propositions of regional projects.

The participation of specialized United Nations organizations was proposed for the study of individual projects, notably: the FAO for agricultural development and especially the rational use of water (irrigation, drainage) for improvement of agricultural production; the WMO for studies concerning the original meso- and microclimatic characteristics of deltaic zones and the influence of proposed land managements (irrigation, drainage, creation of windbreak systems on the formation of microclimates); and Unesco, within the framework of its International Hydrological Programme, which should provide elements useful as a basis for developing new research.

Countries using water from deltas of major rivers for agricultural purposes should implement means of monitoring and measuring the penetration of salt water (flood or underground water), in order to have adequate data for orientating the elaboration of management programmes of these deltas; as for industrial countries undertaking intensive nuclear or thermal power station programmes, they should be aware of the consequences of thermal or radio-active pollution on ecological equilibria and, more especially, the equilibrium of aquatic systems associated with deltas[1]. All these studies should be able to benefit from the contributions of new technology and notably remote sensing techniques. Finally, an *ad hoc* committee should be designated in order to ensure continuity and co-ordination of mutual activities within the framework of the project.

Health aspects of irrigation. The participants recalled the important rôle played by deltas and, more generally, by irrigated zones in the epidemiology of transmissible diseases and of toxic processes associated with the use of pesticides, hence the advantage of an ecological approach taking into account the environmental characteristics of the pathogenic agents and of the human population. The participants gave priority to the problems concerning: schistosomiasis transmitted by aquatic molluscs; malaria and other diseases and illnesses brought about by blood-sucking insects; and prevention of bacterial and toxic (pesticides) pollution.

To this end, it is desirable to develop the assembly and dissemination of data concerning water contamination diseases. A centre situated in Egypt dependent on the Ministry of Agriculture would be able to orient its scientific skills in the direction of ecological multidisciplinarity; to intensify information exchange between this centre and others in the Mediterranean region principally concerned with eco-pathology; and to promote the exchange of researchers with ecological training on specific subjects (diseases associated with parasites, bacteria and toxic products) in the form of courses or participation in united actions.

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1. *The Algerian Delegation expressed reservations on this point.*

6. WATER ECONOMY: PROBLEMS CONCERNING DRAINAGE BASINS AND PROTECTION AGAINST EROSION

6.1 Introduction

Water requirements, expressed in quality, quantity and in their distribution over time (peak periods) are dependent on the population and on the economic development of the land, hence on the exploitation of its other natural resources, renewable or not.

Water resources, supplied by rainfall or atmospheric condensations, are related to regional climatic factors over which man has as yet little power, as well as physical and biological characteristics of drainage basins (relief, geology, soils and vegetation, drainage network).

It is essentially these hydraulic characteristics of drainage basins over which man has the most power, either by modifying natural reserves, or by creating artificial ones by changing the conditions of surface or ground drainage, and likewise altering the conditions of natural purification of polluted water. The increase in pollution due to urbanization and industrialization makes artificial water purification even more necessary, especially where resources are scanty or irregular and where there is advanced economic development.

Drainage irregularity also results in damage associated with more or less concentrated or superficial runoff (erosion, floods, solid deposits) and, to a lesser extent, in the accumulation of certain infiltrated or stagnant water (mudslips and mudflows, formation of hydromorphic soils, salinization). Generally speaking, these accidents owe more to the regularity of the water regime than to the total quantity of water over a longer or shorter period of time.

The development of drainage basins could be conceived as being the organization and exploitation of all the natural resources of a drainage basin (hydrographical unit), to ensure for the population and the economy: sufficient quantities of good quality water; protection against soil erosion and floods; conservation of a quality environment, i.e. health, cultural and aesthetic values associated with the natural elements of land, air and water.

The economy of water, an increasingly valuable fundamental resource, is really the basis of drainage basin management.

6.2 Particularities of Mediterranean drainage basins from the point of view of water economy and their management

Irregular rainfall necessarily results in an irregular surface flow, thus affecting the available water resource, whatever the amount of water the drainage basins can accumulate.

As plains, plateaux, extensive areic depressions have massive underground water reserves in a more or less fossil state because of the slowness of underground waterflow, which provide reserves which refill the depressions according to need, these areas are thus not subject to this irregularity. Even then, it is advisable that use of this underground water on a long-term basis does not exceed the possibilities of replenishment, and that this replenishment is neither by seawater nor salty water.

Huge reserves of underground water rarely exist under mountain basins. The young mountain chains, of pyrenean or alpine tectonic age which encircle the Mediterranean Sea, have rugged relief which increases surface drainage at the cost of infiltration. The interannual glacial reserves, limited to the South of the Alpine massif, are insignificant. The interseasonal snow reserves have a small rôle. Therefore, on the whole, rivers and streams relate directly to the irregularity of the rainfall regime.

This regime is characterized by a concentration of precipitation in winter and a long pronounced summer drought during the period of high potential plant evapotranspiration.

Rainfall is irregular not only on a seasonal basis, but from year to year as well. The temporal pattern is very haphazard, as much for the total amount from showers and rainy periods as for the peak intensity of certain rainstorms, expressed in mm per hour or per minute.

The various regions receive more or less rain and are more or less affected by rainfall irregularity according to their continental position, their geographical situation in relation to sea winds and the degree of ruggedness of their relief.

Except at the subtropical limits of deserts, the least watered regions are fortunately the least affected by dangerous sudden downpours of intense rain. This is unfortunately the fate of very steep mountain blocks exposed to sea winds or dominating low, humid over-heated plains: the Southern Cevennes, Central and Eastern Pyrenees, Liguria, Appenines, Rif.

The disadvantages of such an irregular rainfall regime relate to the management of water and renewable resources.

6.2.1 Disadvantages from the point of view of water management and quality of living conditions

(1) very low or non-existant summer water levels, coinciding with high water requirements for agriculture (irrigation) or tourism, with serious pollution of emissaries;

(2) serious risk of flooding by overflow of strong winter floodwaters or by brief but sudden summer storm floods, a waterflow swollen by a load of erosion alluvium.

The most direct remedy for flood protection in hydraulic civil engineering involves the improvement of flow conditions of the biggest discharges in well-calibrated, rectified and consolidated river-beds. However, the correction of the beds of small torrential tributaries from steep mountain basins upriver, by its series of dams and mudsills, also contributes not only to ease the concentration of water in the river outlet, but also to relieve this water of a dangerous solid load. Indeed, the carried load, by slowing the waterflow downriver, raises the height of the floodwater, thus facilitating overflows.

Nevertheless, the most basic remedy contributing not only to lowering floodwater levels but also to maintaining low water levels downriver consists in the development of big water reservoirs.

However, action can also be taken concerning the size and mobility of natural water reserves contained in the drainage basin by the vegetation and soil by manipulating this vegetation and, in particular, by modifying the tree cover.

6.2.2 Disadvantages from the point of view of erosion and renewable resources

The winter concentration of irregular precipitation is unfavourable for vegetation: intensive crops need a great deal of summer irrigation; the natural plant cover assumes xerophyllous characteristics or dries out in summer becoming inflammable and combustible, as well as a low biomass and an often discontinuous soil cover with little pedogenic influence. This pedogenisis is also affected by a rapid combustion of humus and is often marked by upward salt movements resulting in special soils or crusts which are hardly favourable for closed, vigorous plant formations. For outdoor crops, this results in the limitation of steppe winter cereal crops, the introduction of cultivated

or uncultivated fallow, crop rotation, or in the ancient and disastrous practice of slash and burn agriculture (coppice or cleared maquis) in overpopulated developing countries condemned to be self-sufficient for food production. As for stock-raising, the effects are felt through a lack of summer forage and watering difficulties which limits the use of abstemious, agile cattle and especially goats whose hard mouths are adapted to maquis and garrigues. The summer shortages and the hazards of forage production have often led the population to resort to pastoralism, thus diminishing the worry about conserving soil fertility on more or less commonly shared lands.

The Mediterranean rainfall regime doubly favours the process of diffuse surface soil water erosion practically everywhere in fields and rangeland, and the process of concentrated, gully, deep or bedrock torrential erosion in mountain ravines.

On the other hand, the erosive power of rain on the soil surface is indeed very strongly and positively correlated with intensity; the same is true for concentrated torrential erosion since the removing and carrying forces of the currents in valley bottoms are positively related to both depth and speed and, therefore, to peak waterflow which reflects, with a certain time-lag and a certain reduction, the rain-storm characteristics (hyetogram).

In addition, vegetation is a natural shield which nature provides against erosion, and consequently all climatic conditions which tend to weaken this protection favour the erosion process.

Therefore, these processes are connected, all the way from lateral erosion, which supplies the fine suspended matter which increases the viscosity and density of the current, to concentrated torrential erosion. This erosion eats away into the hillsides by gullying, a more powerful and concentrated flow undermines the base and causes the softened, undermined banks to collapse, thus starting the downwash of coarse material by the effects of consolidation followed by dispersion.

After hundreds and sometimes thousands of years of downwash, the emissary riverbeds, supplied with too much solid load and not regularly enough with water, become blocked with gravelbanks which widen the main beds to the size of true wadis. In these, occasional waterflows wave or wind between these gravelbanks, engendering new perturbations and the uptake of sediments from the riverbanks or from the gravelbanks themselves.

Gradually, through the long processes of coarse debris transport by sudden downwash and uptake by floodwater, the collisions and friction between the pebbles and the

action of weathering on the surface of the gravelbanks (freezing, heat expansion, hydrations, oxidations), the alluvium becomes, according to its resistance or its more or less cristalline composition, sands, silt, fine silt, or even clay particles and dissolved salts. This fine alluvium travels further downriver where its transport and deposition do not cause the same inconvenience as the coarse material deposited upriver by true torrential streams.

6.3 Disadvantages of sediment pollution of streams and rivers, especially for hydraulic developments

The problems of sedimentation in the still water of reservoirs and even in the slow-moving water of canalized rivers are the most serious erosion problems in Mediterranean drainage basins as far as the development of their hydraulic resources is concerned, particularly for irrigation and electrical energy production. Their eutrophication by dissolved salts following weathering processes also sometimes causes problems concerning the quality of living conditions. One of the best tools against this sediment pollution of Mediterranean water is still the restoration of degraded drainage basins and overall soil conservation.

6.4 Recommendations

The working group participants emphasized the impossibility of waiting for results of long-term research on the scientific principles of drainage basin management in order to undertake this management, which is often vital for the populations concerned. This research nevertheless remains an indispensable means of readjusting planning during management operations; it must therefore benefit from sufficient material means to allow it to be realized within the framework of long-term planning.

Taking these remarks into account, it is hoped that:

(1) a practical system of information exchange be set up on all fundamental research, practical experimentation and methodology being carried out, as well as on the results obtained on the management of drainage basins in different Mediterranean countries. It is particularly hoped that the MAB National Committees will provide the MAB Secretariat with a list[1] of organizations and specialists in each country concerned with studies and research on drainage basin management as well as the operations undertaken for such management;

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1. *To draw up this list, it is recommended to also use the data in the possession of the European Economic Community and that of the Natural Resources Committee of ECOSOC in New York. The work of the European Forestry Commission should also be considered.*

(2) contacts between specialists from different countries be encouraged by awarding grants for study tours in Mediterranean countries;

(3) a working group of experts and representatives of each country bordering the Mediterranean Sea be constituted;

(4) finally, that the FAO, Unesco and UNEP study the possibility of including in their working programmes and their 1978 budget a joint meeting whose theme would be: Integrated and applied research on conservation and development of the natural resources of drainage basins.

In this connection, the Conference gratefully acknowledged the proposition made by the MAB National Committee of Morocco to organize such a meeting under the auspices of the FAO, Unesco and UNEP.

7. IMPACT OF POLLUTANTS ON MEDITERRANEAN NATURAL AREAS

7.1 General aspects

The conceptual framework of MAB Project 14 has been established by two task forces which met in Moscow, 23-26 April 1974 and in Ottawa, 5-8 August 1975 (see MAB Report Series No's 20 and 32). Considering these basic elements, the Conference emphasized the importance of developing a theoretical and practical framework for MAB Project 14 adapted to the needs of the countries bordering the Mediterranean Sea.

7.1.1 Definition of the theme "Impact of pollutants on Mediterranean natural areas"

Within the framework of this theme, the following aspects were considered important by the Montpellier Conference: establishment of an evaluation of the situation which would appraise environmental contamination and targets, taking into account physicochemical and biological methods; research on the contaminant pathways in biological chains; assessment of the impacts of pollutants and contaminants on man's environment; research for preventive and curative remedies; and consideration of psycho-socio-economic aspects.

The evaluation of the effects was considered a fundamental, top priority problem which would allow one to point out not only negative but also positive or passive effects, as well as allowing one to control the efficiency of remedies proposed by man to reduce the presence of contaminants.

Eco-epidemiology must be preceded by knowledge about ecosystems and about the ways of making a dynamic situation evaluation. The correlation between the two factors will necessitate the perfection of experimental procedures to which the contribution of biometrics is fundamental, notably through the creation of simulation models.

Comprehensive knowledge of different types of ecosystems corresponds to the concerns of the MAB Programme. The indicator idea of ecosystem evolution is necessary if the procedures are to be reasonably simplified. However, their more or less global significance must be evaluated with great care.

Some details should be given on what is meant by "evaluation of the situation". It does not simply mean the determination of events centred around an ecosystem at a given time. The evaluation must be dynamic and take "contaminant transfer and modifications" into consideration. On the ecosystem level, this must be a global evaluation taking into consideration the whole range of contaminants.

It is here that ecotoxicology enables one to define the effect of an environmental constituant on a target, helping, in the beginning, to simplify the control of the presence of reputably dangerous products - and only these - without forgetting of course the fundamental problem of interactions, nor the influence of factors such as, for example, chronobiology or discontinuity phenomena.

The theme under discussion is an interdisciplinary one for which a great deal of knowledge is indispensable; its originality must be a global approach to phenomena, taking more consideration of the overall impact on the ecosystem of different human activities, represented by a whole set of contaminants, whether they are of physical, biological, chemical, natural or psycho-cultural origin.

An exhaustive list of the needs of those who use the research which takes into account short, medium and long term necessities could be useful.

7.1.2 Relationship between this theme and other programmes, and constitution of a working group

As has already been said, the theme "pollution" is an interdisciplinary one. Within the MAB Programme, it would be useful at first: to draw up a list of research undertaken in other projects which could be included under the theme "pollution"; to suggest, if necessary, programme modifications; to analyse the results obtained and the ways of applying them as they become available.

Similarly, a working group could examine, in order of importance: current national research programmes; the European programmes (1st and 2nd research programmes of European communities, 1972/75 and 1976/80) and the programmes of other international organizations.

All the studies which are outlined here should be specified and programmed within a working group on the theme "impact of pollution and contaminants on Mediterranean natural areas". The main objectives of this group would be to collect the maximum amount of information on the research being carried out, to inform the organizations concerned, to synthesize and to try to render the information compatible with practical exploitation.

On the basis of the research carried out under this theme, it will be necessary to make a prospective study of the evolution of pollution and contaminants of the Mediterranean Basin.

7.1.3 Priorities for the Mediterranean region

Considerable work has still to be done before pollution control actions can be accepted in the Mediterranean region. This could include as priorities the following points: essential long term measures which would allow one to save the Mediterranean Basin environment; socio-economic effects of pollution related to industrialization and tourism; impact of industrial and waste water on the environment and the impact of pollution relating to sea traffic; level of international co-operation, the monitoring and the control of increasing environmental degradation; forms of co-operation between educational institutions and the commissions specializing in this field to motivate public opinion; and the international responsibility of pollution.

The study of the most appropriate measures for the general safeguarding and regeneration of water is of vital importance in the Mediterranean region (fresh water areas, lakes, coastal zones), the industry along the Mediterranean coastline being capable of greatly upsetting the ecosystems. Such a programme could eventually serve a long term monitoring function.

It is also advisable to describe in detail the intake and the outcome of the pollutants from various sources in living organisms and in the environment in general, knowledge in this field being very insufficient and imprecise. In water as in soil, the intervention of micro-organisms can sometimes lead to beneficial biodegradations, but can also give rise to compounds more toxic than the original pollutant molecules.

The research to be promoted in these various fields is linked with the training of specialists and the creation of research centres.

The training of specialists. This necessitates the preliminary acquisition of an adequate base of knowledge in the field of general ecology and especially marine and terrestrial ecology. There must be specialists in the different disciplines of ecology as well as chemists, whose rôle is indispensable, for qualitative and quantitative study of the outcome of pollutants in the environment and their possible harmful effects on the various biosphere constituants in an integrated context, especially in the South Mediterranean region.

The creation of research centres. It is necessary to have a sufficient number of research centres well-supplied with qualified personnel and equipment and with sufficient financial resources to take on and follow up a great number of problems. This is the duty of the governmental authorities of the different Mediterranean countries. In Syria,

the government has started to create a university centre responsible for marine science studies and for pollution control on the Syrian Mediterranean coastline. This centre will function within the framework of the MAB Programme. It is a very long term programme because of the multiplicity of the problems to be studied. It is urgent to coordinate research on the international level by ensuring the indispensable active liaisons between the specialists of the disciplines concerned, notably ecology and chemistry which are the keys to a better existence.

The attention of those responsible for the environment in these countries should be drawn to the fact that if they wish to economize on the training of executive personnel who would not be fully utilized, care must be taken at the moment when new technologies are introduced, so that there is no lag between the use of the tool and the inconveniences which follow its use. In developing countries, the ransom of progress is unfortunately measured by negative environmental effects which are sometimes irreversible. Algeria is attempting to assess the socio-economic aspects of an environmental policy in order to integrate its parameters in the national development and planning policy. A permanent campaign of information and teaching on the most general level, i.e. from the child to the decision-maker, has been set up so as to avoid (for the people concerned or not) antagonisms between the polluters and the victims of pollution.

It is necessary to insist on the fact that in developing countries, the protection of resources should not be considered as an obstacle for socio-economic development.

Finally, it must be recognized that environmental protection in the Mediterranean Basin does not only depend on laws and on recommendations, but is also strongly related to education, for it is the only way to alter individual behaviour. The respect of the law on environmental protection in this Basin becomes a factor of everyday life because it arises from man's perception of this problem.

Thus the aim of education in the field of nature conservation, exploitation of natural resources and control of all forms of pollution must be a definition of values and perceptions so that the individual himself understands and esteems the complex relationships between himself and his civilization and, on the other hand, the environment.

7.2 The example of the effect of air pollution on biotic communities: identification of indicator species for different pollution levels

7.2.1 Introduction

After the first three sessions of the International Co-ordinating Council, the meeting of the expert group on MAB Project 2 (Paris, 1974) finally agreed to give priority to five research themes and, more particularly, to the effects of air pollution on forest ecosystems and the influence of forests on air quality (see MAB Report Series No. 19). Within the framework of this sub-theme of MAB Project 2, field studies have been noted for Spain, Turkey and Yugoslavia at the Potenza meeting, Italy, 22-31 October 1975 (see MAB Report Series No. 36).

7.2.2 Background

The increase in population and the economic growth of the Mediterranean region today make air pollution problems a very current consideration for this region. In over-concentrated and industrial zones, the problems concern especially environmental restoration and health aspects. In rural areas of recent industrialization, they concern especially the protection of natural resources.

With respect to air pollution and its effects on plants (notably the sulphur oxides, carbon oxides, fluoride compounds, ethylene, nitrogen oxides, chlorine and ozone derivatives, soot and particles, the particularity of Mediterranean problems must be noted, related to the original characteristics of the environment itself (climate and soil).

The insufficiency of research in this field, as far as the effects on animals is concerned, must be especially emphasized.

These problems specific to the Mediterranean region are even more important since the research on the effect of air pollution on forest ecosystems has been done especially by non-mediterranean, temperate zone countries.

Another important aspect which must be considered is the necessity of an integrated approach, taking into account in a global manner all the elements of natural ecosystems (soil, fauna, flora) in their relationships with human society (necessarily including the social sciences). Remote sensing could be particularly interesting for this global approach. It must be realized that the studies in this field are still rare in the Mediterranean region.

Another aspect which certainly should be considered is that of indicator species, and of these, lichens, although research can still improve ways of using this indicator. On this subject the necessity of conserving non-polluted control zones to allow the undertaking of such research is to be noted, an activity which would coincide with the concerns of MAB Project 8.

The important functions of forests and open natural areas in the control of pollution must be taken into account, these environments being able to fix dust, gaseous pollutants and even filter bacteria. Knowledge in this field must later be used for management problems: the necessity for example of combining open forests capable of favouring the deposition of solid particles and closed forests capable of holding gases. In such a study on the rôle of forests in air purification, it would also be necessary to conduct research on resistant species of the Mediterranean region.

7.2.3 Objectives

The general objective is to study the effect of air pollution on biotic communities. This objective necessitates the definition and calculation of modifications that air pollution makes on Mediterranean natural areas, by studying and comparing the structure, functioning and dynamics of natural forest ecosystems and of other systems more or less seriously affected by pollution.

The study must not be limited to biological units but must carefully consider pollutant effects on the entire biological system, following the interdisciplinary approach characteristic of the MAB Programme.

With this approach and within the framework of MAB Projects 2 and 14, the objectives to be reached concerning the effects of pollution on biotic communities and the identification of indicator species for different levels of pollution in Mediterranean natural areas are proposed in the following points:

(1) definition of rural regions affected or potentially affected by air pollution in the Mediterranean Basin;

(2) recognition of the effects on the composition, processes and functioning of ecosystems particular to Mediterranean natural areas and especially the impact of air pollution on biotic communities;

(3) knowledge of the active mechanisms of different pollutants, or combinations of pollutants, with air constituants on these ecosystems under the conditions particular to the Mediterranean region;

(4) identification of forest species, varieties and indigenous ecotypes which are particularly resistant to air pollution and which could be introduced into the Mediterranean region;

(5) definition of the lichen and bryophyte flora of the Mediterranean zone, as well as the more complete study of species sensitive to air pollution and which, in consequence, can serve as indicators of air pollution levels;

(6) advice on the possible corrective measures, including land use management, with a view to attenuating the amount of damage to the forest ecosystems of this zone, as well as the study of the effects of forest ecosystems and open natural areas on man's health and well-being through the dispersion and filtration of air pollutants.

For these objectives, it is considered indispensable to have control zones for comparison with polluted zones, within the framework of MAB Project 8, and the conservation of natural areas and of the genetic material they contain will be encouraged along this line.

7.2.4 Research aspects

These aspects can be summarized as follows:

Know the constituants and the active mechanisms of pollutants:

SO_2: observation at different stages of plant growth, photo-sensitive method, assimilation chambers, automatic and semi-automatic analysers SF1 and SF8, plant gravimetric and calorimetric analyses, sulphite and sulphate analyses, indicator organisms, analysis by the West and Gaeke methods and by pararosaniline, dynamic and static captors, network for monitoring emission levels, use of S^{35}.

F : assimilation chambers, air-tight greenhouses, assessment of peroxide injury, monitoring of the gaseous content in the air with a network of dynamic or static captors, fluoride plant analyses by the selective electrode method.

CO : use of C^{14}, assimilation chambers and symptoms of large-leaved plants.

NO_X: specific analysers, indicator plants.

In general, it is indispensable to conduct an anatomical study of the exposed parts of affected plants.

Assess the area affected: use of remote sensing, close range sensors (1:3,000 to 1:20,000 scales) colour infra-red and black and white infra-red films.

Determine the global impact of pollution on the ecosystem: techniques of descriptive, trophic, demographic ecology, study of ecosystem changes with time and its spatial organization.

Define indicator species: determination of species, species distribution maps, correlation with levels of emission, controlled experiments in the laboratory by means of grafting.

Identify resistant species and the effects of open natural areas: assimilation chambers, genetic improvement, fumigation, masts for measuring environmental parameters and gas analyses in experimental arboretums.

7.2.5 Particular aspects of air pollution effects in Mediterranean natural areas

As mentioned above, the Mediterranean region has a specific characteristic linked to genetic differences particular to the living organisms of this environment, and to the particular weather and climatic characteristics of this region (importance of dry season, luminosity, temperature regime, etc.). These conditions are very different from those in Central Europe. Their physio-agronomic significations are shown by the steppes made up of bushes and the sclerophyllous nature of the vegetation. Mediterranean soils have suffered since Neolithic times from man's negative interventions (over-grazing, fire, abusive cropping) in a particularly dangerous climatic context (sudden storms).

Here again it must be emphasized that the majority of studies concerning the impact of air pollution have, up to now, been done in Central Europe, Scandinavia and in North America, in very different natural conditions, which well indicates the necessity to intensify this kind of research in the Mediterranean region.

7.2.6 Current research - existing information

Information on completed and current research on this subject in different countries should be made available.

It is necessary to assemble the existing bibliography and the list of available data for the forest zones affected by pollution in the different countries (area concerned, species affected, types of industry, pollution and damage observed and assessment of damage).

7.3 Recommendations

With respect to research on the theme "Effects of air pollution on forest ecosystems", the Sierra del Cadi project (Spain) was retained as a pilot project at the Potenza meeting (see MAB Report Series No. 36). The projects in Turkey and Yugoslavia were retained as complementary projects.

On this subject, the participants expressed the wish that the different MAB Committees send all information on this theme to the MAB Committee of Spain whose project has been considered as a pilot project and which will be responsible for synthesizing and diffusing this information in view of a future meeting.

In addition, the participants asked that:

(1) the problem of the impact of "Pollution and contaminants" be considered in a more general context and in a global manner by collecting the indispensable information concerning the evaluation of the "pollutant and contamination" situation on the level of each country bordering on the Mediterranean Sea; the list of research undertaken in the field on the effects of pollutants and contaminants on Mediterranean ecosystems, including man;

(2) the MAB Secretariat prepare and dispatch a questionnaire to the MAB National Committees to collect the information necessary for the preparation of a synthesis for a future meeting of the working group created for this purpose and constituted of at least one person per country bordering the Mediterranean Sea. Placed under the auspices of MAB, the working group would be responsible for recording the concrete and complementary programmes specific to the Mediterranean region which conform to the aims of MAB Projects 9 and 14.

8. IMPACT OF TOURISM ON MEDITERRANEAN ECOSYSTEMS AND COASTLINES

8.1 Introduction

The positive economic consequences of tourism for the beneficiary countries are well known. However, in a complete evaluation, it is more difficult to consider the negative consequences of this activity on the quality of the environment which constitutes precisely one of the essential foundations of this activity. A decrease in quality results in a decrease in both the number of tourists and in the resources which their presence generates. Thus tourism shows with particular clarity the narrow relationship between environmental quality and economic development.

Tourism in the Mediterranean Basin has taken the proportions of a veritable seasonal population migration from Northern industrial Europe towards the sunshine and beaches of the South. This results in an intense socio-cultural mixing capable of profoundly changing the character of the cultures which have marked the environments in which they have developed. Thus, tourism provides the opportunity to reflect upon the place and the rôle of environmental perception of both the local population and the holidaymakers.

Finally, tourism is a component, in the global development of a country, which, with others such as industrialization, the rationalizing of agriculture, leads to the transformation of the environment. The qualitative factor is also important, becoming more and more an object of planning and arbitration when there is incompatibility. Any form of human settlement management, notably tourism, in the attractive yet fragile Mediterranean Basin brings sharply into play the quality of coastal ecosystems, socio-economic development and environmental perception by the people concerned. An inter-disciplinary approach is thus absolutely necessary, within the general framework of MAB Project 13.

In a way which will be specified later, the landscape can be considered as a synthetic indicator of the complex interferences of the three areas which have just been mentioned (ecosystem, socio-economic use, socio-cultural perception). In more simple terms, landscape quality is derived from the degree of harmony between a site and the community which occupies it.

Tourism, by the magnitude of its human effects, must be considered as an activity affecting the overall Mediterranean community as well as the more limited communities of nations and regions. Tourism ranks highly, among other things, naturally gives high

importance to the quality of sites and landscapes, depending on the perception of local populations, holidaymakers or those responsible for touristic facilities.

A brief preliminary comment must be made about the difficulty of embarking on this theme. The difficulty comes from the traditional separation of the physical environmental sciences from the human and social sciences, even though they must be integrated. It also arises from the weakness of specific conceptual ideas like the concomitant one of the language necessary to engage in and develop exchanges in this field. It suffices to mention the spontaneous reactions of the population with respect to radical transformations of their physical environment, notably under the conditions of increasing urban population densities in every country in the world, and the establishment of environmental policies and the concern of public authorities aiming at introducing a global outlook to land use management, integrating most particularly the notion of quality. The problem of perception of environmental quality today constitutes a new area for scientific research. In addition, research in the field of geography has priority for integrated research on the management of the land water interface through the study of human systems of land use and perception.

Consequently, a major effort must be made in developing concepts and research on this theme. Within this general framework, study of the conception of the landscape merits particular attention. As explained below, the Conference took some initiatives in this respect. During session debates on theme 7 a general report was presented by Yugoslavia, the acquaintance with different papers were introduced, a discussion in which many people participated took place, and recommendations were elaborated.

8.2 The "Adriatic Coast" Pilot Project

The general report, in spite of its quality, suffered from not having benefited from data other than that gained from the Yugoslavian experience. Indeed, if this theme is compared with others, it distinguishes itself by the novelty of being problematical. In consequence, the little work done in this direction is either recent - and has not been widely distributed - or else has just begun, not yet permitting conclusions to be drawn. This being said, the report exposed the very interesting Yugoslavian action to plan tourism on the Adriatic Coast, following a presentation of Mediterranean touristic activities, which represent one-third of the world's tourism. In general picture of the environmental consequences of tourism, the degrading effects of excessive seasonal concentrations on the quality of Mediterranean surroundings are emphasized: "the image of the touristic environment beneficial to man is beginning to crumble". The pilot project presented (Adriatic III) results from a contract between the UNDP

and the Federal Socialist Republic of Yugoslavia. It aims at going beyond the classical sectorial studies or even the studies of a palliative nature, so as to integrate the environment and its modifications in long-term planning documents (1990), by providing appropriate qualitative analyses and by specifying the ecological impact of management projects. Two fields of research have thus been explored: that of natural factors (air, fresh water, soil) and that of the reciprocal relationships between human activities and the natural environment.

This field was finally abandoned after the first trials, because of the amount of work necessary and the often indirect nature of the relationships described.

The final research phase must come to an end a few months from now. It will therefore be necessary to proceed with the confrontation of the different studies undertaken. Thus, at the end of 1977, the final conclusions can be drawn and made known.

During the discussion which followed the presentation of the general report, the person responsible for the project described a certain number of technical details relative to the method of study. Amongst the first tentative conclusions: the theoretical and then mathematical modelling of the interactions of environmental factors facilitates the interdisciplinary approach, but is found to be difficult to use in practice over too extensive regions. In addition, the fraction of pollution caused by tourism is found to be finally quite small with respect to that caused by urban concentrations and industries. Thus the totality of human activities on the coast must be considered.

8.3 Work conducted in other countries

The papers allowed the participants to become acquainted with the work being undertaken in Spain, France, Tunisia and Greece.

Spain. In Spain, the burden of permanent and seasonal population densities poses considerable problems to the environment: not only touristic pressure but also industrial and agricultural problems (crop intensification), amplified by a mentality tending towards opulence and waste. This is aggravated by the disastrous pollution that occurs on the continental plateau. The need to worry about the protection of aesthetic landscape values has also been emphasized. Studies in this direction have been undertaken by the Chair of Ecology of the Science Faculties of the Seville and Madrid autonomous Universities. This research is carried out on the effects of tourists on ecosystems, on public preferences with respect to various forms of constructed elements in the

landscape (in these circumstances, various types of dams), and on the analysis of reactions to the natural landscape. In particular, a study on these questions is being conducted in the Doñana region, a coastal area containing a quite remarkable and unique dune complex.

France and Tunisia. France and Tunisia have jointly undertaken work on four sites, the island of Djerba and the Cap Bon area in Tunisia, the Nice region and the Languedoc-Roussillon coast in France. This work[1] concerns the integration of considerations relative to the landscape in land use management and also landscape perception by the different categories of population concerned (residents and tourists). The results are expected at the end of 1977 in the form of reports, an audio-visual document and an exhibition.

Greece. Greece showed its interest in this theme in a report on tourism and the environment. The dangers of an inconsiderate touristic development policy are emphasized. The destruction of sites by enormous concrete buildings, the disappearance of the original Greek rural surroundings, etc., reveal the dilemma of socio-economic development, within which tourism, by its very nature, will have to provide the example of paying careful attention to the environment and landscapes. It is necessary to find methods which allow a rational determination of the carrying capacity of a site in the physical sense, as well as in the sociological sense.

The discussion allowed the expression of many participants' comments. The Algerian delegate indicated that his country had opted for a global approach to the infrastructures necessary for development, for as small a transformation of the coastline as possible, with maximum dependence on the existing towns. The integrated development of the coast and the hinterland gives rise to many problems, however, the aim being to avoid touristic concentration. Emphasis has been put on the water factor being limiting in relation to concomitant touristic and agricultural development. In France, methods have been developed by a research group on landscape equilibria to appraise the degree of fragility of landscape units before man's impact, in considering the geomorphology, soil and plant cover, multivariate analysis permitting the identification of vulnerable sectors.

1. *In France, this work is done by the Centre National d'Etude et de Recherche du Paysage (National Centre for Landscape Research Studies); in Tunisia, by two* ad hoc *teams of the Ministries of Agriculture and Public Works.*

8.4 Recommendations

The participants made the following suggestions:

(1) that a list be established of the institutions and organizations concerned and of the work completed, underway, or projected on the subject of Mediterranean coastal landscapes and their transformations, and that the MAB Programme Secretariat propose a master plan destined to orient the work in the field considered;

(2) that a chapter on perception of the quality of the environments concerned by all the social groups involved be incorporated into the work relative to each of the themes of the MAB Programme;

(3) that an assessment be made of the short and long term needs in landscape research and training in all Mediterranean countries in relation with the national and international organizations concerned, and to encourage any initiative intending to develop a specific Mediterranean landscape approach;

(4) that a code of deontology of the activity of tourism with respect to the human receiving and physical environments be studied by initially taking inspiration from the third specific recommendation of the Dubrovnik Colloquium, and that good co-ordination be established with the work which might be undertaken in this same direction by all the agencies of the United Nations, notably at the World Bank Colloquium devoted to tourism, planned for 5-8 December 1976 in Washington;

(5) that a working seminar be organized in Tunisia in 1977 to group together the experts of all the Mediterranean countries concerned by the precise theme of perception of Mediterranean landscapes and their transformations. This seminar, apart from the confrontation of case studies and of methodological work, should give the opportunity to present the results obtained within the framework of the execution of the four preceding recommendations.

9. DEVELOPMENT OF MAB PROJECT 8 IN THE MEDITERRANEAN REGION

9.1 Introduction

MAB Project 8 (Conservation of natural areas and of the genetic material they contain) is making considerable progress all over the world. In September 1976, more than forty countries had proposed some 200 areas to be included in the international network of biosphere reserves, and fifty-seven areas had been officially recognized by Unesco[1].

This network of biosphere reserves is intended to combine ecological conservation of the representative ecosystems and research on the structure, functioning and dynamics of these ecosystems, the study of man's impact on natural systems and the development of means to monitor this impact.

The establishment of such a representative network is based on knowledge of the typology of Mediterranean ecosystems. In this respect, the Udvardy classification of biogeographic regions is found to be completely inadequate for the Mediterranean Basin. It is therefore necessary to set up a theoretical framework for the biosphere reserve network of the Mediterranean region based on ecological and biogeographical matrices.

Another important task remains to be accomplished: the development of the scientific basis for a network of biosphere reserves in the Mediterranean region which would take into account the necessity of restoring the ecological equilibrium of a great many Mediterranean ecosystems, the requirement of local populations which often live in the sites proposed as biosphere reserves or the natural resources that are found there, and the cultural heritage such as historical monuments and sites which are present in many Mediterranean reserves.

9.2 Characteristics of biosphere reserves as compared to other conservation units

The biosphere reserve concept is very flexible, giving each country great freedom for adaptation of the concept to its particular needs. Although there is diversity in the application of the concept, it retains the following main characteristics which distinguish it from national conservation programmes:

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1. *In January 1977, 118 biosphere reserves in 27 countries were officially recognized. Of the Mediterranean countries, Spain, France, Italy and Tunisia have officially designated biosphere reserves. Although some of the sites officially designated do not correspond to the ideal concept of a biosphere reserve, the 27 countries have officially embarked on their development.*

(1) It gives priority to the use of natural zones for research, including research on improving the scientific bases for conservation.

(2) It allows for the inclusion of man-modified ecosystems in the reserve, which serve as controls for the comparative study of modified or unmodified ecosystems.

(3) It gives priority to ecosystem conservation rather than the conservation of individual species.

(4) It ensures long-term continuity of research and environmental monitoring.

(5) It bases selection of sites on their representativeness rather than their unique characteristics.

(6) It provides for the establishment of an international framework of co-operation between countries for conservation and research.

Several points have been explained in the reports on biosphere reserves and other types of reserves:

Relationship between biosphere reserves and other protected areas. An efficient co-ordination between UNEP, FAO, Unesco and IUCN is ensured by an "ecosystem conservation" interagency group which avoids doubling-up the limited resources of these organizations and ensures mutual support in the establishment of the biosphere reserve network and of other protected areas. Close co-operation is also ensured with the Council of Europe between its network of biogenetic reserves and the MAB biosphere reserves.

In addition, Unesco and IUCN are in the process of jointly preparing a document entitled "The biosphere reserve concept and its relationship to other conservation efforts" to explain the distinctions between the criteria of biosphere reserves on the one hand, and of those of other protected areas such as national parks on the other hand.

The national park concept will continue to contribute in an essential way to ensuring ecosystem conservation, and numerous national parks present the requisite criteria for inclusion in the biosphere reserve network. However, in general, national parks have been created on the basis of unique, spectacular, or aesthetic characteristics of ecosystems and not for the protection of representative ecosystems. For leisure and tourism, national parks have an important rôle, but this rôle is often incompatible with the needs of scientific research and monitoring.

The criteria for national parks are such that "manipulative" research, often indispensable for defining man's impact on ecosystems, is generally impossible. In

addition, the criteria for national parks are so strict that modified landscapes are considered unworthy for inclusion in a national park.

Application of the biosphere reserve concept in the Mediterranean region. Of course the criteria established for the biosphere reserves (see MAB Report Series No. 22) cannot be applied everywhere in the same way; the Mediterranean region is one such case because of its marked historical and cultural characteristics (it is difficult to find a truly natural area) and of its heterogeneity: specific criteria for the Mediterranean region must be developed at the meeting planned for 1977 in Turkey for the Mediterranean region.

It is well known that throughout its history, the Mediterranean region has been subjected to ecosystem degradation under the effects of human activities and especially grazing. Although examples of vegetation and relatively natural ecosystems which can be restored do exist, a well-developed network of reserves is lacking in the majority of Mediterranean countries. MAB Project 8 is an incitement to fill this gap. The existing national park network already constitutes a starting point for the creation of a complete system of protected areas.

9.3 Procedure for establishing the network of biosphere reserves

The MAB National Committee of the country concerned has only to send the MAB Secretariat an official proposal accompanied by a description of the site proposed according to the standard format.

The MAB Bureau examines these proposals case by case according to the established criteria, and in particular their international characteristics as far as ecological-biogeographical comparisons are concerned. It is by decision of the MAB Bureau, given this power by the MAB International Co-ordinating Council for the MAB Programme, that a reserve can be authorized to become part of the international network (network of reserves representative of major world ecosystem types, whose aim is nature conservation and scientific research in the service of man, in particular as a reference system to measure man's impact on natural environments). The Director-General of Unesco then issues a certificate.

9.4 Zoning of biosphere reserves

The document entitled "Concepts of biosphere reserves and their relationship to other conservation efforts" edited by the IUCN, should be published jointly by IUCN

and Unesco. It explains, among other things, the essential elements of land zoning within an "ideal" biosphere reserve, thus clarifying the relationships between biosphere reserves and other types of protected areas. An appropriate zoning would be comprised of a central zone, a buffer zone, a restoration zone and a stable zone.

The natural zone or "central" zone receives minimum intervention from human or external activities. This zone serves as a reference site, as a site for fundamental scientific research, and represents one of the most natural unmodified or primitive examples of the biological region. The zone must be as extensive as possible so that it can continue to function as an ecosystem, particularly if the adjacent territories are being exploited by intensive technologies. In addition, this zone must be open for research, education and training, but taking care not to modify the natural material and processes.

In the buffer zone, activities such as lumbering, grazing, agriculture, hunting and fishing, outdoor activities and tourism can be continued in a controlled manner, provided they do not considerably modify natural material or processes. This zone serves as a site for research or experimentation and can include the use of "manipulative" techniques in order to study the effects of human activities and technology on the natural system. In addition, this area is generally set out so that it encircles the natural or central zone and, as such, serves as a buffer against unfavourable external influences. Every research or manipulative activity must be designed, carried out and completed in a way that is carefully integrated into the general functioning of the region.

The restoration zone includes the zones where human or natural activities or catastrophes have greatly altered the landscapes to the point where ecological thresholds have been exceeded, biological processes have been interrupted and species have locally disappeared. In this zone, research, education and training are centred around the restoration of natural resources. The zone serves as a demonstration ground for the restoration of other sectors situated in the biological region.

The anthropomorphic or culturally stable zone is managed so as to protect the stable land use systems where man and the natural environment co-exist in equilibrium. This zone is used for research, monitoring, education and training on the study and understanding of traditional cultures and their technologies. The results can help to develop more appropriate means of land use in other parts of the biological region.

This concept can truly contribute to the preservation and restoration of the diversity of the Mediterranean region. Although at first sight this region does not

dispose of many sites which could be suitable for the creation of central zones ("a" zones), a great many areas suitable for the setting up of "b", "c" and "d" zones of the "ideal" biosphere reserve are to be found. On the other hand, the necessary skills for implementing conservation, research and training programmes within the framework of MAB Project 8 are available.

9.5 Special case of the biosphere reserve cluster

A major conflict of single-purpose reserves is the frequent incompatibility between the conservation and manipulative research objectives of the MAB programme. Hence, protected "core" areas and "peripheral buffer zones" were proposed (MAB Report Series No. 22) to resolve the conflict between different types of reserve utilization. These zones were intended to be contiguous in space. Because contiguous buffer zones available for manipulative studies do not occur around most conservation reserves, the "biosphere reserve cluster" concept was developed. Here, the research on human impacts normally carried out in the buffer zone would be conducted at separate but nearby experimental reserves. According to this concept, a central conservation reserve forms the core of a biosphere reserve cluster, with a contiguous buffer zone (where available) and with nearby experimental reserves fulfilling the manipulation research objectives. Thus, the cluster of reserves, together with the fringe areas needed for future or supplementary studies, can fully address the goals of a biosphere reserve network and at the same time remain compatible with existing land use patterns.

9.6 Species conservation and "gene banks"

A narrow relationship must exist between the biosphere reserves (*in situ* conservation of extensive stable areas containing numerous species with all their wealth of genetic material) and a system of more specific preservation. In this respect, it could be useful to envisage a specific programme of resource conservation for the Mediterranean region, which would be outside the framework of biosphere reserves.

Concerning races of animals, the conservation of domestic races falls within the scope of FAO but it would be useful to ensure, within the framework of MAB Project 8, the preservation of wild or semi-wild races in the reserves. It would be very desirable that the FAO and MAB join together on this subject.

In France, two centres have been created to ensure the conservation of plant species: one at Brest, the other at Porquerolles; this latter is in the process of being set up and it is planned to set up a gene bank and a conservatory for the most

endangered plant species, within the framework of the Park of the Iles of Hyères; but because of the danger of introducing a garden in an island environment, it is possible that the conservatory will be finally set up on the coast near Porquerolles. Stocking the seeds of endangered species at a low temperature, and renewing the stock by cultivation cause problems, since the majority are mountain species and this environment does not exist on Porquerolles. The Mediterranean countries present at the Conference are invited to contribute to this bank, which will be operational in 4 to 5 years.

In the Mediterranean region, MAB Project 8 must develop from the structures established for the conservation of natural areas in Mediterranean countries.

Proceeding from certain national parks, biogenetic reserves and other types of strictly protected areas in the region, a complete network of biosphere reserves can be constructed where each of the major ecosystem types will be represented by a reserve. In practically every case, the existing conserved sites must be extended, planned out, and considerably developed so as to comply with the biosphere reserve concept. In certain types of ecosystems, it will be necessary to wholly protect new sites in order to make "central" zones.

The Mediterranean countries will have to carefully co-ordinate their efforts so as to develop a satisfactory network of biosphere reserves in the region.

9.7 Themes for consideration at the Side meeting

The meeting which will be held at Side (Turkey) in June 1977, at the invitation of the MAB National Committee of Turkey, must be the kick off for this regional co-ordination. The following points will be taken into consideration before, during and after the meeting:

(1) strengthen the conceptual bases of the biosphere reserve network in the Mediterranean region by specifying the aspects of this concept which must be emphasized in its application to the region, and define the scope of the objectives of MAB Project 8 in the region (e.g. it might be desirable to emphasize the restoration of degraded ecosystems in the biosphere reserve projects);

(2) identify what scale of major types of Mediterranean ecosystems must be represented by biosphere reserves;

(3) review the sites already designated as biosphere reserves in the region and assess their potential with respect to the common objectives to be reached in the Mediterranean region and the particular objectives of the countries which created these reserves, some of the sites can serve as models for future project development;

(4) develop the reserve network by finding existing protected areas that can constitute central zones of biosphere reserves representative of the major ecosystem types and which offer the possibility of adding contiguous or separate territories allowing manipulation or restoration operations and/or the maintenance of stable forms of land use;

(5) identify the areas where the major ecosystem types are not represented by potential "central" biosphere reserve zones. Gradually fill these gaps by setting up new protected sites in appropriate regions;

(6) develop, starting from existing reserves, model plans indicating how the central zones, buffer zones, manipulation zones, restoration zones and/or zones of stable land use must be laid out, managed and used to reinforce conservation, research and education;

(7) examine the legislative means in Mediterranean countries for ensuring the smooth running of biosphere reserves including measures for both the protection of the central zones and access to different types of peripheral zones (as well as their management);

(8) develop relations on a regional level between the biosphere reserves of the Mediterranean countries and develop international co-ordination (exchange of information, techniques, personnel) with the countries outside the Mediterranean region, notably with the countries of the isoclimatic (mediterranean) zone.

9.8 Recommendations

After having gratefully noted the proposition of the MAB National Committee of Turkey to organize a meeting at Side in 1977, the Conference participants made the following recommendations:

(1) proposals should be presented for creating biosphere reserves for terrestrial, coastal or marine ecosystems, endangered or not;

(2) the ecological and biogeographical representativeness of the reserves proposed by various countries should be harmonized;

(3) a complementary programme should be orientated more specifically towards the problem of conservation of genetic material, above all of endangered species, especially taking account of the praiseworthy efforts already made in this field by national and international organizations. For this purpose, each country should be asked to rapidly prepare a pre-inventory of the major Mediterranean ecosystems, to propose if possible in each case one or several biosphere reserves and to draw up an inventory of endangered species;

(4) Unesco should place at the disposal of this programme a team of consultants whose task would be to refine the typology of Mediterranean ecosystems;

(5) a representative from each country should be designated to ensure liaisons with the Instituto Nacional para la Conservacion de la Naturaleza (ICONA) which offered to conduct the preparation of a network of representative reserves;

(6) the types of research to be carried out in the biosphere reserves should be specified, in particular concerning genetics;

(7) proposals should be made on the best conditions for the functioning of biosphere reserves and gene banks of interest to the region.

10. SYSTEMS ANALYSIS AND ENVIRONMENTAL MODELLING

10.1 Introduction

During the last decades, systems analysis has widely asserted itself as the most valid approach allowing the understanding and the resolution of environmental problems. Because it constitutes one of its fundamental phases, modelling has been widely used in the fields of forestry, fishing, grazing management, irrigation and pollution amongst others. It can have an important rôle in these domains in helping decision-makers to predict natural world states from various sets of data and their distribution and, in consequence, make a knowledgeable choice between the different strategies in situations where intuition and human judgement can lead to erroneous decisions. This method is particularly suitable when dealing with the fragile soils of arid or semi-arid regions, for which an error in exploitation can have harmful and irreparable consequences. For example, without these prediction techniques, a rangeland can deteriorate in a few years, irrigation of arable land can have undesirable effects (salinization) on neighbouring areas, or can cause the spread of human diseases, animals, or cultivated plants. Starting from climatic norms, the models can also be used to test different combinations of management techniques, and, from there, to optimize the result (e.g. maximization of the stable plant biomass and minimum loss of surface soil with respect to different stocking rates).

Modelling can also constitute a useful tool for research when it is not possible to conduct field experiments; it can serve as a training aid, for giving a better structural and functional understanding of existing ecosystems, for appraising the use of integrated, co-operative research in showing up imperfect knowledge of real world systems, as well as to appropriately allocate resources (human and material) within the framework of vast research projects in which different elements are brought to bear on attaining a common objective.

Considering this potential, environmental modelling is recognized as one of the major concepts of the Man and the Biosphere Programme (MAB Report Series No. 2).

The following chapter proposes essentially to present an evaluation of the present use of models and modelling in the field of environmental management.

10.2 Modelling activities

Simulation models, as a means of acquiring knowledge and as a tool for formulating environmental policies and the corresponding decision-making, are used throughout the

world as a natural product of data processing technology and systems analysis. During the last twenty-five years, modelling has been considerably developed in industrial countries; more recently its use has also spread to developing countries. Nevertheless, before examining in detail the modelling activities in the Mediterranean region, it might be interesting to mention certain major conclusions obtained through the experience of different countries.

In general, modelling activities have made an important contribution to the evolution of ecological research and, in many cases, have been used for practical purposes.

All the same, the application of modelling to environmental problems, as a tool for decision-making, has in many cases given much poorer results than the predictions. This has been attributed to the fact that the models are mainly developed by scientists and that, in consequence, the majority of models have been elaborated to answer certain research objectives which often do not concern decision-making and do not relate to the immediate "allocation/optimization" problems of the authorities. In certain cases, however, research models have been adapted to the decision-making problems, with a noticeable impact on planning strategies and policies. An example is the "Limits to Growth", a concept of the report of the Club of Rome which always serves as a directive principle for discussions on future world planning. The Kichapoo River Embankment and DDT models can also be mentioned, both based on the research of the US/Eastern Deciduous Forest Biome.

Nevertheless, it must be emphasized that modelling is only one of the numerous tools with which to make an appropriate decision, and that it does not replace reflection. The modelling of a real system generally implies a considerable simplification of this system, and there is always a risk of neglecting elements important for the final outcome. The validity of a model as a tool for resource management depends on the skill of the modeller and the user to perceive its potentialities and its limits.

The data integrated in the model (inputs and outputs) must be chosen in collaboration with the manager, the decision-maker and the model user. It is therefore important that the decision-maker and the user participate in the elaboration of the model from the beginning. In order that a model be useful to the manager, it must also consider the socio-economic structure of the systems to be modelled. Specialists from the social and economic disciplines should collaborate with ecologists in these modelling activities so as to establish a dialogue leading to the development of more efficient models.

As a general rule, the complex environmental systems models, particularly those which are imperfectly understood, are valid less frequently and rarely give accurate quantitative predictions. The control interactions which govern these systems are often too numerous and overlapping to be well understood. In consequence, it is hardly surprising that up til now, the successful models have mainly been those which represent relatively simple and well-understood systems and those designed for participating in decisions relating to short time periods. The challenge to be taken up now is the perfection of complex systems models designed to facilitate decision-making in the case of long-term planning.

To make a global evaluation of the current situation of environmental modelling in the Mediterranean region, some major efforts must be mentioned. In Egypt, the project on Systems Analysis of Mediterranean Desert Ecosystems in Northern Egypt (SAMDENE) has already more than two years' experience with simulation models. This project proposes to provide scientific information for identifying and selecting the most suitable of the different possibilities of land use of the Egyptian Western coastal desert on the Mediterranean Sea. It will also allow the acquisition of knowledge on the structure and functioning of the ecosystems of this region, and, for young ecologists, will constitute a context for training in interdisciplinary research.

The first version of a complete ecosystem model for the SAMDENE project has already been developed, whilst a simulation has already been carried out over one year, by three-day steps. It simulates the ecosystem in terms of flow of energy and materials, spatial and temporal variations of plants and animals, as well as soil characteristics in relation to environmental variations.

As was foreseen, certain parts of the SAMDENE complete ecosystem model (particularly those describing the soil-animal components) were unrealistically simplified because of lack of data. However, this version will be continuously updated as more is known about the processes and the interactions between the different elements, until a reasonable approximation is obtained of the flow diagrams for energy and materials in the major ecosystems. In the meantime, small models are developed for the dominant plant species in the major ecosystems for which more information is available than for others at the present time. It is envisaged to use these small models as relatively simple exercises and easily understood demonstrations of modelling procedures intended for those who are not familiar with them. In addition, their validation should be much easier, and for this reason better updating of the weaknesses of the complete ecosystem model should be possible, as well as correction of the complete model sooner than would otherwise have been possible. Afterwards, these models could be grouped together and attached to the complete ecosystem model.

It is also planned to use versions of the complete ecosystem model to simulate the different types of land use which are possible on this Egyptian coastal desert (e.g. grazing, irrigated crops, crops receiving only rainwater, use of wild plant or animal species having an economic value other than for grazing or hunting), so as to predict their development and their effects in order to establish an ecological equilibrium, and, it is hoped, to improve ecosystem productivity. Of course the new factors resulting from the implementation of different types of land use need to be evaluated.

It could be conceived that the field of application of models of the type developed within the framework of the SAMDENE project can be extended to desertification problems and to management decisions generally concerning the arid and semi-arid regions, since the main ecological factors governing the functioning of the ecosystems of this region are the same. This is particularly true for the North African belt whose annual rainfall is similar to the region studied by the SAMDENE project and where the lands are essentially used for sheep and goat grazing and could be easily irrigated if water were available (coming from neighbouring rivers, the ground or the sea after desalinization). The models which are orientated towards direct application to management problems are those which have been developed to analyse grazing and animal production problems in the arid and semi-arid grazing systems in the Judean and Northern Negev deserts. The specific objectives of these models are to evaluate the consequences of flock mobility on animal production for semi-arid rangeland in a traditional economy and in a modern one.

The procedure followed in the elaboration of these models has been to quantitatively analyse the complex problem and to isolate a certain number of more simple subproblems. Each of these subproblems has then been treated separately and analysed with the help of models, followed by the progressive combination of the subproblems and their models.

This procedure leads to the perfection of elementary models for the primary production of rangelands used in the study zone. These models emphasized plant production during a growth season of a rangeland composed of herbaceous plants (particularly annuals) presenting similar characteristics from the point of view of their growth and palatability. Simple models of animal production (secondary production) are also developed by successive approximations in function of feeding rates and the simple parameter of the annual plant production system. The effects of certain seasonal interactions between secondary production and primary production were then examined.

Using quantitative estimations of the parameters, it was then attempted to apply these models to grazing systems in the study region. Estimations of primary and secondary production, in function of rainfall, grazing conditions and animal density, have been obtained for different systems of grazing management. According to the possibilities, these results can be compared to the field data. Due to the fact that these models are beginning to be developed and that the data collected is fragmentary, the predictions and conclusions which are derived must be considered preliminary. Nevertheless, conclusions can be drawn on the basis of the simulations made with these models, which are probably closer to reality than those available beforehand and which resulted more or less from intuitions based on a personal knowledge of real world systems.

The modelling activities of the Department of General Ecology of the CEPE-Louis Emberger (Montpellier, France) can be subdivided into modelling on a regional scale and modelling on a local scale. The first type includes the elaboration of models of plant successions over periods of several decades. It involves essentially transition matrices (first order Markov equations) which have been used to study the variations in the distribution patterns of different types of vegetation. One element of the transition matrix constitutes the rate of transfer from one unit to another in a given period of time.

These transition matrices have been developed with the help of real world measurements made in the areas covered by different vegetation types at two successive dates, taking into account the fact that the vegetation at the "beginning" and the "end" is similarly affected during the estimation period. In the case of real estimations, the transition matrices could be used for simulating the future, as long as there is continuity in the trends observed between the two estimation dates. Estimations are necessary when it is wished to simulate a new scenario which does not exist in the real world (succession in a region subjected to a new type of exploitation).

These transition matrices give only an evaluation of the proportions covered by different vegetation units in the study area. Using a map also makes possible a new representation of the region; then either a deterministic approach is used in which each point is determined by "attraction coefficients" for a certain vegetation type, as a function of different factors (proximity of a village, of a rangeland, etc.), or else a probabilistic approach is used by modelling the transition matrix at each of the points, also as a function of factors similar to those mentioned above.

In Southern Tunisia, the results provided by the matrices have been used to estimate the conditions that would prevail in the region at the end of a period of

simulation. For example, the conditions relating to this area's ability to use different quantities of rain (or water coming from rivers, reservoirs, etc.) can be estimated very schematically.

It is also interesting to note that these transition matrices have on several occasions lead to discussions between ecologists and socio-economists.

The Department of General Ecology of the CEPE-Louis Emberger has used modelling on a local scale to study the short-term variations in the biomass of the steppe vegetation of *Rhanterium suaveolens* in Southern Tunisia. The first endeavour was to simplify the US/Desert Biome model in order to simulate primary production of total dry matter. This endeavour was abandoned when it proved impossible to adapt several of the model characteristics. It was therefore necessary to add "parallel" sub-routines to the existing model. This being done, it was easier to construct a new simpler model more suited to the objectives and the available information. The present general trend of the CEPE is to develop simple sub-models, simulating, for example, the water in the soil.

The University of Barcelona is carrying out a study whose aim is to improve land management of the "Barcelona region" by estimating what could be the possible succession for this region in the short and long term. The method of analysis is based on the hypothesis that the trends in succession observed over the period 1965-1973 (eight years) will continue in the years to come. A "matrix" was elaborated from the beginning from observations describing the eight years of the period, and was used to make simulations which allow to formulate predictions at eight, sixteen, etc., years. This was done with the help of a random distribution of 13,000 points, i.e. a density of approximately 16 points/km^2.

Aerial photographs taken in 1965 and 1972 were also used to identify the points where changes had occurred between the two dates or between 1965 and 1973 (by comparing them with the soil map). The analysis of each of the 13,000 points made possible the construction of a Markov matrix expressing the unit transformations during the eight years.

The simulations showed up the importance of the impact of urbanization in the years to come, if the current trends continue.

In the case envisaged here, it can be difficult to consider the Markov matrices as a tool for prediction of world events. All the same, they can help to bring to the

eyes of the managing authorities certain aspects of management policies, particularly the negative aspects which have occurred during the years preceding the study.

On another level, a few researchers have constructed a model (ECOSYS) which simulates the growth of competitive species considering the spatial organization of individual plants. The evolution of the area occupied by each species depends on environmental factors which change from one point to another in this area, and which also vary with the coefficients of mortality, fertility and of the activity of a species resisting expulsion by another species. This model has been used to study the evolution of litophyte lichens.

The team of the Department of Ecology of the University of Seville has elaborated an "impact recording and minimization system" (IRAMS) whose aim is to quantitatively determine the activities carried out in a certain area and which cause a minimum of environmental destruction (negative effects). It includes the complete description of certain ecological subjects or aspects such as natural vegetation, animals, soils from the point of view of their potential productivity, etc. The groups of homogeneous units are indexed and the information put on punched cards.

The system also envisages different hypotheses of land allocation and several types of land use, which have dissimilar consequences on the environment (e.g. more or less built-up areas, industrial zones, greenbelts reserved for leisure, etc.). For each subject, unit or hypothesis, a set of consequences is determined and the level of impact can be represented by an automatically drawn map.

Another programme (DUNA) was elaborated for predicting the use of the coastal dune systems in the Doñana region (Southern Spain), as a function of the different forms of management related to touristic development.

The DUNA programme is divided into two big subsystems. The first forecasts the variations of the topographic system based on weather data. The second uses this topographic data and predicts the evolution of the stands of *Pinus pinea* on the dunes. In the subsystem, the pine population is a function of the environmental factors (rainfall, evaporation, temperature, depth of underground water) according to the age and the placing of the individual trees. The biological factors such as predation and diseases are also taken into account. This programme is now enlarged in order to include annual plants and to predict herbaceous production.

A third programme (LAGUNA) has been elaborated for predicting the evolution of the vegetation in the depressions between the dune fronts where the underground water

layer is modified. Based on weather data, the programme predicts the fluctuations of the water-table. The information obtained is thus entered into the programme to predict the evolution of the vegetation for each zone. At the present time, this programme is to be linked with a cartographic system to facilitate its use.

In Yugoslavia, a modelling programme has been launched to reach a double objective: to improve the interactions, understanding and co-ordination of the different professional groups working on the Adriatic regional development project and to construct an ecosystem model for evaluating the environmental consequences of this development and to study the protection of this region.

The conceptual model elaborated for the Adriatic Regional Ecosystem (ARE) is constituted of sub-models for air pollution, Karst, lakes, rivers, sea and tourism. The number of subsystem components amounts to 305 for the natural section (all except tourism). The components of the Karst subsystem include various stages of plant succession, soil types, animals, categories of dead organic matter, micro-organisms, chemical elements and pesticides. The components of the lakes, rivers and sea subsystems are divided into chemical and biological categories: the chemical components include organic and inorganic forms, and the biomes are characterized by food-chain criteria. The tourism sub-model defines the environmental impact of touristic activities.

Other activities are today being launched in addition to the modelling work mentioned above which has reached different stages of advancement.

The models currently being elaborated for the simulation of probable environmental modifications in the Nile valley and its delta, caused by the effects of the presence of the High Dam, can be mentioned. These modifications are either physical, i.e. related to the Nile and Mediterranean flora and fauna, or socio-economic, resulting from the transformation of habits and way of life of the people who used to live in the vast basin situated behind the High Dam.

The modelling of energy flows in the South Tunisian ecosystems was marked on the programme of the activities of the US/IBP Desert Biome Tunisian Presaharan Project. A diagram has been made of the components and processes of these ecosystems; it constitutes the starting point for the development of a model which must serve as a basis for planning research and it will serve as a tool for helping decision-making related to land use.

10.3 Problems of development and implementation of models

There is no doubt that the possibilities of environmental modelling are far superior to what has been done during the last decades. The reason why modelling has not contributed what was anticipated does not lie in its inefficiency; it is found on the level of certain constraints and problems which are usually associated with the initial enthusiasm for a new approach. These problems are either related to the construction of these models, or to their practical implementation as tools for decision-making related to the environment.

The science of ecosystem analysis is still too young to allow the construction of environmental simulation models, especially if they are complex, capable of making quantitative predictions with a reasonable degree of confidence. In addition, an *ad hoc* data base is often lacking for validation purposes as well as for supporting long term predictions resulting from simulations. However, it must be emphasized that this does not justify abandoning the development and the use of models. Indubitably, a model based on scanty and qualitative data is much more useful than an intuitive approach, although this latter is valuable for showing up imperfections in knowledge acquired about the real system.

The modelling work in certain developing countries has been affected by the lack of experts and technicians in the fields related to the development and the use of models. In certain cases, the data processing methods are also inadequate. This should not constitute a serious difficulty because many models demand neither great experience nor powerful computers.

The lack of communications and interactions between the model constructors and the scientists from different disciplines, particularly those studying the environment, is another problem which prejudices the progress of modelling techniques. Divergence of professional views between the model constructors and other scientists can also hinder the communication between theory and modelling activity.

When prefabricated models were used instead of constructing new specialized models, difficulties were encountered, caused by the incompatibility of the calculation systems and the programming languages. In addition, the ease of transfer of models is hindered by inadequate documentation.

One of the major reasons for the limited belief in the potential of modelling comes from the premature attempts tending to use research models for decision-making.

It must be realized that in order to take decisions on an environmental problem, the use of a model which has not been fundamentally built for resolving this specific problem could cause a certain disappointment for the model user. Research models are valuable and necessary to improve understanding of real systems; they are not always suitable for decision-making.

The decision-makers and sometimes those responsible for research organizations are not well-acquainted with environmental simulation models and their potential for helping to analyse and synthesize the different possible policies. This is particularly true in developing countries, but does nevertheless exist in developed countries and constitutes a major obstacle to the application of modelling techniques to environmental problems. This problem is associated with a lack of communication between the model constructors and the different hierarchical levels of decision-makers, who are generally used to other additional methods and must become accustomed to the idea of using models in the process of decision-making.

The use of modelling for studying the ecosystem is a well-developed practice. It seems, however, that at present the stage has been reached when it becomes necessary to make a critical synthesis of all the methods explored. This synthesis, taking into account all the successes and failures of the approach used, should make possible starting out again with a new approach.

The following recommendations would enable a better diffusion of the modelling tool and would stimulate the exchanges between scientists.

10.4 Recommendations

The participants formulated the following recommendations:

(1) that young graduate students continuing research on the environment be allowed the possibility of taking courses and of acquiring practical training in centres using modelling. Some of these courses should be destined for decision-makers at different levels so that they can know more about the principles and the possibilities of systems analysis and modelling, in order that they can become aware of the efficiency of these models;

(2) that the exchange of knowledge and local experience in modelling between neighbouring countries be encouraged, just as the exchange of the people who elaborate the models. This would allow the promotion of exchanges of ideas and would demonstrate the helpful contribution made by models. Agreements could also be made in order that the data and the models of one country be accessible to another country. In this respect, model formulation and documentation should be standardized by a specialized group, in order to facilitate their transfer as well as their use in other modelling systems;

(3) that financial means be available to cover the high cost of data processing of the MAB-Mediterranean pilot projects as well as of the participation of modelling experts in the efforts undertaken in this field in countries attempting to develop this approach;

(4) that the MAB National Committees of the countries bordering the Mediterranean Sea do everything to encourage research in modelling. Regular courses should be organized for graduate students in order to present them with the principles of environmental modelling. It is also recommended to improve the relations between those who are responsible for decision-making and those who elaborate the models;

(5) that efforts be undertaken to improve the co-ordination between ecologists and socio-economists in the field of modelling, in order that models can be profitably used for management and development, and that the MAB National Committees of all the countries bordering the Mediterranean Sea encourage research undertaken with the collaboration with researchers having modelling experience for each of the fourteen MAB Projects.

11. TRAINING OF MANAGERS AND TECHNICIANS

11.1 Introduction

The debate was introduced by justifying the choice of the Organizing Committee. Referring to the different levels of environmental education and training:

level 1: general environmental education (in or out of school);

level 2: specific environmental education for professional groups of individuals like engineers and generally for all those who take decisions;

level 3: specialist environmental training for foresters, ecologists, etc.

in effect, level 3 involves the least considered case up till present, that of executive personnel and more especially junior executives. This lack of consideration is particularly felt in the French-speaking Mediterranean countries. Such training should have a MAB approach, i.e. an integrated global view of problems. Material considerations make it necessary to distinguish what could be done immediately and what could be done only much later.

For the immediate future, trained technicians should be taught about the MAB approach and about its usefulness either in existing structures (field centres, laboratories or teams working on MAB projects), or in structures which could easily be created with limited human and material means according to particular needs in a given situation or country. This is an experimental phase during which alterations should be made in function of the results obtained.

Ultimately, it is no longer a question of adapting existing structures but of creating new ones, on the basis of the results obtained in the first phase at all levels, which ensures us that this new phase will receive truly motivated people and commits us to co-ordinate with the organizations responsible for levels 1 and 2.

To begin with, this necessitates an inventory of what already exists; this also assumes the existence of a new type of teacher, conscious of the need to integrate the MAB approach into the respective curricula.

In particular, with respect to the MAB-Mediterranean problems, regional co-operation should exist. Every MAB-Mediterranean programme should have a real field centre adapted to the programme, accepting students from the 3 levels. Biosphere reserves could also be used for this purpose.

At the end of their training, the technicians from all levels should be integrated into teams working on MAB research.

11.2 Requirements

To begin with, the working group discussed the overall problem, each participant referring to his own experience. At first, attention was drawn to the necessity of making executive personnel aware of environmental problems. To do so requires the availability of information, consistency in language and, finally, an overall framework for considering these environmental problems. No doubt it will also be necessary to keep an eye on proficiency requirements and qualifications. However, it is essential to plan ahead to provide employment opportunities for trained personnel.

11.3 Current experiments

This discussion naturally provided the opportunity to become acquainted with current or planned experiments in a few Mediterranean countries. Although not exactly within the scope of the Conference, the working group took an interest in the extensive campaign launched in Algeria for environmental education, mainly on level 1. It became particularly apparent that it would also be an important subject of special consideration to take an interest in the liaisons between all three levels.

Training of executives and technicians in mosquito control. The theoretical and practical courses in mosquito control organized by the Faculty of Medicine of Montpellier and the Interdepartmental Agreement for mosquito control (Entente Interdépartementale pour la démoustication) supported by Unesco at Montpellier in September 1977 was considered a model worth following. Such a course should include theoretical, ecologically based teaching and practical, operational teaching, as much as on the mosquito as a nuisance as on the mosquito as a vector. It should emphasize the importance of the integration of knowledge, the notion of integrated control and the chemical methods associated with physical and biological techniques.

Regional centres. In connection with this, the working group was informed of the results of the Sfax meeting (1975) on MAB Project 3 and of the creation of a range management training centre for field technicians at Bou-Grara in Southern Tunisia.

Discussion then started on the possible dangers of creating numerous centres of this type. It was clear that at the present time there is no real overlapping of work. The range management centre at Rabat is interested in semi-arid zones and, because of this, has a different aim than the Tunisian centre which is especially

concerned with arid zones. All the same, there is a tendency for each country to create its own training centres, which does not always help international co-operation. One of the urgent requirements is to take an inventory of these centres while recording different countries' real needs. The working group nevertheless found itself divided by two opinions: on the one hand, each country should have the freedom to create its national centres and international organizations not favour any particular centre; on the other hand, limited means are available to both countries and international organizations and it is hoped that centres will be created in line with climatic constraints and socio-economic situations and, consequently, with the most pressing needs for complementarity. It is this opinion which is expressed in recommendation 7. In any case, the current inventory is indispensable; it must not omit an assessment of facilities for receiving trainees and it must establish the material means necessary for the working of these centres (see recommendation 3). This latter aspect did not escape comment at the Conference. International co-operation could work for executive training only in so far as the international organizations could provide scholarships allowing exchanges between countries and especially between training centres.

Environmental training for decision-makers and teachers. The working group continued the discussion by directly taking up the proposed text for recommendations. Although they volontarily kept themselves to the problems concerning executive personnel, the group wanted to express the necessity of making not only ordinary people aware of environmental problems, but decision-makers in particular. There was a debate upon this latter aspect which brought out that decisions related to the environment are in effect taken by top level people who are too often badly informed and who are hardly even prepared to understand the problems in question (cf. recommendation 2).

In other respects, the working group noted the fundamental importance of teachers from every level of education instilling the MAB point of view. These teachers must already be converted to its philosophy, to its general conception of approaching problems and to its global multidisciplinary methods. Even though some reservations were expressed on this subject, recommendation 5 received more or less unanimous agreement.

Finally, the working group earnestly hoped that a meeting regrouping the representatives of the Mediterranean countries could be organized as soon as possible to ensure harmony and co-ordination in training programmes and to establish a network for exchange between the national institutions specializing in the training of technicians (recommendation 8).

11.4 Recommendations

The participants insisted on the fact that every environmental problem must have a global approach, i.e. simultaneously taking into account all the environmental and developmental factors and their interrelations. Amongst other things, this should lead to the breaking down of barriers between the different disciplines. With this point of view in mind, they made the following recommendations:

(1) Lectures and courses should be organized or developed in the region's institutions and in field centres and laboratories involved in MAB-Mediterranean programmes for technicians and executive personnel. These latter would learn to take an interdisciplinary approach when working on integrated problems concerning man and the biosphere such as techniques of mosquito control, range management, forestry, etc.

(2) A special effort should be made to make decision-makers aware of environmental problems and, more particularly, an interdisciplinary approach; this effort should not ignore the importance of teaching similar environmental awareness at the grass roots level.

(3) A global inventory should be made of the material means allowing exchanges for training purposes, so as to better preserve the portion which must be allocated for training technicians at all levels, including executive personnel.

(4) This general inventory should also be extended to the structures and organizations which give training in the specialized disciplines relating to the environment (in particular the MAB-Mediterranean programmes), again in order to ensure the amount necessary for training technicians.

(5) In the future, teachers at all levels should give their courses an interdisciplinary approach, and themselves have a global view of problems.

(6) Every new structure for training technicians, some of whom will work on MAB-Mediterranean programmes should remain to the extent possible within the context of these programmes, and should always provide for courses, at least at the end of the training period, with one of these teams.

(7) In the nearest possible future, complementarity and co-ordination of the activities of research and training institutions should be encouraged by regional co-operation.

(8) A working meeting should be organized as soon as possible regrouping the representatives of all the Mediterranean countries to harmonize and co-ordinate training programmes and to establish a network of exchange between institutions specializing in the training of technicians, especially for executive personnel.

12. INFORMATION EXCHANGE

Considering the necessity to improve the flow of information among all the Mediterranean countries, and gratefully acknowledging Egypt's proposal, the Conference recommended that:

(1) the task of preparing an information bulletin for Mediterranean countries be entrusted to the MAB National Committee of Egypt;

(2) the MAB National Committees of the Mediterranean region actively contribute to the publication of the information bulletin, notably by sending the information they consider useful to the MAB Committee of Egypt;

(3) the MAB Secretariat and the Unesco Regional Office for Science and Technology (ROSTAS) in Cairo provide the necessary practical means at the request of the Egyptian MAB Committee.

ANNEX 1

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ANNEX 2

ADDRESS BY MR. ANSQUER, MINISTER OF THE QUALITY OF LIFE OF FRANCE

Mister Chairman, Ladies and Gentlemen,

It is a great honour for the Minister of the Quality of Life to welcome to France so many important scientists from the Mediterranean countries. In one way or another, we all have common concerns: whether it be the relations between man and his environment, man and nature, pollution and contaminant control or tourism and leisure activities.

For several days you will review the research which you are undertaking in these different domains and this initiative, which we owe to the French National Committee of the Unesco "Man and Biosphere" programme, allows us to meet together in the beautiful city of Montpellier. I need not recall its thousand year old university tradition, but I am sure that these surroundings will inspire your work.

I greet the Unesco respresentatives who will speak to you about the scientific programme itself. In different ways, France attaches great importance to this programme.

Firstly, this importance is due to the action of my country and to the responsibilities which I exert relating to scientific research. Within my budget, almost 15% of the funds (i.e. approximately 6 million dollars) are devoted to research and are used in order to create a synergetic effect together with the resources from laboratories, large organizations and industrialists.

The present-day priorities for national scientific research favouring the environment and our living conditions are the following:

- to reveal the little known relationships between water, air and sea pollutions which are too often treated separately;

- emphasize the importance of the sub-soil and its disturbances;

- identify the "fragile" environments, notably humid zones, endangered species;

- study the environmental impacts of "new energy sources" even before they become highly developed;

- assemble predictive data allowing for long-term forecasts into the future.

Through these major lines of research, the choice of investigations undertaken in the wide environmental field is dictated by the problems which are posed and which will be posed at every moment by the relationship between man and the environment.

The second reason for which France attaches so much importance to your work comes from the regional dimension of research and action.

The Mediterranean coast which is moreover linked to its hinterland is, we know, a fragile zone and this is why our country has created or planned various means of intervention.

The first example is the recently-established coast Conservatory which should carry out land acquisitions for the State of areas which should unquestionably benefit from the protection of their fauna and flora and from the maintenance of sites and tourism.

The second example is the creation of regional natural parks (those of the Camargue, Corsica), national parks (Cevennes and soon Mercantour) and natural areas (islands of Port Cros and Porquerolles). We are also trying to promote a policy for developing the Mediterranean foothills, reconciling the maintenance of sites and rural habitats, associating the revival of ancient activities, for example pastoral activities. This is the case of the Luberon, the Verdon Gorges, the Southern Alps.

Natural under-sea parks are the latest of our initiatives, which I intend to start in 1977.

In all these domains, we are careful that research is closely associated with actions but that it conserves the quality indispensable for its originality, namely great conceptual freedom in order to be creative and imagine future situations or predict the actions that could be taken so as to already prepare the policy for tomorrow.

And quite naturally I come to talk about the necessary international, even worldwide, dimension of an environmental policy which is yours. This is the third reason - and the most fundamental - for France's interest.

As an eminent Unesco director recalled with respect to MAB in Paris last November:

"More than ever, separate national efforts are not sufficient; science and technology have become the key areas for international co-operation between all countries, whatever their political system or their level of development. It is only by a close international collaboration that one can hope to elaborate the necessary scientific and technical infrastructure".

The French Government shares this point of view and emphasizes that if there is a region where this should prevail, it is really here, in the Mediterranean Basin, a meeting place of such diverse and yet intimately mixed cultures and civilizations, that one can talk of a Mediterranean temperament and behaviour, even a particular entity, open as much on the future as founded on the past.

The Mediterranean region is evolving. Since man has lived on its shores, he has left a considerable mark to the point that certain people have voiced their fear that its waters and its coastline will one day no longer be able to completely and normally satisfy the rightful needs of the local people.

It is from you, Ladies and Gentlemen, that we expect the answer to all the questions which the Mediterranean authorities are asking themselves about fishing, agriculture, tourism, industrialization, urbanization, etc.

If all the Mediterranean nations desire development and progress, they do not want the irrationality that will definitely lead to ruin and decadence in a completely polluted universe.

Respecting national identities, we must therefore consent to a united effort leading to the evolution of the Mediterranean region.

For its part, France is closely associated and will always associate with all international initiatives taken to ensure the survival of this Basin which is our common patrimony.

I will not come back to the importance which we attach to our participation in this programme

on man and the biosphere only to mention our participation in the Mediterranean action plan, established by the countries bordering the Mediterranean Sea under the sponsorship of the United Nations Environment Programme.

Accompanied by a scientific marine research programme which fortunately complements the continental MAB programmes, it includes two other planes of reference: one legal, one socio-economic.

> The so-called "Barcelona" agreements are the first legal actions. You are aware of them. They concern the marine environment more than the terrestrial environment which you will deal with here, but there is a direct relationship between terrestrial problems and the protection of seas and oceans.

These agreements are restrictive and strongly emphasize the will of the signatory States to apply themselves to the protection of the Mediterranean region.

For France, they will mean the elaboration of a fifteen-year investment plan negotiated with all those concerned - administrations, industries, towns, villages - and which will aim at providing purification facilities for the sources of pollution; the most important of these sources will be ready for operation before 1985.

Again, within the framework of these agreements from 1977 onwards, France will permanently and systematically monitor hydrocarbon waste from ships. Remote sensing techniques are now well-developed, proof is unassailable due to samples taken immediately in the wake of an offender and the administrative responsibilities are clearly defined. This monitoring will complete the verifications of our national network of monitoring sea quality.

> As for the socio-economic plane of reference, it includes a project which France has proposed to carry out for her Mediterranean partners: the "Blue Plan for Mediterranean action". More will be said about this later on. Allow me to say that it is a project which is ambitious but which we want to be realistic. It should be a real charter for the management of the Mediterranean Basin and should guide the decision-makers from different nations by giving them the elements for appraising and evaluating their choices with respect to ecological equilibrium and territorial harmony. We will greatly need the results of our investigations to establish this action plan and we will never fail to ask for your participation such as that of the International Commission for Mediterranean Scientific Exploration.

All these international initiatives could not be realized if they were not supported by concrete actions through bi- or multilateral State co-operations.

Some have been undertaken here and now, others will soon be established with various scientific objectives. I hope that as early as 1977, we can make a first evaluation of these actions, which must not lose sight of the imperative necessity of the formation and training of multidisciplinary teams of top-level specialists.

In this field, the Mediterranean Agronomic Institute, the first of its kind, created by the International Centre for Advanced Agronomic Studies in the Mediterranean (CIHEAM) here at Montpellier, for already more than fifteen years bestows high quality advanced teaching in not only the management of agronomic problems but also more generally in the problems of growth and development. Several thousand executives have thus been trained to the satisfaction of the North Mediterranean members of this Centre and also of other Mediterranean countries, so much so that a project for closer association is currently being discussed.

Along the same lines, the International Centre of Water Resource Management will soon be opened near Nice. Indeed, water represents a rare asset and an indispensable factor of the quality of life and is henceforth essential to train in all fields of study, not only excellent water research workers and technicians, but also decision-makers capable of managing resources.

The United Nations organizations and more particularly the United Nations Environment Programme and Unesco from October 1977 onwards, will extend their support to the International Centre of Water Resource Management and will hold seminars where two-thirds of the participants will be scholarship-holders from developing countries.

Thus the Mediterranean region is always a meeting place and an illustration of international co-operation and today we are the living example of this. Whatever the singularity of each individual personality, you have all come freely to take part in discussions and to comply with the demands necessary for making common scientific progress in the management, protection and future of the Mediterranean Basin.

Ladies and Gentlemen, I hope that your meeting will be a great success and that Governments can benefit from your results and thus provide a better quality of life for their peoples.

ANNEX 3

THE SARDINIAN PILOT PROJECT

This project concerns the integrated study of the impact of grazing on forest ecosystems

1. The Sardinian situation

In Sardinia various degrees of forest degradation are to be found, a forest whose ecological equilibrium is endangered just as in the degradation of ancient cultivated areas more or less invaded by woody plants. What kind of evolution is desired for these marginal zones which are no longer considered as representative of "good" forest nor "good" rangeland and are neither cultivated nor cultivable?

The number of sheep in Sardinia has gone from one million at the end of the 19th century to two million in 75 years. During the same period, there has been a decrease in agricultural activity and consequently a decline in the upkeep of the land. Under these two influences, the flocks of sheep have been seeking more land which has often resulted in the spread of brush and forest fires and which were even more serious as the land was less maintained than before. In consequence, a law has been established to protect the forested areas.

However these lands can have several functions. Dr. Barneschi of the Tempio Pausania Cork Institute has studied the possible uses of Sardinian lands. This was developed at the Montpellier Conference with respect to the functions of forested areas:

(1) Forest for wood production: this necessitates using introduced species and special management techniques (ligniculture, even-age stands, rotational cutting...).

(2) Forest for environmental equilibrium: the Mediterranean "climax" forest composed of a mixture of *Quercus* can have an important rôle in the creation of microclimates, erosion control, hydrological maintenance and regulation.

(3) Forest for grazing purposes: in view of the demand for forage, it seems impossible to maintain the forest exclusively for its rôle in environmental protection and it is therefore necessary to envisage using it for the production of organic matter (sprouting plants, brush, natural herbaceous vegetation). As is said above, the problem is posed in terms of animal-forest equilibrium, and thus brings out several axes for research.

2. Research framework and programme

In order to try to begin to answer these questions of general interest to the countries of the Mediterranean Basin, the Sardinian Cork Institute and the Zootechnical and Cheese Institute have proposed a research programme which has been retained as a pilot project by the Potenza expert Conference (see MAB Report Series No. 36).

Geographic situations. On the whole, the project consists of the study of five stations situated in environments all tending to have a dry climate but with certain differences. These stations have been chosen to cover all of the natural situations found in the Mediterranean Basin.

(1) Mamone (Nuoro Province). This station covers 2,814 ha-1,763 ha being available for the project - at an altitude varying from 118 m to 930 m. Parent material is either volcanic (diorite) or metamorphic (mica-schist). The aspect is mainly East, South-East and South. Four types of plant cover can be distinguished: monospecific and even-aged stands of cork oak (640 ha) and Holm oak (117 ha), brush (759 ha) and rangeland (247 ha).

(2) Isili (Nuoro Province). This station covers a plateau varying between 565 and 707 m in altitude. 620 hectares are available for research on soils whose parent material is essentially calcareous (dolomite) with a Southern aspect. It is mainly a stand of Holm oaks (444 ha), but there are also 71 ha of brush and 94 ha of rangeland.

(3) Is Arenas (Cagliari Province). Situated at the South-West of Sardinia, this station has the hottest and driest climate of the island and is highly representative of the stations found in North Africa. The sub-soil is made up of ore-bearing schists and also sands of aeolien origin. The aspect is West, North and North-East, and the altitude varies between 0 and 444 metres.
The area available for research, 2,683 ha, is made up as follows: 581 ha of Holm oaks, 1,839 ha of brush and 242 ha of rangeland, plus about 20 ha of cork oaks.

(4) Asinara (Sassari Province). This station also has a hot, dry climate with a South South-East and West North-West aspect. Its altitude varies between 0 and 202 m. The sub-soil is composed of mica-schist and granite. The plant cover is very degraded and consists essentially of brush: in effect, 3,235 ha of the 3,420 ha available for research are covered with brush.

(5) Foresta di Burgos (Sassari Province). Unlike the preceding stations, this one lies in a rather mesophilous environment. It covers a plateau whose altitude varies between 675 and 785 m, with a North North-East aspect. The sub-soil is mainly gneiss and mica-schist and basaltic lavas are found on the upper parts. It covers an area of 1,025 ha of which 398 ha are more or less open mixed forests (Holm and white oak), 228 ha brush and 399 ha rangeland.
This area belongs to the Istituto Zootecnico e Caseario per la Sardegna whilst the others are reformatory settlements.

Experimental programme. Exploitation of forests by animals can be envisaged on a seasonal basis (forest, brush and rangeland rotation) or on a permanent basis (forest and brush), with the combination of one or several animal species.

The simultaneous presence of several animal species, apart from the fact that it is customary in many Mediterranean regions, is interesting to

study because it might lead to better use of the produced biomass owing to the differences in food niches of each of these species.

In the same connection, one could also think of comparing the behaviour of an exotic race, which has been more or less in close contact with forests all throughout its history, with the behaviour of a so-called improved race.

Independently of the time of grazing and the choice of species, several grazing densities should be studied.

Finally, it is fundamental to maintain an animal-free area for each case.

All this leads to the definition of the 25 ha plots, which should be chosen at right angles to the contour lines for each station under consideration and should include: brush, white oak forest and degraded, higher altitude Holm oak forest.

To start with, the number of plots and the number of measurements to be made in each of them, the necessary alterations in methodology and the adaptation to the pluridisciplinary approach, mean that work is limited to the one station of Foresta di Burgos. This station has a more favourable setting than the others as well as the advantage of having full control over the animal material and the presence of a full-time technical and scientific staff.

The animals are cattle of the local Sardinian race (nursing cows) aged 3 years or more, and are always in the plots except for December and January, with only the natural vegetation as food. However it is planned to take the animals out of the plots if more than 50% of the seedlings disappear, and to give complementary feeding (hay) if the cows lose more than 15% of their weight.

Two stocking rates are considered, one low = 1 cow/3 ha and one high = 1 cow/1.5 ha. The measurements made on the animals will involve: growth by monthly weighings and at each event of the life cycle; milk production of the mothers; browsing behaviour and qualitative and quantitative food intake.

There are of course several studies on the environmental characteristics (edaphic, climatic, floristic...).

State of progress of the work at Foresta di Burgos.

The experimental plots have been chosen and a first floristic survey has been completed. The animals available for experimentation have been set aside and will go into the plots in Autumn 1976.

This project falls well in line with the zootechnical work undertaken at the Foresta di Burgos station where a nucleus of females of the pure Sardinian race will be installed in view of conserving the race. This herd will therefore partly use the local forest and rangeland.

The interest of this programme lies especially in providing answers to the hypotheses formulated by Dr. Barneschi on the rôle of animals in the creation or regeneration phase of the forest. Its realization depends of course on the possibilities of financing it on the national Italian level as well as on the international level.

It will contribute to the specification of the standards of reglementation which ought to be accepted by both parties (foresters and animal raisers). For the moment, it appears that without this reglementation, any attempt of introducing or re-introducing animals into forests would end in failure.

3. International co-operation

The achievement of international co-operation is indispensable from three points of view if real progress in Mediterranean research is to be made.

From an intellectual point of view, the furtherance of these interdisciplinary concepts, the development of a working methodology at the data collecting level as well as on the perhaps more delicate level of analysis and interpretation of results, necessitates frequent meetings between research workers. The urgent human and ecological problems of animal raising in the Mediterranean region call for rapid awareness of the necessity of a new step foreward. In another connection, analysis of different situations allows a gradual and correct formulation of the real problems, and thus the development of rational solutions.

From a practical point of view, agronomic research is very unequally developed in Mediterranean countries; inequality with respect to the global effects of research and qualitative inequality in the sense that in most cases, efforts have been made in a piecemeal fashion.

From a present-day point of view, a first Franco-Italian co-operation is being set up around the Sardinian pilot project, supported by very close scientific ties developed during the last ten years between the research workers of the Sardinian Istituto Zootecnico e Caseario and the INRA Department of Animal Genetics on the problems of cattle and sheep raising in the Mediterranean region (dairy ewes and nursing cows).

In the same way, contacts have been kept up between the Cork Institute at Tempio Pausania and certain research workers of the INRA Department of Forest Research. In this situation, co-operation works in several directions: between countries and between disciplines.

The Sardinian experience could be used fairly directly in neighbouring Corsica to benefit its research programmes on models of development.

Contacts with Spain have also developed around this Sardinian project concerning the preparation of a co-pilot project which could be located in the Estremadura Dehesa, whose evolution from an endangered sylvo-pastoral equilibrium is posing a few problems.

In other respects it would also be interesting if North African countries brought in their concerns on reafforestation and the control of grazing activities in relation to the evolution of arid zones, the important needs for primary products and population growth.

Most particularly in the South Mediterranean region, relations should be envisaged with those operating the ARIMED programme developed in Southern Tunisia on aspects of animal management just as with possibilities arising from forage tree plantation.

MAB's Project 8 on "Biosphere Reserves" is not totally separate from programmes 2 and 3 in that the valorization of ecosystems is accompanied by the necessity to conserve local plant and animal ecotypes which are often remarkably productive and adapted to the environment. This has been well understood in the Sardinian project, where the livestock concerned constitutes a nucleus for conserving the Sardinian race of cattle. This is found in MAB Project 8 and is also the concern of international organizations such as the FAO which has planned to develop a systematic inventory of Mediterranean cattle and sheep genetic material. In the Dehesa case, the programme could benefit from the work done by an important FAO project on rangeland productivity

and evolution... On the French side, the DGRST through the "Management of Natural Renewable Resources" Committee has incited the development of the Corsican, garrigue and "causses" programmes.

To try to organize co-operation is also to try to harmonize all these initiatives and these concerns. Co-operation will exist if there is really a need for it to come about. It is these concrete actions which should be sought first, carrying them out as each programme develops.

To conclude by answering the question of whether it is really necessary to think about the problem of grazing in forests when badly used rangeland exists, one can reply that the fundamental problem is really that of animal-forest relationships, and that this will necessitate experiments of long duration (10 to 15 years) and, therefore, a commitment on the part of national or international authorities.