

Regional Management of Mediterranean Ecosystems in Spain¹

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Most of Spain has a typical Mediterranean climate. Because of its geographic situation and topography, many different climate varieties are represented, from the arid in southeastern Spain to the Mediterranean high mountain in the Sierra Nevada. This variety of climates gives rise to a series of ecosystems, normally much altered by human activity, and very difficult to restore because of their fragility and climatic characteristics.

The European Mediterranean climate is characterized by a very dry summer. Rainfall normally takes place in a few days but is very intensive. Together with a rough topography, this causes torrential watercourses. This is an aspect which conditions the management and control of large areas of our country.

The vegetation climax is the sparse forest or woodlot with evergreen xerophilic species, of which the holly-oak (Quercus ilex) is the most representative, occupying the greatest area. The most characteristic coniferous species in this region are Pinus halepensis, the Mediterranean subtype of Pinus nigra, Pinus pinaster, and Pinus sylvestris.

In the temperate and dry zones, the holly-oak overstory leaves room for the wild olive tree (Olea europea), represented in the transition zones by the "coscoja" (Quercus coccifera). In the driest zones, and where erosion has degraded the soil, the Mediterranean "garriga" appears on calcareous soils, representing the tropophylla vegetation and forming a clear and discontinuous bush. On siliceous soils the "maquis" appears, a closed underbush of rockrose (Cistus) with "lentiscos" (Pistacia) and strawberry trees (Arbutus)

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Abstract: Management of the fragile and greatly modified ecosystems in the Spanish Mediterranean climate is complex. Rainfall occurs in a few intensive storms on rough topography. Climax vegetation is sparse forest dominated by evergreen xerophilic species. The emphases of the National Institute for Nature Conservation (ICONA) are forest hydrology restoration, restoration of forest potential, attainment of forest structure, and protection of natural spaces with singular ecological characteristics. This paper discusses the goals of management, evolution of forest management, management problems, scientific information in forest management and restoration, and national level studies on reforestation, hydrology, and desert control.

among which the holly-oaks (Quercus ilex), kermes oaks (Quercus faginea), and isolated pine trees stand out.

The scarcity of tree species compatible with our climate, and the differentiation between the existing ones, have caused numerous "endemismos." Professor Luis Ceballos considers that this is due to the isolation of Spain between the Pyrenean Cordillera and the Mediterranean Sea. Among these species are the Spanish fir tree (Abies pinsapo) in the Penibetica Mountains. In North America, north of the 36th parallel, more than 450 species of autochthonous forest trees can be cited, while in the south of Europe there are hardly more than 70. From fossils, it is known that many species now living far from the Mediterranean zone were present during the Tertiary in the European Meridian. This data should be useful for the restoration of degraded ecosystems, in which selection is difficult due to the scarcity of autochthonous species. Thus we could try to restore some trees lost by accident in the Mediterranean zones. On the other hand, the diversity of our Mediterranean climates allows us to try some species which were earlier represented in the habitat but later were replaced by other species of minor rank. Professor Ceballos considers that there are three conifers in a progressive stage to be borne in mind for the restoration of Mediterranean ecosystems: cypress (Cupressus sempervirens), cedar (Cedrus atlantica), and spruce fir (Abies pinsapo).

GOALS OF MANAGEMENT

Forest management is a dynamic concept as a consequence of social, economic, and political conditions. The human being has always tried to make full use of the resources available to him. While the resources were abundant and the population's necessities were met, there was no clear commitment to management. The forest was considered only as a timber producer and a supplier of fuel, which meant intense deforestation in Spain. When the resources became scarce and the needs for forest products increased, there was concern about the precarious situation of our forest, and a

period of forest conservation began in the middle of the last century, coinciding with the creation of the Forest Corps.

Every ecological system has an optimum level of stable and permanent vegetation representing the biological maximum permitted by environmental conditions. In the Spanish forests the vegetation climax is represented by more or less closed forests of coniferous trees in the high mountain zones and of hardwoods in the middle and low mountains, and only in the dry zones of the littoral and on the tops does the bush represent the climax. The resulting ecosystems are briefly described according to land use; the limitations of this work do not allow us to particularize each one of the existing ecosystems and their precise relations.

The Spanish School of Management was born as an offshoot of the German School of Tharand, and its focus was basically economic, addressing maximum timber production. However, it was early adapted to the characteristics and problems of the Mediterranean forests, first taking into consideration other products, such as cork and resins, and from the beginning giving preponderance to soil protection. Already in 1930 it was taking into consideration such indirect benefits as esthetic, scientific, health, and recreational values.

Thus, we reached the present consideration of the forest as providing for multiple use, and the concept that forest management should direct and guide it to the optimum indicated of its natural, social, and economic functions, through convenient planning in time and space for its exploitation, utilization, substructure, and improvement within the limits imposed by the biological requirements.

This direction towards the optimum implies the following master lines of activity:

- Forest hydrologic restoration of watersheds.
- Forestation of areas with forest potential.
- Attainment of a suitable structure of forest stands.
- Protection of natural spaces with singular ecological characteristics.

As a result of past actions, there are at present nearly 2 million ha under management, the first dating from 1895, most of them softwood species (1,450,000 ha) mainly Pinus sylvestris and P. pinaster (each 466,000 ha) P. larico and P. halepensis (each 200,000 ha) P. uncinata (100,000 ha) and smaller surfaces with P. pinea, P. radiata, P. canariensis, and Abies pectinata. For hardwoods, there is a total area of 380,000 ha, most of these being Fagus sylvatica and Quercus robur (200,000 ha). Eucalyptus (125,000 ha), Q. suber (50,000 ha), and small areas of other Quercus spp. are included.

Almost half of the management work was concluded during the decade 1951-61.

Among the intact or little degraded ecosystems is the holly-oak forest of Quercus ilex, the most representative for the Mediterranean zone. It is the most typical tree in Spain and there are approximately 550,000 ha high forest, 850,000 ha woodlot forest, and 856,000 ha of coppice forest. During historic periods, this forest covered the majority of our land area. Its perfect adaptation makes it take advantage of all the Mediterranean climate characteristics, first of all keeping the soil moisture, thanks to the density of its crowns and the thickness of the organic horizon formed under it. These permit it to vegetate perfectly during the long dry periods, having strong resistance to drought, hot weather, and the dry air of the Mediterranean summer. It extends from sea level to 2000 m elevation, where it can be found in the Sierra Nevada, although its optimum is between 200 and 1200 m.

In a more humid environment, the climatic vegetation consists of gall oaks (Quercus faginea) and cork-trees (Quercus suber). The first can be found in almost all the provinces in Spain. It is perfectly adapted to the humid Mediterranean soil and is a half-light tolerant species. It can reclaim the habitat from where it was displaced and usually does at the expense of holly-oak, which acts as a subclimax species in the humid Mediterranean soil. The second oak species can be found on siliceous soils in the southeast and northeast of the country. In the mountains, Pinus sylvestris is extensively represented, and occupies this habitat from the Pyrenean Mountains to the Sierra Nevada, where in Cerro del Trevenque it reaches its most meridional spontaneous form.

The climax ecosystems of mountain peaks generally form a dwarf bush of savins, integrated by Juniperus sabina humilis and Juniperus communis nana, accompanied by cushioned bush of brooms mixed with fescue grass, which is graminaceous grass with stiff leaves.

On sandy ground and littoral marshes, the vegetation climax is integrated by Juniperus phoenicea, Retama monosperma, Lotus creticus, Corema album, etc., adapted to resist the action of dominant winds, which are very common in these zones.

Of great ecological value is the interesting ecosystem in the National Protected Space of "El Sabinar," on the coast of Almeria in the southeast of Spain. Its basic association of Juniperus and Pistacea is sporadically joined by Tamarix, and composes, with its fauna, a sabulous biocenosis, the only one on the Andalusian coast. It is a relic ecosystem, which once, in historic times, occupied all this coast.

As an example of transformed ecosystems, which have obtained an ecological balance due to the treatment received, there is a degenerated form of

the holly-oak forest, known as "dehesa" (open woodlot with pasture). Its main object is the production of fruit (acorn). The brushwood vegetation has been taken away in order to obtain a pastureland and in this way a mixed grazing is obtained for pigs, cows, and sheep. The "dehesa" is formed by gradually reducing the tree density and modifying the crown of the holly oaks by successive prunings.

Finally, there is a stable ecosystem, which has not changed in 2000 years, known from the writings of the Greek Strabon, who crossed the Roman Empire during the time of Augustus and was consequently contemporary with Jesus Christ. In his "Geographica" book III, "Iberia" he describes his journey from Tarragona to Jativa, and from there, he writes: "he gradually left the coast, arriving later at the so-called "Spartarius", a big field without water where the "esparto" (matweed) grows abundantly."

This "esparto" is used for the weaving of cord and is exported all over the world, but mainly to Italy. The "spartarius campus" is a big plain extending from Cartagena to Almeria; it has remained almost unchanged since Strabon saw it.

As the oaks are the most representative family of the Mediterranean forest trees, the cistaceae are the most characteristic bushes; their formations of dense brush (maquis) reach the height of a man or even more, and occupy great areas of the country. Examples are "Sierra Morena" (the dark mountain), the name of which alludes to the dark green rockroses (jara) when they are seen in the distance; and the Montes de Toledo, Extremadura and Baja Andalucia, forming a stable ecosystem in regression, where the "Quercus coccifera" is present, not reaching tree size, and over which old individuals of holly-oak and cork-tree stand out. In the extensive representation of the cistaceae, Cistus ladaniferus predominates with C. laurefolius and C. populifolius, accompanied by the lentisco (Pistacia lentiscus), the strawberry tree (Arbustus unedo) and a big group of small heath (Erica), thyme (Thymus), rosemary (Rosmarinus), etc.

Degraded Ecosystems

In vast zones of Spain, a big alteration of the natural environment has taken place over the years. The climax ecosystems have been replaced by others very distant from the potential climax. The result has been a continuous deterioration of the soil as a consequence of the erosion produced by the lack of a suitable vegetal cover. In this way vast zones of the country are covered by deeply degraded bush, frequently with thorny plants, especially labiates.

A greater number of Spanish foresters are dealing with the management of these degraded ecosystems as their main mission and with a restoration criterion. Due to the degradation of

these ecosystems and their fragility, the restoration has to be carried out starting virtually from the last stage of the phylum.

As we know, the management of an area consists in organizing it according to silvicultural and economic criteria in order to obtain the maximum protection, social, and production benefits. It is generally not possible to obtain these three maxima at the same time and therefore it is necessary to establish an order of priority among the possible objects.

HISTORICAL EVOLUTION OF FOREST MANAGEMENT

The deforestation stage has been as long as the history of Spain. Spain's geographic situation at the crossroads of Europe and Africa, its mild climate, and the abundance of its resources, were the reasons why different peoples settled in Spain. There was no serious deterioration of the environment while the population was still sparse, but repeated impact on an ecologically fragile environment determined the deterioration of the natural ecosystems and made restoration difficult, as the lack of vegetal cover accelerates the erosive process. The principal causes for deforestation have been these:

- The plowing of forest soil in order to install agricultural plantations, later abandoned.
- The secular protection of cattle. As Spain is a rather mountainous country and not propitious for the creation of meadows, grazing has been carried on with sheep and goats for 3000 years. During the Middle Ages and later in the 16th century, the wealth of Spain was based on its millions of sheep, with their privileges of pasture and browsing, which caused irreparable damage to the forests.

In "History of the Spanish Institutions" Professor Valdeavellano says that the origin of the "Mesta" was the associations of shepherds and local cattle breeders, who joined together during the Middle Ages in every municipality two or three times a year to take care of the pasture of their cattle. Those meetings were normally held after the reconquest of each town. By 1273 the cattle breeders and shepherds in the Kingdoms of Castilla and Leon were constituted in only one municipality of the "Mesta". Alfonso X granted it privileges and ordered its decisions to be obeyed. As all cattle of the "Mesta's" municipality were considered a service to the King, he ordered that the cattle should be safe and secure all over the kingdom, grazing freely on any pasture they came across as long as they didn't damage the cultivated fields, scythed pastures, and pasture woodlots. The honorable municipality of the "Mesta" took charge of the nomadic cattle and also the routes or paths used for the changing of livestock from summer pasture on the mountains in the north of the kingdom to winter pasture on the mountains and places in the south. These paths or "canadas"

had a set width when passing across the cultivated fields, but on the mountains and uncultivated grounds the cattle could cross anywhere. The preponderance of the "Mesta" can be observed in the well-organized net of royal paths, lanes, and footpaths still existing and complete with resting-places, watering-places, and bed-grounds, today managed by ICONA, and consisting of 425,000 ha.

Another deforestation factor is numerous wars, when fire often was used as a punishment; the land or forest that the enemy was going to occupy was burned. The successive invasions of Celts, Phoenicians, Cartaginians, Romans, Germans, Arabs, and French people among others, destroyed a great part of the forests. The Reconquest, which succeeded the Arab invasion and lasted eight centuries, caused a great deal of the destruction of the forests. As Dr. Erich Bauer says in "The Spanish Forests in History", the Spanish expression "emboscada" (ambushed) alludes clearly to attacks from dense forests, where the enemy could hide. To avoid ambushes, many forests were felled and burnt.

The situation of Spain with 3000 km of littoral has made it necessary during almost 3000 years to dispose of a great quantity of wood for the construction of ships. For this purpose the best oaks and pines were used to fill the demand for wood by the merchant navy and the Navy, which since the 15th century attended the presence of Spain in a great part of the world, especially on the American continent.

To this whole process, a policy of freedom from mortmain was in effect during the past century, with very unfavorable consequences for the forestry sector; 5.5 million ha of public forest and 2 million ha of forest belonging to the Church were auctioned and most of them were felled by the buyers.

Conservation starts with the creation of "Direccion General de Montes" in 1833 and the Corps of Forest Engineers, who established the most efficient measure to preserve the rest of the forest richness in Spain, the creation of the Public Forest Catalogue. The forests included in this catalogue are untransferable, unseizable and imprescriptible, the last condition limited to 30 years.

The catalogue included more than 10,000 forests with an area greater than 6.5 million ha, which were classified and catalogued, forming the first starting-point for the defense and restoration of the forests in Spain. The first Forest Law is dated 1863 and was in force until 1957, when another was published. Almost a century in force guarantees the success of its conception. From that period a series of dispositions served as a legal base to conserve the forest patrimony. It is worth mentioning the creation of the "Patrimonio Forestal del Estado" in 1935, very efficient in the conservation and restoration of the forest.

Its mission was to restore, conserve, and increase the "National Forest Patrimony" and to create the National Institute for Nature Conservation (ICONA) in 1971, which continues the labor of the "Patrimonio Forestal del Estado," amplifying its functions regarding the conservation and restoration of natural ecosystems.

MANAGEMENT PROBLEMS

Problems in forest management can be divided into three groups: legal, social, and practical.

- Legal: Very complete legislation regulates action in the State forest and in general in the Public Utility forests, as well as in hydrological forestry restorations, but there is a lack of legal operative instruments for acting in the private forests in general.

Once approved, a forest management plan is enforced in the forest by legislation, requiring a management revision plan every 10 years.

In forests without a management plan, ICONA has to approve the harvesters of wood by marking and spotting standing trees to be cut and finally checking the felling. Excluded from this duty is wood on private property within the harvest area, intended for domestic use.

- Practical: Lack of resources, forest fires, amateur ecologists, weekend excursionists, lack of professionals, privileges without duties, and some very altered ecosystems are the practical problems that a Technical Director of Management or Restoration has to resolve.

- Social: These vary with regard to the economic situation. In periods with economic depression the forest resources are always over-exploited. To make the pasturage more productive an extra range count per ha is needed. This damages the forest, and its herbaceous and even ligneous vegetation will diminish in a very short time, with irreversible degradation of the soil. The occupation of forest areas for urbanization and industrial plants often takes place at the expense of forest area.

SCIENTIFIC INFORMATION IN FOREST MANAGEMENT AND RESTORATION

A multiplicity of data and observations of interest are available. As forest management in Spain began in 1895, the amount of scientific data is very important.

The main parameters used are soil characteristics (geological formation, depth, composition, physical conditions, rush of water, etc.); orography and configuration of the ground; hydrographic position; climate (rainfall, seasonal distribution, temperature, relative humidity, etc.) expressed in bioclimatical diagrams; flora

(species, vegetal associations, etc.); fauna (convenient and injurious species, etc.); diseases and plant pests; statistical risks of forest fires; livestock pressure (class and quantity); density of human population (characteristics and grouping); communication and access ways; mill industries; touristic and recreation demand, etc.

As well as scientific information about forestry, all complementary information is used: complete records of meteorologic stations in the forest, edaphologic studies, measurements of the soil moisture available for the roots of the plants, and the influence, dose, and results of the fertilization of forest soils.

In forest stands, species are analyzed for basal area, site quality, diametric distribution, height-diameter and diameter-age relations, stand volumes (tree-volume tables and management, tariffs), stand growth, etc. Industrial investigations are also used, as performed by the Forest Research Centre on the use of different species, characteristics of different products and agents acting on them, production and consumption studies, etc.

A consequence of the meticulous study performed and of the planning of the aims to be reached is the selection and settlement of the necessary measures, which end in a series of activities in time and space, with different intensity and method.

The management action can be integral or limited, the first referring to forest yielding products for a single market and the second referring to isolated forest stands of less importance.

When a plan has been made, a model is chosen for the forest, setting forth its management division, stand structure, method of management, rotation, reproduction period, allowable cut, felling method, accessory systems, means to use, financing, etc., as well as a quantified objective.

Management projects are revised periodically (every 10 years) by accumulating and studying the obtained data or modifying or maintaining the directives indicated in the management project. In any management project or revision, there are three approaches: long term (general plan), medium term (special plan), and short term (annual plan).

Restoration Projects

Due to the fragility of the Mediterranean ecosystems, once the ecological balance is broken by man, generally through cutting or burning the tree vegetation, a progressive and irreversible deterioration is produced which requires management action.

The restoration of these very fragile and degraded ecosystems requires detailed scientific information to provide foresters with the necessary means of planning the management. This information should always be completed with the experience obtained from earlier restorations.

The first requirement is a complete study of the "habitat" on which the restoration will be performed. Information on the physical medium should include:

a. Morphologic characteristics, with analysis of the topographic aspects of the area to be studied; compactness index and relief studies.

b. Information about the soil in two ways: one analytical and another calculating indexes which can define the type of soil reaction.

c. Study of the climate through an analysis of meteorological data of the established seasons.

A parameter, recently introduced for this type of study is the bioclimatic diagram by Montero de Burgos and Gonzalez Rebollar. It is an invaluable help in the restoration of the Mediterranean ecosystems, as, due to the scarcity and irregular distribution of rainfall, a technique of climatological analysis with biological basis is needed, giving great importance to water balance.

The bioclimatic diagrams provide exact information, but are restricted to the proximity of the station. Bioclimatic maps serve the biological aims of the restoration by providing detailed and accurate information for the area.

d. Vegetation studies, carrying out analyses of associations and of indicator plants, of vegetation dynamics for land use, of climatic regression scales, and of the situation of the vegetation on the scale; also phytosociological studies as indicators of the species to be used.

Hydrological forestry projects, especially corrective work, are revised every 5 years to check if everything has been carried out according to plan and if any rectifications are to be done. Modifications of the project due to the influence of the work already accomplished can be made on reasonable justification.

It is of great ecological value to succeed in restoring the climax vegetation of the Mediterranean area as far as the tree forest, but there are a series of edaphological and economic factors that condition such restoration. The first one limits the nature of the plants to be installed, as the climax species are very exigent with respect to the environment and need a rather mature soil for good development. It has been proved that the climax species have very limited development and difficult rootage in eroded soils with little depth, little organic matter, and little-developed horizons, and this is the condition of most of the soils to be restored.

Another limiting factor is economic. As the areas to be treated are always large, the cost of conditioning the soil to give it the nutrition and texture it needs in order to receive the climax species are always too great for the Forestry Administration.

Therefore, regeneration of the vegetation climax must be restricted to forests with favorable ecological conditions; those with a more fully evolved soil, where the natural vegetation is conserved, even if only in shrubby form. We will describe the regeneration system used in the reconstruction performed by ICONA on holly-oak forest, the most typical Mediterranean forest. This is taking place in various forests, especially in Sierra Nevada, in the province of Almeria in the south-east of Spain, in an area with subhumid climate according to the Emberger classification.

The "habitat" on which we are acting contains a bushy vegetation of holly-oaks formed by discontinuous stunted bush-spots with some young shoots. The soil is very eroded, particularly in areas without bush cover. It has been cut for fuelwood and charcoal several times; the last felling was some 30 years ago, and it has supported continuous grazing by goats, which have eaten the annual buds. All this has produced a regression of the normal formation of the holly-oak, so that it reaches its most bushy form.

The reforestation system used consists of a combination of protective treatments completed with line planting of plants in bags and seeding of acorns. The initial treatment consists of a selection of young buds, which are pruned; a cleaning of surrounding brush; and a brushing of strips, even with the ground, in order to stimulate the sprouts and coppice shoots. This brushing is done manually or mechanically according to the slope and the degree of protection of the vegetation needed. The manual system is used in stands with mature soil. This careful treatment is very advantageous because it doesn't produce any appreciable alteration of the soil; the shoot distribution is much better and the ground is consequently better covered. Motor brush cutter or manual tools are used for the brushing, as in working at ground level, stones interfere with the action of the gear. The mechanical system is used in stands of lesser slope and with a more closed bush. The brushing at ground level is done with a bulldozer of 75 to 180 CV, cleaning alternate strips following contour curves.

The restoration system that gives best results is a combination of the three described treatments. The young existing shoots are first pruned and cleaned. Afterwards alternate strips are brushed with tractors at the level of the ground, and the tree bush and creeping vegetation is brushed by hand, for better distribution of the shoots. In the open strips, which are brushed with the bulldozer, the forestation is completed

with a seeding of acorns and a planting of seedlings in bags on areas without bush.

With this system, a diversity of ages of the climatological ecosystem is obtained that guarantees its persistence. Finally when the selected stems have reached enough development, it is necessary to make a selection of the shoots, normally by cutting the surplus ones with long-handled pruning scissors. Once a tree crop is obtained, an important alternative is presented in the areas with less slope, consisting of a clear woodlot "dehesa" which permits grazing.

An important help in monitoring of regeneration treatment and comparison between the development of treated and untreated examples of the same stool is amplified microphotography on which the evolution of the shoots and the vegetative stage of the stems can be observed.

The management or restoration plan of a forest or a catchment basin is studied and written up by the Technical Director of the forest, who has the title of "Ingeniero Superior de Montes" assisted by "Ingenieros Técnicos Forestales" and an "Ingeniero Técnico Topógrafo". Specialists in other subjects, normally edaphologists and biologists, collaborate in the study. The Technical Director of the forest is in charge of the fulfillment of the plan and of necessary revisions. Periodically, there are specialization courses in the "Escuela Técnica Superior de Ingenieros de Montes," and others organized by ICONA, which those interested can attend as appointed by the Director or at their own request.

The new techniques, results of management, etc., are published in specialized magazines, among which we mention Central Station of Ecology ("Estación Central de Ecología") Forests ("Montes"), Wild Life ("Vida Silvestre"), etc. The results of special projects and reports on the development and conclusion of the courses and seminars, etc., are published in the "Monografías" of ICONA. The results of the forest research are published by INIA, which includes the Forest Research Institute.

NATIONAL LEVEL STUDIES

Only studies closely related to management, restoration, and utilization of the natural environment are indicated.

National Plan of Reforestation

The object of the plan is to recover the barren areas with forest; where it is necessary, to do a reforestation with protective, productive, or socially beneficial effect. It comprises some 5.5 million ha and is to be performed in 50 years. A photogrammetric study of Spain has been required, each photogram covering a surface of 500 to 800 ha.

National Hydrological Plan

Its purpose is to regulate water yield, for which agrohydrological management of the catchment basins is necessary.

At the present time, the study is in a predefinition phase. A data bank has been formed, in which all studies and projects have been inventoried. With respect to the Natural Space, which is the sector where ICONA takes action, information on water supply and demand has been gathered.

Forest areas and new plantations have been mapped, as well as future reforestations, Natural Spaces with special protection, erosion centers, and restoration work on degraded ecosystems classified as necessary, performed and to be performed.

Register-cards of water demand as per use, and maps of water demand have been made.

Special plans of greatest interest are those referring to Protected Natural Spaces, e.g., the National Parks.

Desert Control Program

The deep valley of the Mediterranean Sea, the origin of civilization, has suffered through its history a progressive deterioration of the natural resources, caused by human activity with abusive practices of soil and a continuous use of some limited natural resources in a very fragile natural environment. This is mainly due to the characteristics of the Mediterranean climate, with a brief rainy season and a very irregular distribution of rainfall, where long periods of hot, dry summer and violent rainfall are frequent. The rough topography and the lack of a convenient vegetal cover in large areas gives a torrential character to most of the catchment basins. This gives tree vegetation very limited development in large areas; recovery of the ecosystem that man has altered is difficult.

The frequently torrential rainfall, the rough topography, and the lack of necessary vegetal cover results in very much altered ecosystems in important areas, where the erosion has impoverished the soil, with progressive exhaustion of the renewable natural resources. This pattern has decisively affected the, social and economic history of the area.

Increasing deterioration of the environment, aggravated by some very dry years in the south-east Spanish part of the Mediterranean watershed, has given desert control problems preference over other work in Spain.

At an international level, the World Conference on desert control held in Nairobi in 1977 made obvious the necessity for greater knowledge of the phenomena that produce the desert, and for

improved technology to control it. At the same time, it was recommended to promote the necessary action to fight against the deserts at a national level as well as at an international level.

Spain has therefore followed a policy of conservation of the natural environment and reforestation programs, since the last century when the Forest Corps was created. Three million ha have now been reforested. With the obtained experience of restoration, it is considered that desert problems have such specific characteristics that the best way to fight efficiently against it is to establish a program to study and monitor erosion in Spain. For this purpose a working group has been formed within ICONA, in collaboration with the University and the Research Centers. It is working with the LUCDEME project (Struggle against the Desert of the Mediterranean).

As the problem covers a big part of the Mediterranean watershed, the Spanish Government is interested in promoting the cooperation of the Mediterranean Nations so that the studies performed and the recommendations reached will serve the Mediterranean countries with these problems.

The objects of this project are:

- To deepen knowledge of the existing national resources and their condition before their degradation due to human activity.
- To know in detail the reasons for the deterioration of the resources and their degradation levels.
- To define the existing correlation between the deterioration of the natural resources and the social and economic decline of the affected rural areas.
- To analyze the techniques applied up to now and to design new techniques for desert control.
- To study the costs of restoration of the natural resources, in order to develop the rural areas and achieve higher levels of life quality, analyzing the cost-benefit relation.
- To study historical research of this area, which traditionally has been the meeting point of developed and underdeveloped worlds. This Spanish area with great desert problems was a developing center during the first period of our occidental civilization with the culture of "Los Millares", "Villaricos" and "El Argar", probably due to the climatic conditions, that were good for the people and hostile for the environment.
- To continue research of the natural resources, ecology, land use, degradation level of the resources, sociology, meteorology, forest hydrology, etc.
- To study traditional systems of land use and evaluate technology applied on the works already

performed and the techniques used. Study application of new techniques adapted to the Mediterranean ecosystems, etc.

- To improve utilization of the activities and results of research and technology for training of experts and investigators through symposia, courses, workshops, etc.

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