

# FORESTS IN THE SOUTH OF EUROPE BETWEEN SOCIAL-ECONOMIC EXPECTATIONS AND PROTECTIVE MEASURES: THE CASE STUDY OF SICILY (\*)

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The Sicilian forest patrimony for 2/3 consists of allochthonous and exotic species introduced through reforestation during the last 50 years (Eucalyptus, Mediterranean Pines, Austrian Pine, *Pinus laricio*, *Pinus insignis*, etc.) and for the remaining part of autochthonous or seminatural species (European Beech, Turkey Oak, Cork Oak, Pubescent Oak).

It is quite similar to other Mediterranean forest areas in the E.U. (Greece, Spain, France) and to other regions, such as Portugal, which are as well considered Mediterranean.

Forest policies in Spain and Portugal have been characterized by the choice among the various species of Eucalyptus for reforestation of grasslands and marginal arable lands, while Kermes Oak have actually been replaced by *Pinus insignis* and Atlas Cedar throughout the redsoils of the coastal plains and hills in French Provence.

The basic difference between the above-mentioned countries and Sicily

## ABSTRACT

In this paper the authors describe the current guidelines of forest and environmental policy at national and regional level and criticize their efficiency even in relation to the policies of other E. U. countries (situated in the Mediterranean region). Then they propose some alternative management systems that, at the same cost, could offer new chances of growth for the forestry sector and the other related sectors (the creation of wood-processing industries with the consequent trade of these products and touristic activities inside protected woody areas) and other social benefits of a various nature. On the basis of a set of qualitative evaluation criteria, this research aims, by means of discrete multicriteria methods of analysis (Eigenvalue or Prioritization Approach and Regime Analysis), to evaluate three hypotheses by deriving finally a ranking of possible solutions. This research is designed to assist public decision-makers in regional planning of the sector. The results show how the management plan considering both the use of woodlands use and the recreational-touristic potential of some woods, presently subject to a strict but unjustified environmental protection, is by far the most attractive alternative.

## RÉSUMÉ

*Après des considérations sur les directives actuelles de la politique forestière et de l'environnement, soit au niveau national que régional, et sur leur efficacité par rapport aux politiques des autres Pays de l'U.E., les auteurs proposent des solutions alternatives d'aménagement du territoire qui pourraient offrir d'autres chances de croissance en termes de valeur ajoutée du secteur forestier, ainsi que de développement des autres secteurs économiques. Il faudrait en effet considérer les effets de la création d'industries de transformation du bois, du conséquent commerce de produits forestiers, de l'ouverture des zones protégées au tourisme, outre plusieurs bénéfices collectifs. Cet étude vise - sur la base d'une série de critères d'évaluation qualitative et d'une méthode d'analyse multicritère ("Eigenvalue" et Analyse de Régime) - à évaluer les alternatives en dérivant enfin l'ordre de succession des solutions possibles. Il peut aussi aider les administrateurs publics à mieux orienter leurs choix au moment de la planification régionale du secteur. Les résultats montrent que, dans certaines zones soumises à de très étroites contraintes de protection de l'environnement, l'aménagement prévoyant l'utilisation de bois allochthone et l'ouverture des forêts aux activités touristiques et récréatives, se profile comme la solution la plus avantageuse en ce qui concerne les aspects sociaux, économiques et d'environnement.*

lies essentially in the constraint system —unparalleled in other countries —set up by the Regional government in order to protect autochthonous forests at present entirely included in Parks and Reserves and therefore economically unproductive.

A peculiarity which characterizes Sicilian forest area is the fact that woods have been often built on lands which were marginal not only for agricultural use but also for silviculture; therefore productive results, either from the qualitative or from the quantitative point of view, have always been discouraging and the only function they carry out is the protective one, considering the widespread hydrogeological instability existing in Sicily. It is noteworthy to point out that these woods suffer from diseases due to insects and fungi because the level of attention paid for them has never proved to be sufficient and consequently even the quality of landscape offered by them is on average quite low, with important exceptions

in some protected areas.

Besides, the establishment of the hydrogeological (prohibition of deforestation to prevent soil erosion) and landscape constraints has affected the expected utilization of over 30,000 hectares of pure Eucalyptus and mixed forests with Eucalyptus (both are Region property), meant to have a soil protection function.

The existing trade-off among socio-economical aspects (Forestry Added Value and employment), as a result of such internal policy, and the positive externalities rela-

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ted to the other forest functions, is being analysed in this research, within the space limits allowed by the Congress. Firstly in the paper some of the main socio-economical and environmental indicators are evaluated with the aim of helping public decision-makers to choose among different forest management systems. The adopted methodology is based upon two widespread methods of multicriteria analysis, and particularly the Eigenvalue or Prioritization Approach —which is utilized in the first stage of the procedure —which determines the generation of cardinal weights on the basis of qualitative statements on the difference of importance for each pair of criteria —and Regime Analysis in the following steps of Multicriteria evaluation.

#### THE SICILIAN FOREST PATRIMONY AND THE DIFFERENT FUNCTIONS OF WOODS<sup>(1)</sup>

The Sicilian forest patrimony<sup>(2)</sup>, its consistency and its role in both the island's environment and economy, have variously changed over the years and this has sometimes been due to the different political tendencies that have each time privileged its economy, employment and protection.

The most recent interventions have determined the absorption of approximately 45.0% of the above mentioned forests into protected areas, causing therefore the rise of social and economical conflicts, and leading to new debates concerning both occupational implications and those relating to the management and optimization of the natural resources.

The Sicilian forest land has an extension of approximately 283,000 hectares, of which about 77.0% (218,476 ha) with a density above 50% and 23.0% (64,524 ha) with a scattered and irregular density.

Taking into account the most recent data, in relation to the belonging of the whole forest area, we may deduce that 48.7% (137,821 ha) is Regional property, about 16.5% (46,733 ha) is local town property and about 34.8% (98,667 ha) is private property.

The most prevalent renewal of forestry, about 77.7%, is high forest, while the remaining part, 22.3%, is sparse coppice and coppice with standards; the composition of the area appears to be 16.0% conifer forest, 17.0% broad-leaved wood, 21.3% mixed conifer and broad-leaved areas, 22.3% coppice and 23.4% degenerated woodlands.

As for the areas with a density above 50%, 46.9% are pure forests of which about 74.0% broad-leaved and the remaining part conifer.

As for the prevailing potential function of the forest, an accurate analysis of the areas with a density above 50% shows that for 53.5% (107,392 ha) the productive function<sup>(3)</sup> is predominant, for 27.4% (55,071 ha) the naturalistic and landscape function, and finally for 19.1% (38,269 ha) the protective one.

These aspects, and in particular those concerning the

productive function, do not exactly correspond to the present distribution, because of the constraints, which are particularly strict for park and reserve forests, they are subject to.

As for those forest areas to be found inside the three regional parks<sup>(4)</sup> and which represent about 65%<sup>(5)</sup> of the whole protected surface, safeguard measures have led to different effects in the local economies in relation to the different incidence of the three principal components i.e. natural-environmental, tourist and agroforestry, the latter still deeply rooted in the internal areas.

Inside the protected areas, planning interventions are aimed at retraining the naturalistic and environmental aspects in order to support the possible tourist development (agrotourism, rural tourism, etc.) which should replace, as a source of income, traditional productive activities such as sheep-rearing, wood-industry, etc. and agriculture, whose conventional system is gradually being orientated towards low environmental impact systems, such as those to be found in organic agriculture.

The Regional productive forests outside the protected areas cover an overall extension of about 74,000 ha, and include about 18,000 ha of pure Eucalyptus, 15,000 ha of mixed forests with Eucalyptus, 17,000 ha of Mediterranean Pine forests and over 12,000 ha of Cork Oak. Other productive species which may be found are Black Locust, Acacia melanoxylon —planted to preserve the soil —European Chestnut, Ash Tree, Persian and Black Walnut and Planetree Maple; on the whole the extension of broad-leaved plants reaches about 14,000 ha.

From this brief report on the characteristics and the role of forests in Sicily, it is quite evident how various and not easily solvable are the problems related to them.

Besides, it should be noted that the present forest patrimony in Sicily, principally situated in the hilly and mountainous areas that represent the largest part of the Sicilian territory, has increased by 100,000 hectares over the last 35 years.

#### NATIONAL AND REGIONAL LEGISLATION ON FORESTRY AND ENVIRONMENT AS SOURCES OF CONSTRAINTS

The national forest system is at present subject to diffe-

(<sup>1</sup>) Because of the scarce reliability of national forest statistics by ISTAT, data of the Regional Plan of forest defence and protected areas, by the Regional Forest Division with the cooperation of the Regional Forest Farm, that considers the whole forest area reaching an extension of approximately 283,000 ha, and the estimates of G. Ascuto (1992) based on the data given by Regional Forest Farm, that distinguish a forest area with a density above 50% from the minor one, have been taken into account.

(<sup>2</sup>) The Sicilian forest area represents about 11.0% of the whole extension of the island (Tree Density Coefficient).

(<sup>3</sup>) Productive function is here to be referred as timber utilization.

(<sup>4</sup>) "Etna" Park, "Nebrodi" Park and "Madonie" Park.

(<sup>5</sup>) The extension of each Park is the following: 58,095 ha for Etna Park, 39,940 ha for Madonie Park and 85,587 ha for Nebrodi Park; the whole extension of the 91 natural reserves is 34,930 ha.

rent constraints that condition its utilization, and have partly determined its development; apart from those constraints concerning the institution of the protected areas —nearly half of the Sicilian forests —other constraints of great importance are referable to the national legislative activity.

This aspect deserves to be deeply dealt with elsewhere, but a hint on the principal factors that have influenced the Italian and regional forest policy may here be useful.

The birth of a national policy concerning Italian forests dates back to 1923 with the law establishing the hydrogeological constraint, but an authentic forest policy is to be found as late as 1985 with the so-called landscape constraint; a year later the law no.752 provides the national forestry Plan, considered as the first real specific and organic State intervention in this field.

Since the middle of the 80's, the national policy has been influenced by the EEC one, that has produced several legislative acts concerning all those strategies aimed at the safeguard of the environment.

From an organizational point of view, in Sicily the most significant moments are to be seen in 1949, with the constitution of the State forest Farm, and in 1972 the Regional property Corps, with forestry police functions.

The actions that characterise the post-war period are those aimed at the recovery of vast grasslands and marginal arable lands, with reforestation and afforestation that, especially in the years 1960-1975, determined the strengthening of the present forest patrimony.

In the mid 70's two important laws - no. 36 in 1974<sup>(6)</sup> and no. 88 in 1975<sup>(7)</sup> - providing intervention plans were issued, while at the beginning of the 80's<sup>(8)</sup> the process of institution of Regional Parks and Reserves is initiated and then completed in 1991; in 1984 an important act, L.R. no. 52<sup>(9)</sup>, is issued and thanks to which considerable funds for soil protection and research are granted.

The following legislative interventions<sup>(10)</sup> aim at increasing the autonomy of the Region Forest Farm, both amplifying its field of intervention and making the acquisition of new land possible.

In conclusion the regional forest law of 6 April 1996<sup>(11)</sup> provides rules in order to increase the forest patrimony intervening in all those aspects connected both with the management of forests and the Boards established in

order to run them.

From an environmental point of view, the constraints that mostly burden on the forest patrimony are those concerning the protected areas.

As for parks, four different levels of constraints concerning zoning inside their perimeter have been put into effect; from the outer band (D zone) we reach the most internal areas of great interest from a naturalistic-environmental point of view (A Zone) where "integral constraints", prohibiting any activity at all., are in force. On the other hand natural reserves are distinguished, according to their management objectives, in "integral" for an integral preservation of the environment providing exclusively scientific interventions; "orientated" where cultivation works, both agricultural and pastoral, compatible with the preservation of the environment are allowed; "special", for special and delimited functions of biological, geological, ethnoantropologic preservation; "genetic", for the safeguard and preservation of the genetic patrimony of animal and vegetable populations.

Inside the reserves, according to the zoning in force two different areas are distinguished: A, with integral constraints and B, with only partial constraints.

#### FORESTRY ADDED VALUE (F.A.V.) AND EMPLOYMENT

##### Forestry Added Value

In the last five years, both for the lack of wood-processing industries in Sicily and in relation to the constraint system, the wood utilization and shelling of cork have been reduced to their minimum, just about reaching approximately 18.0% of the potential production.

The valuation of the wooden bulk and of the cork in theory withdrawable in absence of prohibitions, has here been carried out according to the distribution of the different types or "functions" of forests and average annual growth obtained from literature (Asciuto A., 1989; Asciuto G., 1992).

In order to simplify things and considering that the prevailing destinations of wood are as firewood and box for fruit, a single stumpage price (weighted mean value) equal to £/ton 20,000 has been adopted, while as for cork the estimated price is equal to £/ton 135,000. Assuming the hypothesis of valorization of the productive potentialities implied in the allochthonous woods (106,000 ha) with the contemporaneous creation of timber industries in Sicily, the stumpage price is supposed to increase to 25,000 £/ton as for wood and to 165,000 for cork.

**Table 1** contains the average annual potential production and the relative "stumpage" value which has been obtained either in the present situation and under the assumption of a reasonable utilization of potential wood and non-wood resources.

These figures show how the lack of internal industrial

<sup>(6)</sup> Regional Law no.36, 16 August 1974: "Extraordinary interventions in the field of soil defence and afforestation".

<sup>(7)</sup> Regional Law no.88, 29 December 1975: "Interventions for soil defence and preservation and adjustment of forest production facilities".

<sup>(8)</sup> Regional Law no.98, 6 May 1981: "Precepts for the institution of parks and natural reserves in the Sicilian Region".

<sup>(9)</sup> Regional Law no.52 of 1984: "New interventions in the forest field".

<sup>(10)</sup> Regional Law no.2, 18 February 1986: "Extraordinary interventions in the forest field" and the Regional Law no.16 of 1989: "Precepts concerning forest interventions".

<sup>(11)</sup> Regional Law no.16, 6 April 1996: "Legislation rearrangement concerning forests and vegetation protection".

**Table 1 Sicilian Forestry Added Value for wood and cork in the present and in the potential situation (values in Italian lire).**

Kind of forest (1)	Surface (2) (ha)	Average annual growth (tons/ha)	Potential scenario				Current scenario			
			Production (tons)	Average stumpage price (Lire/ton)	Stumpage value (millions Lire)	Forestry Added Value (millions Lire)	Production (3) (tons)	Average stumpage price (Lire/ton)	Stumpage value (millions Lire)	Forestry Added Value (millions Lire)
Deciduous Oaks (Pubescent O., Turkey O.)	20,000	2	40,000	25,000	1,000	800				
Evergreen Oaks (Holly O., Cork O.)	23,000	2	46,000	25,000	1,150	920	10,000	20,000	200	160
European Beech	6,000	2	9,000	25,000	225	180				—
Conifers (Cluster pine, . Italian Stone p )	30,000	4	120,000	25,000	3,000	2,400	500	20,000	10	8
Aleppo p. and others Eucalyptus spp. )	26,000	6	156,000	25,000	3,900	3,120	27,000	20,000	540	432
(Longbeak E., Tuart, etc. Other broad-leaved (Cork)	1,000 (8,500)	7 (0,5)	7,000 (4,250)	25,000 165,000	175 701.250	140 561	4,300 (1,200)	20,000 135,000	86 162	68.8 129,6
<b>Total</b>	<b>106</b>		<b>378</b>		<b>10,151.25</b>	<b>8,121</b>	<b>41,800</b>		<b>998</b>	<b>798.4</b>

Source: Our estimates.

(1) Rare density forests and those which particularly have protective, natural and landscape valency have not been included.

(2) These figures have been rounded off.

(3) Average production of the period 1990-1993.

The Forestry Added Value results to be 798.4 millions lire in the current situation and 8,121 millions lire in the potential scenario.

demand and the constraint system determine an annual loss of Forestry Added Value equal to £ 7,322,600,000 (table 1).

Present employment and the labour requirements in the hypothesis of a different valorization of forest resources

To estimate the average degree of labour per hectare in the forest field in the two situations taken into account, "present" and "potential", is not easy because the regional policy has so far pursued mainly employment aims by using, for the whole forest area of regional property (approximately 167,000 hectares), 3,000,000 annual working days, corresponding to about 10.5 w.d./ha and to nearly 18.0 w.d./ha if this amount of labour were attributed only to woodlands of Regional property or of local town property but managed by Forestry Regional Corp.

Therefore any comparison should be made by taking into account the limits of the potential production area, equal to 106,000 ha (about 40% of the total surface).

Besides, in the woodlands of private property and in the others (116,000 hectares approximately), the annual employment of labour is estimated to be about 100,000 w.d./ha.

Summarizing, in the present scenario (strict constraints and lack of timber cuttings) the overall employment is the following:

- Regional management woods w.d. 3,000,000
- private and local town management woods w.d. 100,000

Total w.d. 3,100,000

Under the assumption of a gradual replacement of allochthonous and exotic woods with woods of autochto-

nous species and of a more careful work in the field of the wood ecosystem, the employment would be the same as the current one, with the only difference that the workers would be employed in the conversion as follows:

- Regional management woods w.d. 3,000,000
- private and local town management woods w.d. 100,000

Total w.d. 3,100,000

Assuming that the productive forests (106,000 ha, divided into 90,000 ha with a public management and 16,000 ha with a private management) are regularly cut (in order to simplify, a yield equal to the annual average growth has been assumed) and that the constraints concerning touristic and agrotouristic fruition in the less important woods from the naturalistic point of view (about 40,000 ha) were relaxed, employment would be expected to raise further on:

- overall present employment w.d. 3,100,000
- added employment due to wood and cork utilization (2 w.d./ha) w.d. 212,000

- employment in the sectors related to wood and cork processing w.d. 200,000

- direct employment involved in tourist activities w.d. 40,000

- induced employment brought about by tourist activities w.d. 20,000

Total w.d. 3,572,000

#### FOREST UNPRICED SERVICES

At present, for lack of felling, the forest "unpriced" services, particularly the ones concerning soil protection and scenic beauty are exalted, while the recreational-touristic service (which is offered only in some forests

in protected areas) turns out to be marginal because of the constraint system currently in force.

Now each forest function will be examined briefly, taking also into consideration the present situation and the potential one, under certain assumptions.

#### Naturalistic function

Except for Eucalyptus forests and a part of Pinewoods (on the whole about 40,000 hectares) which actually do not have any naturalistic interest, this function —with remarkable differences related to the present species, to the morphological characteristics, the altitude of the “station” and its distance from inhabited areas, etc. — could be attributed to 160,000 hectares of sicilian forests. But only 50% out of these ones, that is 80,000 ha, holds a real naturalistic function; on the contrary, in the other woodlands some touristic and agrotouristic activities could be undertaken without bringing about serious impacts on the main environmental components.

#### Landscape function

At present the woodlands which perform an important landscape function are restricted to some small areas in the three regional Parks; on the contrary most of Sicilian woods, even those which could offer this service, are not appreciated from this point of view because of the lack of cultivation treatments due to the strict constraint system.

The opening of 50% of natural woods to an ecocompatible tourism would not produce a remarkable reduction of the landscape function on condition that environmentally-friendly infrastructures are carried out.

#### Recreational-touristic function

At present the recreational-touristic fruition of forests is strongly limited by the hydrogeological and landscape constraints, so that just few “picnic areas” have been fitted till now.

It would be desirable to relax the current constraint system and use the endowment funds provided by agrotouristic legislation in order to set up, also inside the woodlands, free-time facilities; this policy could lead to positive economic and occupational returns without a meaningful prejudice for the environmental protection.

#### Hydrogeological protection function

Most of Sicilian reafforestations only offer this very service, even if in many cases the purpose they were carried out for was quite different (the productive one).

Assuming that potential timber and non-timber productions are utilized, and environmental constraints are relaxed and that in the meantime a half of the natural woods in the protected areas are made available for the touristic and agrotouristic fruition, their function of soil conservation would not suffer significant prejudice, on condition that clear-felling is not carried out on large

adjacent surfaces and that visitors' overcrowding is avoided, especially in the areas more subject to erosion risk.

#### THE MULTICRITERIA DECISION MAKING (MCDM) TECHNIQUES AND THE ADOPTED METHODOLOGY

Multicriteria methods are considered as tools to evaluate the performances of different alternatives according to a certain number of conflicting criteria in problems of decision making.

In the case of forest management, in the last decades forest was considered only as timber-producer and therefore it was seen only from the economic point of view, but the rise of issues, related to environmental protection made the inclusion of many other aspects (hydrogeological protection, recreation, conservation of biodiversity, quality of landscape, etc.) necessary.

But the emergence of multicriteria analysis at the beginning of the seventies was limited by data requirements (usually expressed in quantitative form) that were rather heavy. This problem stimulated the exploration of new paths in the field of the operational research and in the last '70s a second generation of multicriteria evaluation methods came out. These methods required a lower level of data, which could be incomplete, ordinal or qualitative.

In the study, given the nature of the aspects involved in the problem, it would have been difficult to determine quantitative values of the weights directly and therefore a method which deals with weights formulated in qualitative terms has been chosen, that is the Eigenvalue-Prioritization Approach (see Saaty T.L., 1977). The aim of this method is to create cardinal weights on the basis of qualitative statements on the differences in importance for each pair in the set of considered criteria; Saaty proposes a nine-point scale, called “fundamental scale”, to express differences in importance.

These statements have been obtained through interviews in which experts in the different fields have been asked to make pairwise comparisons of the criteria and of the objectives.

“Multi” is the software which has been used, got ready by a team of researchers from the Polytechnic of Turin; by means of a calculus algorithm it provides the elements (weights) of the eigenvector of the pairwise comparisons matrix, which corresponds to the maximum calculated eigenvalue.

In the subsequent phase of the evaluation, where the attractiveness of the alternatives is judged, Regime Analysis is the selected technique because it does not require cardinal information that would not be easily available in this context.

It works on pairwise comparisons between alternatives, which in this case are: the present management of Sicilian forest patrimony (scenario no. 1), the conservation of forest patrimony carried out on one hand by repla-

cing gradually allochthonous and exotic woods with autochthonous ones and on the other hand keeping the current constraint system in the protected areas with some exceptions for the woods which present high historical values (scenario no. 2) and the creation of internal demand of wood and non-wood products (wood and non-wood-processing industries) combined with a relaxation of the environmental constraints in some woods inside protected areas (scenario no. 3).

The substantial aspect that characterizes this method from the others is that it does not consider either the value of the difference or the ratio between the evaluation matrix elements, but only the majority or minority relation which exists between them.

The first step of the analysis consists of the construction of an alternative plans behaviour scale, on which the effects Matrix is based.

From the matrix elements, binary vectors of Regime are identified, whose elements are marked by the "+", "—" and "x" signs according to the majority, minority or equality relations existing between the alternatives compared for each criterion; these elements are then combined in a matrix, the so-called Regime Matrix.

In order to evaluate the attractiveness of an alternative in comparison with the others, the weights come out from the first part of the analysis now are related to the sign originated from each pairwise comparison, making the weighted Regime matrix.

From the summation of the weights of each alternative behaviour (characterized by the "+" or "—" sign) a value is obtained which represents the preferability of an alternative plan compared with the other.

Then a concise index Vai (from the weighted Regime matrix) for each alternative is calculated; from their comparison the final ranking of the alternative management plans is derived.

The results of the application will be discussed briefly in the following section.

#### THE APPLICATION AND THE RESULTS

A sustainable development of mountain forestry areas, without any reduction—for social reasons—of the current employment (which is actually too high in comparison with the real labour requirements of Sicilian woods)—is being considered by this study as the main goal of a new regional policy in the forestry field

The following sub-objectives, resulting from the more urgent issues experienced by the whole community, even though each of them is expressed by a certain group of interest, are linked with the main one in a hierarchical framework:

- 1) Preservation of population in mountain areas;
  - 2) Protection of natural forest patrimony and of biodiversity;
  - 3) Economic valorization of forest resources.
- Ten evaluation criteria, depending upon the sub-objectives,

have been chosen to express the main aspects linked with the planning problem: training level of workers in the forestry sector; Forestry Added Value (FAV), concerning both the raw sorters and the processed products; landscape quality; biodiversity; hydrogeological protection; forestry employment; agrotourism and green tourism employment; use of historical and cultural value of woodlands; agrotourism and green Tourism Added Value (TAV); efficiency of public expenditure in the forestry sector and in the sectors correlated to this one.

In comparisons with the present management of regional forest areas, two hypotheses of management system have been supposed; the interventions concerning these ones and the current situation are briefly described as follows:

A1) The current scenario is characterized, as pointed out before, by the presence of reforestation with allochthonous species without any naturalistic and landscape importance. Only forest works concerning mere maintenance of woods and fire control are carried out, because no wood utilization is in progress. The forestry employment has mainly social purposes and the result is an average labour force per unit of area approximately equal to 18 work-days per hectare, corresponding to the labour requirements of an intensive tree plantation.

In the natural woods a strict constraint system precludes populations' and tourism use and limits as well the opportunity of restoring historical and cultural goods.

A2) This hypothesis contemplates the gradual replacement of allochthonous productive species (Eucalyptus and Pine forests covering about 106,000 ha), according to a detailed pluriennial programme of cuttingwoods with para-natural woods and the maintenance of the present constraint system with the only exception regarding the restoration of buildings of great historical value and their opening to an eco-compatible tourism through bound paths.

Forestry and agrotouristic training is supposed to be carried out in order to achieve these results, without any significant increase in the current level of employment (A1).

A3) This scenario comprises wood use of allochthonous species with a prevalent productive function (106,000 ha), carrying out of first and second wood and cork working industries and total opening to the tourist and agrotourist use in 40,000 ha of natural woods with the restoring of the historical and cultural patrimony.

These interventions will involve the vocational training both for the present workers of the forestry sector and for other workers to be employed in the agrotouristic activities and in the wood-processing industry.

The first step has concerned the estimate of the weights related to the sub-objectives in the context of the main objective; it has been carried out by interviewing ex-

**Table 2a Pairwise comparisons Matrix.**  
**Sub-objective no. 1: Preservation of population in mountain forestry areas.**

Evaluation criteria	Vocational training level of forestry workers	F.A.V.	Quality of landscape	Biodiversity	Hydrogeological protection	Use of historical and cultural value of woodlands	Forestry employment	Tourism employment	T.A.V.	Efficiency of regional expenditure in the sector
Vocational training level of forestry workers	1	1/3	4	5	1	5	1/5	1/3	1/2	1/4
F.A.V.	3	1	5	5	1	3	1/3	3	3	2
Quality of landscape	1/4	1/5	1	1	1/5	1/4	1/6	1/3	1/3	1/5
Biodiversity	1/5	1/5	1	1	1/6	1/3	1/7	1/5	1/5	1/5
Hydrogeological protection	1	1	5	6	1	4	1	3	3	1
Use of historical and cultural value of woodlands	1/5	1/3	4	3	1/4	1	1/5	1/3	1/3	1/5
Forestry employment	5	3	6	7	1	5	1	3	3	3
Tourism employment	3	1/3	3	5	1/3	3	1/3	1	1/3	2
T.A.V.	2	1/3	3	5	1/3	3	1/3	1/3	1	4
Efficiency of regional expenditure in the sector	4	1/2	5	5	1	5	1/3	1/2	1/4	1

**Table 2b Pairwise comparisons Matrix.**  
**Sub-objective no. 2: Environmental protection of natural forest patrimony and preservation of biodiversity.**

Evaluation criteria	Vocational training level of forestry workers	F.A.V.	Quality of landscape	Biodiversity	Hydrogeological protection	Use of historical and cultural value of woodlands	Forestry employment	Tourism employment	T.A.V.	Efficiency of regional expenditure in the sector
Vocational training level of forestry workers	1	5	2	1/4	1/2	3	1	3	3	3
F.A.V.	1/5	1	1/3	1/5	1/4	1/3	1/4	2	3	1/3
Quality of landscape	1/2	3	1	1/3	2	3	1/2	3	3	1/2
Biodiversity	4	5	3	1	4	5	2	4	4	3
Hydrogeological protection	2	4	1/2	1/4	1	3	1/2	3	3	1
Use of historical and cultural value of woodlands	1/3	3	1/3	1/5	1/3	1	1/3	2	4	1/2
Forestry employment	1	4	2	1/3	2	3	1	5	5	1
Tourism employment	1/3	1/2	1/3	1/4	1/3	1/2	1/5	1	1	1/3
T.A.V.	1/3	1/3	1/3	1/4	1/3	1/4	1/5	1	1	1/4
Efficiency of regional expenditure in the sector	1/3	3	2	1/3	1	2	1	3	4	1

**Table 2c Pairwise comparisons Matrix.**  
**Sub-objective no. 3: Economic valorization of forest resources.**

Evaluation criteria	Vocational training level of forestry workers	F.A.V.	Quality of landscape	Biodiversity	Hydrogeological protection	Use of historical and cultural value of woodlands	Forestry employment	Tourism employment	T.A.V.	Efficiency of regional expenditure in the sector
Vocational training level of forestry workers	1	1/3	1/2	3	3	1	1/3	1/2	1/2	1/4
F.A.V.	3	1	2	4	3	4	3	3	4	2
Quality of landscape	2	1/2	1	3	3	2	1/2	2	1	1/3
Biodiversity	1/3	1/4	1/3	1	1/3	1/2	1/3	1/2	1/2	1/5
Hydrogeological protection	1/3	1/3	1/3	3	1	2	1/2	1/2	1/2	1/4
Use of historical and cultural value of woodlands	1	1/4	1/2	2	1/2	1	1/3	2	1/2	1/2
Forestry employment	3	1/3	2	3	2	3	1	3	2	2
Tourism employment	2	1/3	1/2	2	2	1/2	1/3	1	1/3	1/3
T.A.V.	2	1/4	1	2	2	2	1/2	3	1	1
Efficiency of regional expenditure in the sector	4	1/2	3	5	4	2	1/2	3	1	1

pers who have evaluated the relative importance of each sub-objective and, at the end, a ranking of these has been obtained.

Then a group of respondents has been asked to judge the relative importance of the criteria in order to mini-

mize the subjectivity deriving from the arbitrary assignment of weights by decision-makers, by means of pairwise comparisons according to the Fundamental Scale by T.L. Saaty.

This procedure has been followed for every sub-objec-



tive and a generation of cardinal weights has been the result (tables 2a-2b-2c).

As to sub-objective 1 (Preservation of population in mountain areas), the most significant criteria concern, in a decreasing order of importance, Forestry employment (0.2332), hydrogeological protection (0.1525), efficiency of public expenditure (0.1065) and T.A.V. (0.1051).

The consistency of the statements given has been evaluated through the Consistency Ratio<sup>(12)</sup>, which represents a threshold value and its superior limit is equal to 10%; in this case, from the calculations it results to be 8.61% and therefore the validity of the procedure is acceptable.

As for sub-objective 2 (Protection of natural forest patrimony and of biodiversity), the interviewed have considered that the most important evaluation criteria are biodiversity (0.2673), forestry employment (0.1371) and the training level of workers in the sectors (0.1306), which totally reach 0.53. Even in this case the C.R. is far below the critical value of 10%, being equal to 7.95%.

The weights assigned with regard to sub-objective 3 (Economic valorization of forest resources), reported entirely in the Appendix, indicate that the noteworthy aspects are related to Forestry Added Value (0.2290), Forestry employment (0.1546) and efficiency of public expenditure in the sector (0.1533).

Then, with the purpose to obtain a single assignment of weights, the weighted mean has been determined by taking into account the relative importance of each sub-objective with regards to the main objective.

The final weights derived from these calculations are reported in the Appendix and according to them, on average the most considered criteria are Forestry employment (0.1838), Forestry Added Value (0.1294), hydrogeological protection (0.1167) and the efficiency of public expenditure in the sector (0.1142).

With this step the utilization of Saaty approach's ends and the application of Regime Analysis comes into play. A scale of the behaviour of the alternatives, which evaluates the effects of each alternative action on the criteria, has been chosen (see Appendix).

A group of experts of the different fields has studied and analysed the effects brought about by the above-said management plans on the considered criteria; the scores given according the Scale have been summarized in the Effects Matrix (table 3).

The alternatives have been pair-compared for each criterion by considering only majority, equality

or minority relations between them; in the Regime Matrix (table 4) these ones are simbolized by +, = and - signs. From this matrix it emerges that A1, in the pair-wise comparison with A2, does not prevail for any criterion, performs equally for five criteria, while performs worse for the remaining five criteria; in the comparison with A3, A1 performs better for Biodiversity and Hydrogeological protection, equally for the Landscape quality and worse for 7 criteria.

When A2 is compared with A3, it performs better according to Landscape, Biodiversity and Hydrogeological protection, because it includes actions which mainly aim at improving environmental aspects; besides it performs equally as to the use of historical and cultural

**Table 3 Effects Matrix.**

Evaluation criteria	Alternatives		
	A1	A2	A3
Vocational training level of forestry workers	1	3	4
Forestry Added Value	1	1	3
Quality of landscape	3	4	3
Biodiversity	3	4	2
Hydrogeological protection	4	4	3
Use of historical and cultural value of woodlands	1	3	3
Forestry employment	4	4	5
Tourism employment	2	2	3
Tourism Added Value	2	2	4
Efficiency of regional expenditure in the sector	1	3	4

**Table 4 Regime Matrix.**

Pairwise comparisons Evaluation criteria	A1 > A2	A1 > A3	A2 > A1	A2 > A3	A3 > A1	A3 > A2
Vocational training level of forestry workers	-	-	+	-	+	+
F.A.V.	=	-	=	-	+	+
Quality of landscape	-	=	+	+	=	-
Biodiversity	-	+	+	+	-	-
Hydrogeological protection	=	+	=	+	-	-
Use of historical and cultural value of woodlands	-	-	+	=	+	=
Forestry employment	=	-	=	-	+	+
Tourism employment	=	-	=	-	+	+
T.A.V.	=	-	=	-	+	+
Efficiency of regional expenditure in the sector	-	-	+	-	+	+

**Table 5 Weighted Regime Matrix.**

Weights	Pair-wise comparisons Evaluation criteria	A1 > A2	A1 > A3	A2 > A1	A2 > A3	A3 > A1	A3 > A2
0.0912	Vocational training level of forestry workers	-0.0912	-0.912	0.0912	-0.0912	0.0912	0.0912
0.1294	F.A.V.	x	-0.1294	x	-0.1294	0.1294	0.1294
0.0637	Quality of landscape	-0.0637	x	0.0637	0.0637	x	-0.0637
0.1090	Biodiversity	-0.1090	0.1090	0.1090	0.1090	-0.1090	-0.1090
0.1167	Hydrogeological protection	x	0.1167	x	0.1167	-0.1167	-0.1167
0.0484	Use of historical and cultural value of woodlands	-0.0484	-0.0484	0.0484	x	0.0484	x
0.1838	Forestry employment	x	-0.1838	x	-0.1838	0.1838	0.1838
0.0662	Tourism employment	x	-0.0662	x	-0.0662	0.0662	0.0662
0.0774	T.A.V.	x	-0.0774	x	-0.0774	0.0774	0.0774
0.1142	Efficiency of regional expenditure in the sector	-0.1142	-0.1142	0.1142	-0.1142	0.1142	0.1142
1.0000	Overall scores	-0.4265	-0.4849	0.4265	-0.3728	0.4849	0.3728

<sup>(12)</sup> The formula and the calculations are reported in the Appendix



value of woodlands and worse in relation to the other criteria.

At this stage of the analysis it has been necessary to take into consideration the relative importance of the criteria, in order to evaluate correctly the performances of the management systems; therefore the weighted Regime Matrix has been obtained (table 5), where each sign of the Regime Matrix has been linked with the numerical value of the weight correspondent to the criterion analysed. For each pair of alternatives, these values related to every criterion are added in the column; the total value obtained represents the overall behaviour of the first alternative in comparison with the other one.

In order to derive a ranking of the alternatives an Aggregated Index (Vai) has been determined for each alternative by adding the values scored by this one with the other ones and the sum obtained has been divided by the number of them minus one.

From the values of this Index, A3 is the plan which would give the best results, on account of good perfor-

mances according to the socio-economic aspects, without significant worsenings of the environmental criteria; on the contrary, A2 performs very well for naturalistic aspects but it does not improve at all the other criteria; finally A1, the current scenario, is the worst alternative because it does not promote any development for the mountain populations and even from the naturalistic point of view it does not perform well because woods are not managed as they should, even according to naturalistic silviculture.

The ranking obtained by the study, even though it is the result of a quite general analysis of the question, can represent a useful methodological approach to help public decision-makers firstly in the choice and secondly in the implementation of new regional policies in the forestry sector. These may be able either to reduce the current gap or to start a process of socio-economical development in forest areas of the sicilian inland mountain and, more generally, of Italian and European southern areas. ●

### APPENDIX

#### EIGENVALUE - PRIORITIZATION APPROACH (T. L. SAATY, 1977)

##### FUNDAMENTAL SCALE

Values	Definition	Explanation
1	Equally important	Two criteria contribute equally to the objective
3	Weakly more important	Slight prevalence for the first criterion
5	Strongly more important	More apparent prevalence for the first criterion
7	Demonstratedly more important	The prevalence for the first criterion is proved
9	Absolutely more important	The evidence for the first criterion is of the highest order
2, 4, 6, 8	Intermediate values between two subsequent classes of importance	When it is difficult to choose between two classes of values and a compromise is necessary
Reciprocal values	If one of the above-said values is attributed to <i>ij</i> , the opposite comparison <i>ij</i> will have its reciprocal value	

Consistency Index (C.I.):  
C.I. =  $(\lambda - n) / (n - 1)$

where:  $\lambda$  stands for the maximum Eigenvalue *n* stands for the set of criteria (10)  
Consistency Ratio (C.R.):  
C.R. = C.I./Random Consistency

##### RANDOM CONSISTENCY TABLE

Matrix order (number of elements)	1	2	3	4	5	6	7	8	9	10
Random Consistency	0	0	0,58	0,90	1,12	1,24	1,32	1,41	1,43	1,49

In this case, where the matrix elements are 10, the Random Consistency value, according to the above table, is equal to 1.49 and it will be the same in the three cases.

If C.R. is less than 10%, which is considered a threshold value above which it is necessary to reiterate the procedure of prioritization, the results can be considered acceptable.

*sub-objective no. 1* (Preservation of population in mountain forestry areas)

Maximum eigenvalue is equal to 11.154832

C.I. =  $(11.154832 - 10) / (10 - 1)$

C.I. =  $1.154832 / 9 = 0.1283$

C.R. = C.I./1.49

C.R. =  $0.1283 / 1.49 = 0.0861$

if this value is expressed by a percentage, it will be:

C.R. = 8.61%.

Given that C.R. is less than 10%, the obtained result can be considered acceptable.

*sub-objective no. 2* (Protection of natural forest patrimony and of biodiversity)

The maximum eigenvalue is here equal to 11.066132.

C.I. =  $(11.066132 - 10) / (10 - 1)$

C.I. =  $1.066132 / 9$ ; C.I. = 0.1184

C.R. = C.I./1.49

C.R. =  $0.1184 / 1.49 = 0.0795$

if this value is expressed by a percentage, it will be:

C.R. = 7.95%.

*sub-objective no. 3* (Economic valorization of forest resources) The maximum eigenvalue is here equal to 10.829534.

C.I. =  $(10.829534 - 10) / (10 - 1)$

C.I. =  $0.829534 / 9 = 0.09217$

C.R. = C.I./1.49

C.R. =  $0.09217 / 1.49 = 0.0619$

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if this value is expressed by a percentage, it will be: C.R. = 6.19%.

Weights assignment to the criteria for the three sub-objectives			
Evaluation criteria	Sub-objective 1	Sub-objective 2	Sub-objective 3
Training level of workers	0.0734	0.1306	0.0623
Forestry Added Value	0.1560	0.0383	0.2290
Quality of landscape	0.0232	0.0963	0.0978
Biodiversity	0.0198	0.2673	0.0325
Hydrogeological protection	0.1525	0.1061	0.0545
Use historical value	0.0385	0.0563	0.0568
Forestry employment	0.2332	0.1371	0.1546
Tourism employment	0.0918	0.0370	0.0598
Tourism Added Value	0.1051	0.0293	0.0994
Efficiency of public expenditure in the sector	0.1065	0.1017	0.1533
<b>Total</b>	<b>1.0000</b>	<b>1.0000</b>	<b>1.0000</b>

The final assignment of the weights is the following:	
Evaluation criteria	Weights
Training level of workers	0.0912
Forestry Added Value	0.1294
Quality of landscape	0.0637
Biodiversity	0.1090
Hydrogeological protection	0.1167
Use historical value	0.0484
Forestry employment	0.1838
Tourism employment	0.0662
Tourism Added Value	0.0774
Efficiency of public expenditure in the sector	0.1142
<b>Total</b>	<b>1.0000</b>

## REGIME ANALYSIS

(E. HINLOOPEN. P. NIJKAMP. P. RIETVELD. 1983)

## SCALE OF THE BEHAVIOUR OF THE ALTERNATIVES

5 Very Good

4 Good

3 Sufficient

2 Bad

1 Very bad

Aggregated Index  $V_{ai}$

$V_{ai} = \text{Total score from pair-wise comparisons}$   
(n-1)

where:

n stands for number of alternatives (3)

$V_{a1} : \frac{-0.4265 - 0.4849}{(3-1)} = \frac{-0.9114}{2} = -0.4557$

$V_{a2} : \frac{+0.4265 - 0.3728}{(3-1)} = \frac{+0.0537}{2} = +0.0269$

$V_{a3} : \frac{+0.4849 + 0.3728}{(3-1)} = \frac{+0.8577}{2} = +0.4288$

From the value of the Aggregated Index  $V_{ai}$  it emerges that  $A_3$  ranks far better than  $A_2$  and  $A_1$ .