AESTIMUM 62, Giugno 2013: 67-88

Alessandro Petrontino
Vincenzo Fucilli

Dipartimento di Scienze Agro-Ambientali e Territoriali, Università degli Studi di Bari Aldo Moro

E-mail: *ale.petrontino@gmail.com*
vincenzo.fucilli@uniba.it

High Nature Value Forests identification: A case study in Apulia region – Italy

The strengthening of environmental compliance and the introduction of new challenges in rural development policy have led to a wide shift of resources toward specific objectives, concerning the conservation of particular areas identified as High Nature Value Farmlands/Forests (HNVF). These areas represent important elements of rural strategies due to their ability to allow both biodiversity and economic development. The aim of the research is to create an analysis frame, with Multi Criteria Analysis method and GIS elaboration, in order to identify forests that meet the HNV concept. The analysis examines also several aspects related to the multifunctional role of forests and the effect that different contextual factors might have on it. The research provide a support in terms of implementation and resource distribution of the Rural Development Programme in a field where the main efforts have been yet spent on agriculture, leaving forestry behind.

Keywords: *High Nature Value Forests, Multi Criteria Analysis, GIS*

Parole chiave: *Aree Forestali ad Alto Valore Naturalistico, Analisi Multicriteria, GIS*

1. Introduction

The involvement of European forests in the broad theme of rural development raises many technical and legal issues on their role in social, environmental and economic impacts. While often national legislation of several states has firmly remained anchored to the exclusive production of material goods (food and wood products), EU legislation has focused on the issue of production of environmental services, resulting from forestry activity. The attention given to the overall forestry sector is nonetheless confirmed by financial data on forestry issues in RDPs. The forestry schemes, indeed, play a significant role in the complex of measures implemented by each region. They enclose new significant objectives related to environmental services fostered by forest management and forest surface increase.

The strengthening of compliance and the introduction of these new challenges, pursued through the EU rural development policy, led to the allocation of significant resources. The nature of the challenges and the important budget provision, have in the rural development programming 2007-2013 a key role for the fulfilment of environmental policies, in particular as biodiversity rises. High Nature Value Farmlands/Forests are believed to be able to maintain both economic viability and biodiversity preservation. This is the main reason that makes these areas a strategic element for RDP objectives. Thus, forests have been designated as suitable areas in which to promote preferential schemes and where to foster a significant resource provision (EEA Report No. 1, 2004).

In addition to financial support, the regulatory framework has introduced a monitoring and evaluation system that also covers HNV areas. By using a set of specific indicators, the Common Monitoring and Evaluation Framework (CMEF) provides a unified system to outline trends and influences on HNV systems: Baseline Indicator n. 18 (surface classified as HNV), Result Indicator n. 6 (surface managed in a sustainable way due to RDP schemes intervention), Impact Indicator n. 5 (percentage variation of HNV surface). The contribution of CMEF represents only a rough guide for the evaluators. Identification of HNV Forests represents a big debate issue due to the extreme variability of habitat and forest categories in EU. It does not allow to give a unified procedure as well as to use a unique set of data for each region/nation. This difficulty is also exacerbated by the scarce data available, such as regional forest inventories, detailed cartographic information and data on species distribution. The Institute for European Environmental Policy (IEEP, 2006) gave a first hint, based on CMEF indicators, to help management authority in classifying HNV Forests. Italian National Rural Network tried to quantify for each Italian region the extent of HNV Forests, employing IEEP criterion and the indicators from Ministerial Conference on the Protection of Forests in Europe (MCPFE). This was a first attempt to collect an important set of criterion, including: forests in protected areas, presence of natural constraint, forest structure and management status.

In relation to the occurrence of these recent policy transformations, also affecting the future regional planning cycle (2014-2020), the research try to meet the needs of the programming process for the RDP schemes, rearranging the methodology of identification in such a way that takes into account economic, social and environmental domains. The primary aim is to develop an analysis frame in order to identify and characterize forest areas that meet the concept of High Nature Value. This will contribute to provide scientific support to assist local development planning and programming in a field where the main efforts were spent on agriculture, leaving behind the forestry aspects so far. The analysis system examines the various aspects related to the multifunctional role of forests and the effect that different contextual factors might have on it, considered in terms of "threat" and "socio-economic" settings.

Forest areas in Apulia Region face an unusual dimension in comparison to other Italian regions, due to a low density, low productive perspectives and a considerable overlap with less favoured areas. The main objective of the research is to correctly identify HNV Forests in Apulia Region – Italy[1].

The interaction of the attributes deriving from territory, structural characteristics and management domain of the forests suggest to refer to a specific method, MCA, for the identification of HNV Forests. The application of multicriteria analysis and geographic information systems supported by socio-economic and environmental indicators is highly used in literature, also accompanied by the involvement of expert knowledge (Richard *et al*. 1998; Naesse, 1997; Bateman 2002; Strag-

[1] Where an estimation of the National Rural Network led to quantify the HNV forest as the higher percentage (35%) in comparison to other Italian regions, even though Apulia has a pretty low forest area index (7%).

er and Rosenberger 2006; Oliveira *et al.*, 2008;). The relevance of correct identifications of indicators has been widely discussed, also in the detection and monitoring of sustainable forest management. (Adamowicz 2003; Brang *et al*. 2002; Gough *et al*. 2008; Hall 2001; Mrosek *et al*. 2006).

As suggested by Malczewski (2004), MCA requires the application of the principle of suitability. Land-use suitability based on GIS has been applied in several studies, especially in ecological approaches to determine suitability of habitat for plant and animal species (Pereira and Duckstein 1993; Store and Kangas 2001), as well in assessing the environmental impact of land use transformation (Moreno and Seigel 1988) and in the wide scale planning (Phua M-how, Minowa 2005). The predictive power of MCA, supported by GIS, can also be valuable in investigating particular aspects of a studied area or to assess specific land uses, highlighting the environmental, economic or social basis of the analysed object, relying on the interchange relation of different attributes, criteria or indicators that clearly define the phenomenon. Therefore MCA based on GIS is an appropriate method to correctly identify HNV Forests in specific contexts.

A priority aspect of the multicriteria analysis is to assign an appropriate weight to the attributes involved in the analysis. The weighted linear combination (WLC) is one of the most commonly used techniques in MCA based on GIS, especially in decision making procedures. The method is often used in the analysis of choice/selection of suitable sites and for problems of allocation and evaluation of resources (Hobbs 1980; Han and Kim 1988). Indeed, the reason of the popularity of this method lies in the even combination of "algebraic" operations and cartographic models, associated with an extreme intuitiveness and accessibility of results.

Finally, about expert knowledge, there is a wide use in literature of questionnaires submitted to study groups, asked to provide insights and judgements. The expert subjectivity appears mostly in the weighting phase of the analysis. In order to channel this subjectivity in a more formal way it is recommended to apply the pairwise comparison (Strager and Rosenberger 2006; Store and Kangas 2001). The calculation of final index of land suitability, obtained by adding values of each attributes multiplied by the respective weights, can be found in literature that assess the ecological value of forests (Leskinen *et al*. 2003).

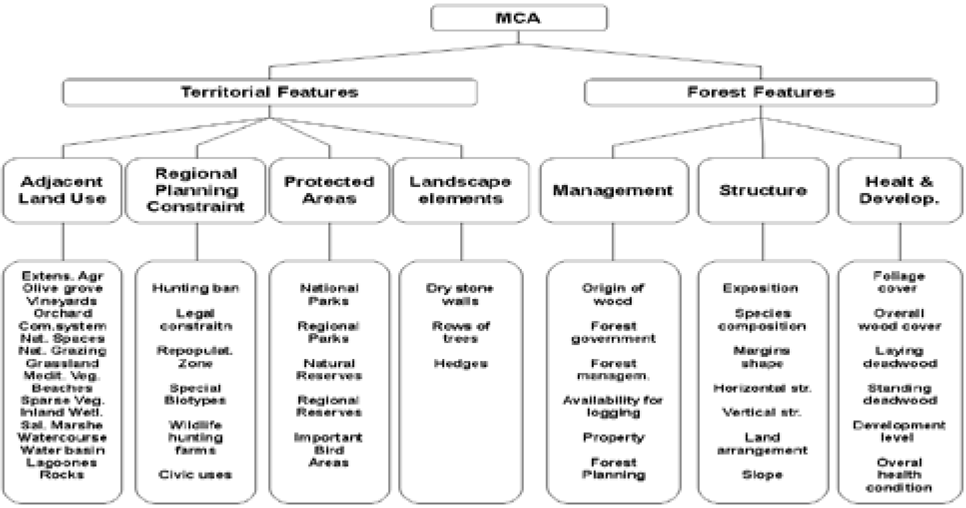
As stated before the main aim of the research is to correctly identify HNV Forests in Apulia. But a correct multidimensional identification requires also a characterization of the HNV Forests (in terms of socio-economic context evaluation and threat level assessment). In fact, also a characterization model is proposed, with the aim to investigate the sustainability and resilience of HNV Forests in Apulia.

2. Methods

2.1 HNV identification

The identification of HNV Forest areas in Apulia follows the approach set by National Rural Network, but it is a specific research based on MCA, GIS and an expert knowledge integration. The research takes into account the reproducibility of the methodology in order to represent a benchmark case study for other regional and national contexts, although different conditions and different available data might change the structure of the analysis. As expressed in IEEP report, the main issues to be represented in the HNV Forests identification process should be related to both territorial features (i.e. natural constraint, protected areas, land use margins, landscape elements and forest structure) and management features (i.e. texture, horizontal and vertical structure, species distribution, forest management, deadwood, average age and age distribution). Therefore a classification is needed, in order to create an analysis frame where to allocate each feature. Thus, a tree structure has been built, using Classes and Sub-classes (Fig. 1). Starting from the upper classification level, the first includes two Classes: territory and forest features. The territory has four Sub-classes: adjacent land use, territorial constraints deriving from regional plans, landscape elements and protected areas. Forest features Class includes: management features, structure features, health and development features.

Figure 1. Features classification.



Each Class and Sub-class contribute in a different way to the naturalness of the forest, affecting the environmental services provision, in particular for the biodiversity support. The main challenges of the methodology can be summarized, indeed, in the selection of the features allocated in each Sub-classes and in the weighting of the Classes and Sub-classes of the analysis frame. Experts in forestry have been chosen from various domains (academic and research institutions, regional services, environmental associations) and have been involved in the survey in order to select features and to assess the extent to which each feature can affect positively the natural level of the Apulia forests. Two questionnaires, submitted to each expert through an online form, was structured according to the feature classification. The former requires a feature selection and, only for territorial features, a buffer zone statement (distance at which the positive effect of the feature occurs). The latter instead is built according to the pairwise comparison method in which Classes and Sub-classes are considered in couple (belonging to the same level of the analysis). The responder is required to assign a pair of values according to the following table (Tab. 1) where a range of 1-1 up to 1-9 or 9-1 for each couple must be chosen.

Table 1. Pairwise comparison values.

Value	Explanation
1	Equally important
2	(intermediate)
3	Weak importance
4	(intermediate)
5	Strong importance
6	(intermediate)
7	Very strong importance
8	(intermediate)
9	Absolute importance

Values are then elaborated to obtain a weight ranging from 0 to 1. Sub-classes are recalculated in proportion to the weight of the belonging Class. The resulting features and weight are then implemented in a GIS, based on the Land Use map of Apulia Region. An index is calculated for each Sub-classes. Adjacent Land Use, Protected Area and Regional Planning produce indexes determined by the presence or absence (or proximity) of the features on the forest polygon. Thus the value of the indexes are determined exclusively by the respective weight of the Sub-classes. Landscape element index, instead, is strictly influenced by the density of features on forest polygons. In this case the index is calculated multiplying the weight by the landscape element density (e.g. meters of stone walls per hectare). The indexes of Management, Structure, Health and Development Sub-classes have to take into account the different forest categories listed in the National Forest Inventory (NFI), since it is based on a regional scale. Due to the different forest classification of NFI and Corine Land Cover (CLC) level IV (used as a base map to identify HNV Forests), an adaptation is needed to match the forest categories of the two sources (Tab. 2).

Table 2. Adaptation of the forest categories classification.

National Forest Inventory	CLC level IV
Black pine forests	3.1.2.2 Mountain pines forests
Mediterranean pines forests	3.1.2.1 Mediterranean pines forests
Beech forests	3.1.1.5 Forests dominated by beechs
Rovere, downy oak, common oak Turkey oak, Cerro, farnetto oak, fragno oak	3.1.1.2 Forests dominated by deciduous oak forests
Ash and hornbeam forests	3.1.1.3 Mesophytic broadleaf forests
hygrophilous woods	3.1.1.6 Forests dominated by hygrophilous species
Holm oak forests Cork oak forests Other Evergreen broadleaf forests	3.1.1.1 Holm oak and cork oak forests
Arboriculture	2.4.4 Agroforestry areas
Undergrowth	3.2.3.1 high bush
low woods	3.2.4. Areas of evolving woody and shrub vegetation
Shrubs	3.2.3.2. Low bush and garrigue

Each category of the inventory can be represented by a value determined by the frequency of positive feature occurrence, observed in relation to the total hectares amount of the same category. The indexes of the forest Sub-classes hence are obtained multiplying their weight by the respective frequency value. At the end, forests are represented by polygons characterized by an overall Natural Value Index (V) in which the score obtained by each polygon results from the application of the following formula, deriving from the rearrangement of the methodology used by Leskinen *et al.* (2003) :

$$V = LUw + RPw + PAw + (LEd \times LEw) + (MAf \times MAw) + (STf \times STw) + (HDf \times Hdw) \quad (1)$$

where V is the Natural Value Index; LUw is the weight of Land Use, RPw is the Regional Planning weight; PAw is the Protected Area weight; LEd and LEw are respectively density and weight of Landscape Elements; MAf and MAw represent frequency and weight of Management features; STf and STw represent frequency and weight of Structure features; HDf and HDw are frequency and weight of Health and Development features.

Natural Value Index is then standardized in order to obtain a new classification characterized by a minimum value of 0% and a maximum value of 100%. This allow to classify the forest polygons in 5 equal categories (20% wide). A cautionary 60% threshold is set up, in order to select only polygons with the highest Natural Value Index. Such a classification allows to identify the higher concentration "hot points" for HNV Forests in the regional context as well as to detect the contribution of each forest category to the overall HNV area extent.

2.2 Context assessment of HNV Forests

The characterization for identifying perspectives and evolutions of HNV Forests in Apulia Region follow two main directions: socio-economic context evaluation and threat level assessment. The former seeks to classify the region areas on the basis of a multitude of factors linked with forest utilization and related products, social role of forests and their alternative use. The latter lead to a territory classification mainly on the basis of natural, territorial and anthropic threats.

Two aggregated indexes (SE and TH) have been calculated, according to the average of the performance of each factors on a municipal scale (Tab. 3).

Table 3. Context aggregated indexes.

Analysis	Index	Factors
Socio-economic	SE	Percentage of woods in agricultural enterprises
		Density of working age population
		Development classification (RDP)
		Presence of forestry companies
		Presence of paper and wood companies
		Presence of farmhouses with naturalistic and forest tours licenses
Threat	TH	Forest fire classification
		Urbanization level
		Depopulation level
		Desertification vulnerability
		Percentage of land use with an adverse effect on forests

Due to the heterogeneous values deriving from the single factors calculation, results have been processed with a standardization procedure on the basis of regional scale performances. This enabled to obtain two homogeneous set of values able to be summarized in the respective SE and TH indexes through average calculation. In order to produce a distinction between records with a positive or a negative performance of the indexes, a threshold value has been set. The threshold matches the average values of the performances for the two indexes. A map of each index has been produced.

Single Municipalities have been classified basically by differentiating the overall extent of both indexes:

- "optimum" municipalities (those recording a good performance for both indexes);

- municipalities whit bad performances for both indexes;
- municipalities whit bad performances for a single index (SE or TH).

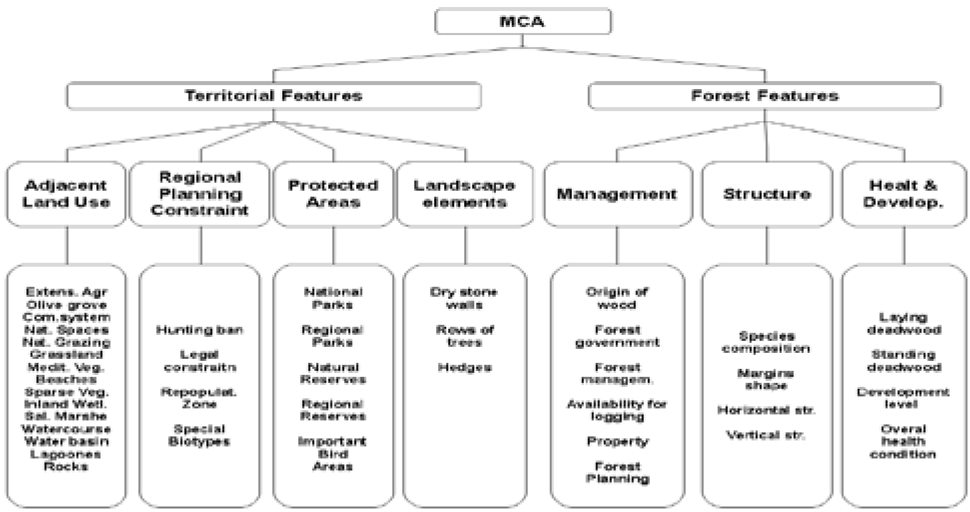
Apulia forest areas and HNV Forests can be characterized overlapping the maps deriving from the two consecutive analysis in a GIS. This allow to identify forests areas to be assisted and its main needs to be supported in a RDP frame implementation.

3. Results

3.1 HNV identification

The questionnaires responses of each expert have been elaborated separately and then aggregated in a single result data set. The first questionnaire lead to select a set of features for each Sub-Class, as reported in the following diagram (Fig. 2). Furthermore, the questionnaire allowed at the same time to select a buffer zone of positive effect for each selected feature (Tab. 4).

Figure 2. Selected features.



The second questionnaire assigned a weight for both Classes and Sub-Classes. Sub-Classes weights resulted in the following distribution: 20.3 for Adjacent Land Use, 18.5 for Regional Planning constraints, 41.1 for Protected Areas, 20.1 for Landscapes elements, 27.8 for the forest Management, 32.9 for the forest Structure and 39.3 for forest Health and development status.

Table 4. Buffer zone selection.

ADJACENT LAND USE	Buffer zone (m)
Extensive Agric.	800,00
Permanent coltures	800,00
Complex systems	1,000.00
Natural spaces	1,300.00
Natural grazing	1,500.00
Grassland	1,200.00
Mediterranean veg.	1,500.00
Beaches and dunes	1,100.00
Sparse veg.	1,000.00
Inland wetlands	1,400.00
Salty marshes	1,400.00
Watercourses	1,000.00
Water basins	1,100.00
Lagoones	1,100.00
Rocks	1,100.00

REG. PLAN. CONSTRAINT	Buffer zone (m)
Hunting ban	2,000.00
Legal constraints	1,800.00
Repopulation zone	1,700.00
Special Biotypes	1,400.00
PROTECTED AREAS	
National park	2,300.00
Regional reserves	2,200.00
Nat. Reserves	2,200.00
Regional parks	2,100.00
IBA	2,000.00
LANDSCAPE ELEMENTS	
Dry stone walls	300.00
Rows of trees	300.00
Hedges	300.00

Looking at the upper level of the tree structure, Classes achieved the following weight: 29 for Territory features and 71 for Forest features Class. The Classes weights proportion produced a reallocation of the former Sub-Classes weight that therefore had to be recalculate. The following diagram (Fig. 3). reports the weight distribution of each Sub-Classes.

The analysis proceeded with the indexes calculation in the GIS. Landscape elements, deriving from the Technical Regional Map of Apulia (SIT Puglia), have been overlaid to the forest map in order to assign to each forest polygon the index value calculated on the basis of elements density, according to the buffer zone of positive effect (Fig. 4).

Indexes of the three Forest features Sub-Classes (i.e. Management, Structure, Health and Development) derive from the elaboration of the data available on the NFI. Each CLC forest category have been assigned a specific index in relation to the frequency of positive features occurrence in the corresponding NFI category (Tab. 5)

The score of Natural Value Index, obtained for each forest polygon by the application of (1), has been standardized. Forests are then classified according to the standardized value, as resulting from the following map (Fig. 5). Moreover, in order to identify the HNV Forests, only forests belonging to the two highest classes (60-80%; 80-100%) have been considered (Fig. 6).

Figure 3. Weight distribution of the Sub-classes.

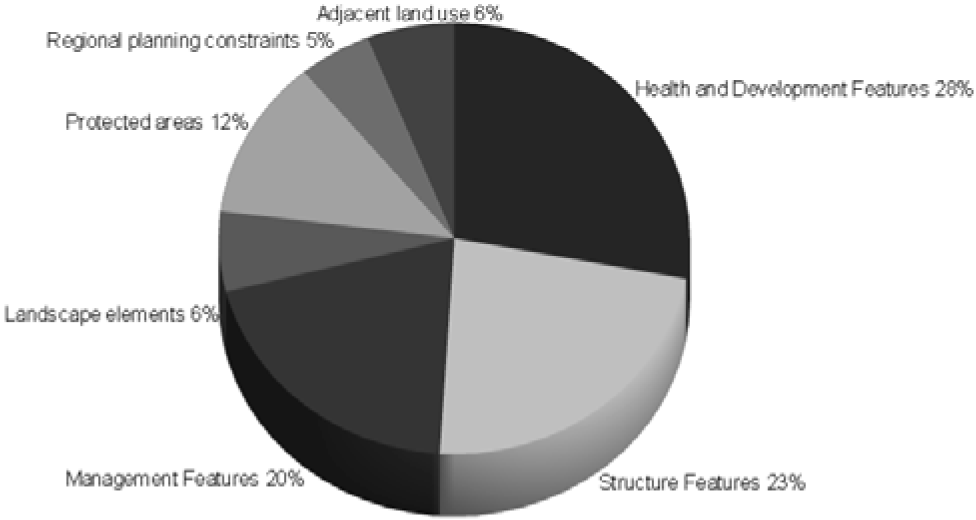


Figure 4. Landscape element distribution within the selected buffer zone.

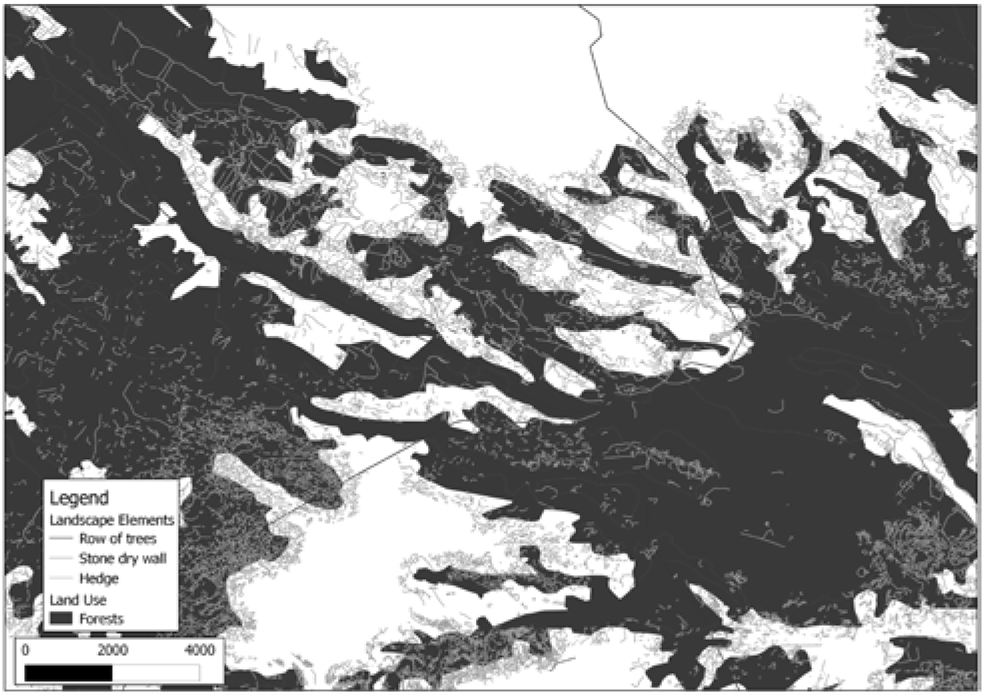


Table 5. Forest Sub-classes index calculation.

clc class and name	clc class	Origin of wood	Forest Government	Forest Management	Availability for logg.	Property	Forest Planning	Management Index
Pure forests	*Mixed forests*							
3.1.2.2 Mountain pines forests	3.1.3.2.2	0,00	100,00	25,00	0,00	70,59	94,12	48,29
3.1.2.1Mediterranean pines forests	3.1.3.2.1	33,33	100,00	38,69	2,68	47,62	100,00	53,72
3.1.1.5 Forests dominated by beechs	3.1.3.1.5	91,67	91,67	100,00	0,00	96,73	100,00	80,01
3.1.1.2 Deciduous oak forests (durmast, downy, common)	3.1.3.1.2	16,27	11,84	41,27	1,48	15,44	86,84	28,86
3.1.1.2 Deciduous oak forests (turkey, farnetto, fragno)	3.1.3.1.2	23,96	22,92	45,83	1,04	35,55	92,71	37,00
3.1.1.3 Mesophytic broadleaf forests	3.1.3.1.3	30,77	30,77	61,54	0,00	58,22	100,00	46,88
3.1.1.6 Forests dominated by hygrophilous species	3.1.3.1.6	100,00	100,00	100,00	1,00	53,12	100,00	75,69
3.1.1.1 Holm oak and cork oak forests	3.1.3.1.1	25,58	16,28	53,49	2,33	52,58	88,37	39,77
Other woodlands								
2.4.4 Agroforestry areas		0,00	0,00	0,00	0,00	0,00	55,71	9,29
3.2.3.1 high bush		50,00	100,00	100,00	50,00	12,50	100,00	68,75
3.2.4. Areas of evolving woody and shrub vegetation		66,67	100,00	100,00	22,22	22,22	88,89	66,67
3.2.3.2. Low bush and garrigue		88,89	100,00	100,00	32,58	9,55	87,32	69,72

clc class and name	clc class	Species composition	Species composition	Margins shape	Horizontal str.	Vertical str.	Structure index	Structure index
Pure forests	*Mixed forests*	*pure forest*	*mixed forest*				*pure forest*	*mixed forest*
3.1.2.2 Mountain pines forests	3.1.3.2.2	50,00	100,00	0,00	25,00	25,00	25,00	37,50
3.1.2.1Mediterranean pines forests	3.1.3.2.1	25,30	100,00	12,05	45,25	55,96	34,64	53,32
3.1.1.5 Forests dominated by beechs	3.1.3.1.5	0,00	100,00	0,00	100,00	100,00	50,00	75,00
3.1.1.2 Deciduous oak forests (durmast, downy, common)	3.1.3.1.2	0,00	100,00	19,08	52,81	91,27	40,79	65,79
3.1.1.2 Deciduous oak forests (turkey, farnetto, fragno)	3.1.3.1.2	1,04	100,00	7,29	53,13	84,37	36,46	61,20
3.1.1.3 Mesophytic broadleaf forests	3.1.3.1.3	7,69	100,00	15,38	84,62	92,31	50,00	73,08
3.1.1.6 Forests dominated by hygrophilous species	3.1.3.1.6	0,00	100,00	0,00	100,00	100,00	50,00	75,00
3.1.1.1 Holm oak and cork oak forests	3.1.3.1.1	6,98	100,00	11,63	86,05	97,67	50,58	73,84
Other woodlands								
2.4.4 Agroforestry areas		55,71	/	0,00	0,00	0,00	18,57	
3.2.3.1 high bush		25,00	/	12,50	100,00	100,00	45,83	
3.2.4. Areas of evolving woody and shrub vegetation		11,11	/	33,33	100,00	88,89	48,15	
3.2.3.2. Low bush and garrigue		10,57	/	23,80	100,00	100,00	44,79	

clc class and name	clc class	Laying deadwood	Standing deadwood	Develop. Level	Health condition	Health and Development Index
Pure forests	*Mixed forests*					
3.1.2.2 Mountain pines forests	3.1.3.2.2	4,69	13,14	25,00	28,57	17,85
3.1.2.1Mediterranean pines forests	3.1.3.2.1	34,89	2,96	19,94	57,43	28,81
3.1.1.5 Forests dominated by beechs	3.1.3.1.5	66,67	23,54	8,33	33,33	32,97
3.1.1.2 Deciduous oak forests (durmast, downy, common)	3.1.3.1.2	11,25	7,00	52,96	73,67	36,22
3.1.1.2 Deciduous oak forests (turkey, farnetto, fragno)	3.1.3.1.2	1,89	6,28	47,92	57,29	28,35
3.1.1.3 Mesophytic broadleaf forests	3.1.3.1.3	21,96	7,40	53,85	15,38	24,65
3.1.1.6 Forests dominated by hygrophilous species	3.1.3.1.6	0,00	0,00	100,00	100,00	50,00
3.1.1.1 Holm oak and cork oak forests	3.1.3.1.1	14,59	0,89	67,44	39,53	30,61
Other woodlands						
2.4.4 Agroforestry areas		61,87	30,64	n.d.	44,29	45,60
3.2.3.1 high bush		n.d.	n.d.	n.d.	50,00	50,00
3.2.4. Areas of evolving woody and shrub vegetation		n.d.	n.d.	n.d.	33,33	33,33
3.2.3.2. Low bush and garrigue		n.d.	n.d.	n.d.	69,86	69,86

Figure 5. Natural value index distribution.

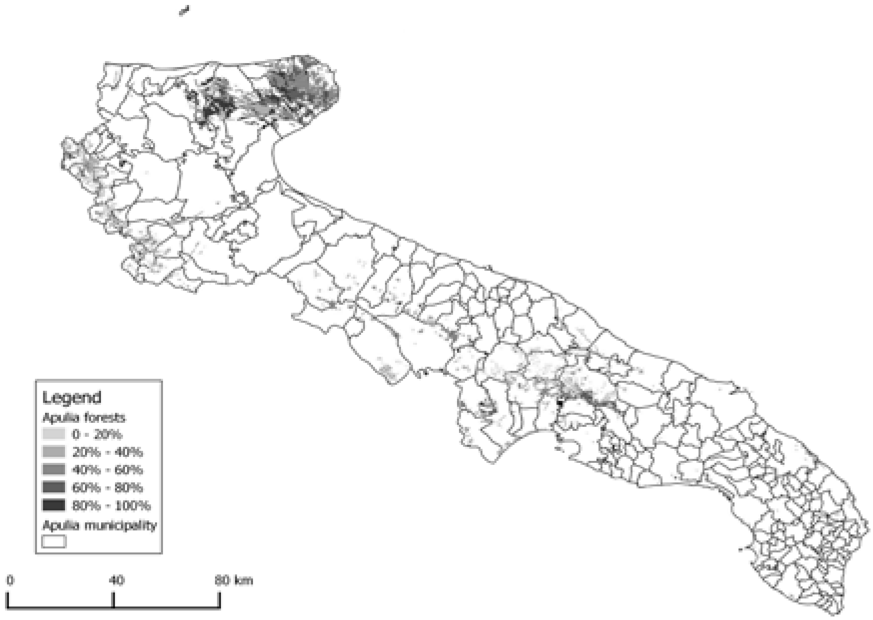
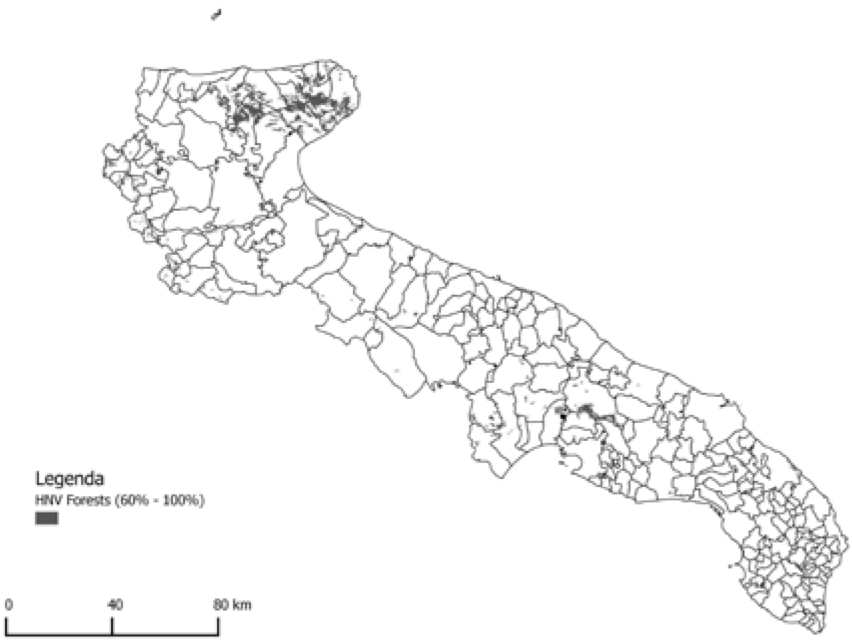


Figure 6. Identified HNV Forests.



Apulia HNV Forest surface is about 34% of the total forest amount, with 52,000 hectares. In the GIS, 321 out of 1159 forest polygons analysed resulted to have a V score higher than 60%. The average surface of the HNV polygons is 18% greater than normal forest polygons. The areas of evolving woody and shrub vegetation (3.2.4) widely contributed to the total amount of HNV Forests, with about 63%. Mixed forests of Holm oak and Cork oak (3.1.3.1.1) cover 12.5% of HNV, High bush (3.2.3.1) covers about 11.8%, while Beech forests (3.1.1.5) 10.2%. The CLC 3.2.4 is the category with the highest Natural Value Index since more than 96% of its surface has been classified as HNV, as well as the Forests dominated by hygrophilous species (3.1.1.6) in which there is a high incidence of HNV. The analysis lead to exclude some specific categories, such as Agroforestry areas (2.4.4) Mediterranean pines (3.1.2.1), deciduous oak forests (3.1.1.2) and Mesophytic broadleaf forests (3.1.1.3), due to the anthropic origin and to a production oriented management to the detriment of the environmental services oriented management.

3.2 Context analysis

The analysis of each socio-economic index returned a specific data capable to synthesize the strengths and weaknesses of the Apulia region, showing the distribution of municipalities in relation to their degree of socio-economic level according to the forest sector. The chart below shows the municipalities of Apulia classified by a socio-economic classes width of 10% and forest areas divided by natural level, as obtainable from the previous analysis (Fig. 7)

The analysis was also carried out to outline a framework for the study of the deterioration causes and to assume possible scenarios of the forest land of Apulia on the basis of mutual relation of forests with specific threat factors (Fig. 8).

By a first assessment it can be stated that the majority of the Apulia municipalities resides in the first 4 classes, characterized by a low level of socio-economic development. This is accompanied by a greater degree of forest cover right in the first three classes (about 60% of total forest amount). On the other hand the threat map illustrates that most of the Apulia forests belong to areas in which there is a low threat index while about 8% of them can be considered under severe threat.

The threshold value for both indexes have been chosen on the basis of the average performance reached in each index by the municipalities. The joint combination of different socio-economic and threat conditions allows to outline four group of municipalities (Fig. 9):

- "optimum" municipalities: high socio-economic index and low threat index values.
- municipalities with high threat vulnerability (and high socio-economic index value).
- municipalities with socio-economic weaknesses (and low threat index value).
- disadvantaged municipalities: socio-economic weakness and high threat vulnerability.

Figure 7. Socio-economic index classification.

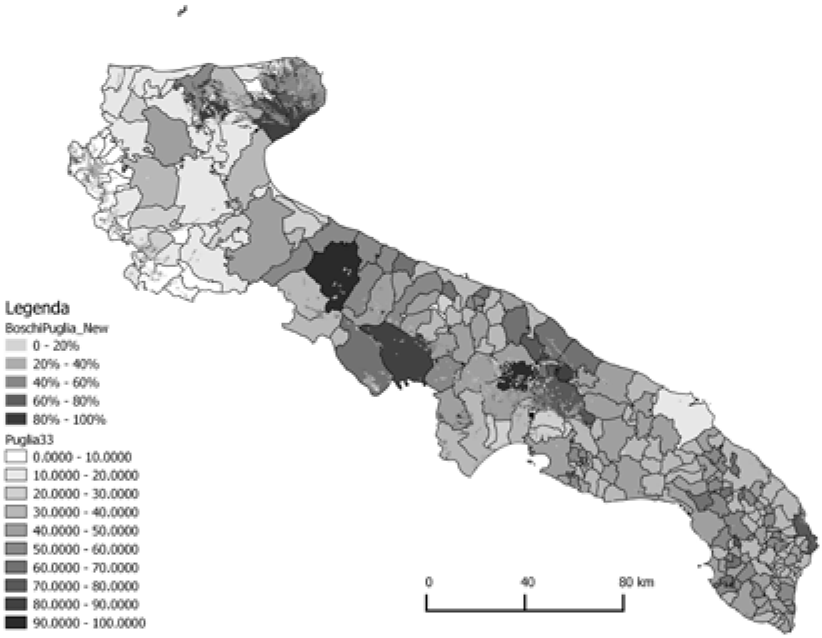


Figure 8. Threat index classification.

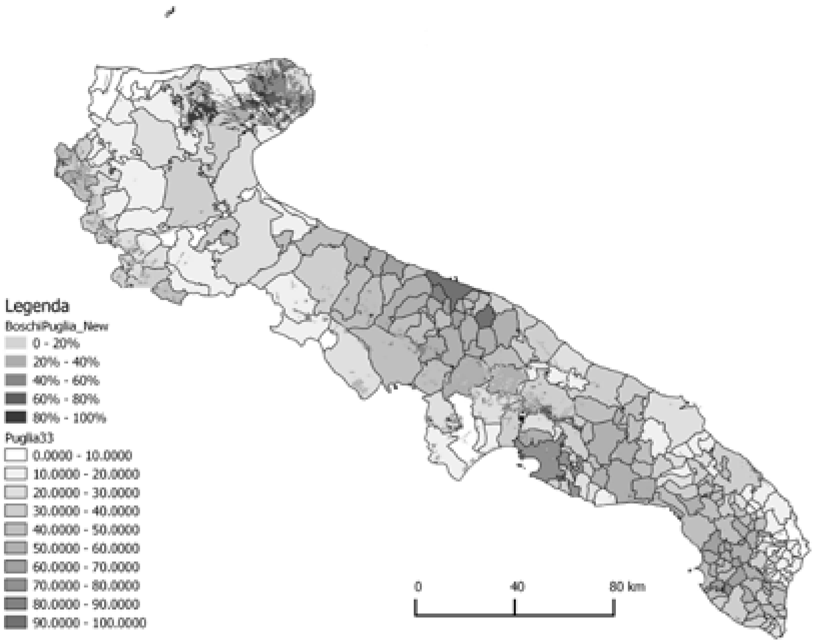
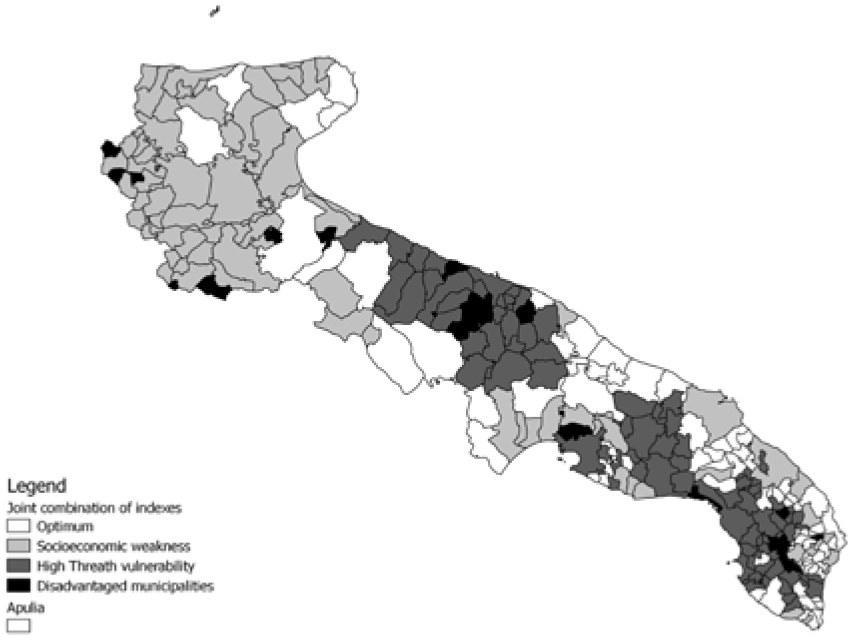


Figure 9. cross-classification of the two indexes.



A large part of the Apulia HNV Forests are included in positive context conditions (36%) corresponding to the 76 *Optimum* municipalities. Therefore these forests can easily emancipate in terms of multifunctionality, away from negative aspects of context condition. Approximately the same number of municipalities belongs to the second and the third group (i.e. respectively 83 and 79), even though HVF Forest areas are mainly included in municipalities with low socio-economic shortage (51%) in comparison with those threatened (2%). Municipalities that instead showed poor performance for both aggregate indices are 20, with a total HNV Forest area of 2.7%.

4. Discussion

The data achieved allow to state that 34% of the Apulia forests can be classified as HNV. The amount diverges strongly from the national average where the HNV share is about 25% (Trisorio *et al.* 2009). This is a positive result but in absolute terms, the HNV Forest covers in Apulia only 52,000 ha in comparison with the national average that is 107,500 ha per region (INEA 2009). The reason of such a disparity rely on the regional forest coverage of Apulia which is one of the lowest in Italy.

The great part of HNV Forests are enclosed in the North area of the region where at the same time it can be recorded the highest rate of forest coverage. An-other core area for HNV is the hilly central part of the region at the border of the provinces of Bari and Taranto. A particular concentration of adjacent favourable land uses and landscape elements, such as stone dry walls and hedges can be observed in this area. An increase in the average surface of the forest polygons classified as HNV compared to *non*-HNV forests confirms the theory, expressed in many studies, that shows the surface extent as a quality factor to be taken into account in the assessment of habitat fragmentation. Some of the forest categories that largely contribute to the HNV surface, such as Beech forests, Holm oak and Cork oak forests, hygrophilous forests and Mediterranean vegetation play an important naturalistic role in the Apulia context. They are often enclosed in protected areas and constitute green corridors and not-economically utilized woods, where environmental and recreational functions are the only services provided. Furthermore, the MCA excludes coniferous forests that in the region result from quite recent afforestation plans, that, in fact, have mostly a mono-specific texture, regular layout, geometric plant distribution and even age and diameter classes. It confirms the criteria proposed by IEEP (2006) which indeed suggests to exclude anthropic systems from the HNV identification. Mesophytic broadleaf forests and Agroforestry areas are then excluded mainly due to their productive attitude. This reflects in a low value for Management and Structure attributes due to a high anthropic intervention.

The context analysis provided a benchmark datum to focus on further assessments in order to evaluate the positive aspect of the regional territory as well as to highlight threats for the forest preservation[2].

The aim of the socio-economic analysis for the forest sector seek to return a framework of regional economic and social context in which the forests continue to perform its role as a multifunctional element. It confirm the attitude to the conservation role of forestry on the basis of a set of indicators aggregated at the municipal scale. The choice of indicators emerged from the analysis of relations between the logging industry, the social texture, the correlated companies and aspects related to a non-productive use, such as tourism and recreation whose importance is gradually growing (Pettenella 2010). The results overlapped to the HNV Forests give an idea of those areas whose preservation is supported by the socio-economic context. The achievement of a performance ranking of the municipalities of the Region may be an element of great importance in the programming phase of the RDP, both for schemes implementation and resource allocation based on a georeferenced procedure.

The results show that the majority of municipalities in Apulia is strongly characterized by unfavourable contexts for the forest development. This result is exacerbated by the large enclosure of woodlands just into the municipalities with the lower socio-economic classes. The forest coverage index, indeed, tends to decrease as the socio-economic rise up. The northern part of the region is affected by the

---

[2] This phase of the work have been set up to reference the RDP analysis in a more clear and comprehensive frame.

lowest socio-economic classes, proven also by a high land abandonment share. The higher socio-economic performances associated with a medium share of woods are recorded in a particular area in the central part of the region[3]. In such areas the activation of virtuous processes, accompanied by non-invasive land uses on forests, are probably favoured by rural and sustainable tourism. Only two municipalities in the north Apulia perform the highest socio-economic performances associated with a high forest share[4] Here the reasons for this positive result are likely to be found in close connection with the use of forest land for economic purposes, although the presence of a protected area[5] could have regimented the logging industry towards more sustainable uses.

As like as the socio-economic assessment, the choice of threat indicators meet those factors that traditionally affect forests because of relation of competition (urbanization) or negative interaction (adjacent land use, desertification) or even destructive effect (forest fires) or factors related to the social dynamics particularly common in underdeveloped areas (depopulation). The results show the major frequency of municipalities on values of medium and low threat. One element of particular importance emerges from the analysis of the areas containing HNV Forests, especially those belonging to Gargano, Subappennino Dauno, and Murgia Tarantina, where the averages and maximum values of threat index are strongly below the regional values.

The joint examination on socio-economic and threat aspects lead to identify homogeneous groups of municipalities according to the reciprocal relations of the indexes performances. Such a grouping, overlapped to the delimitation of HNV Forests, enabled to identify those areas requiring greater protection or where specific actions were needed. The municipalities are distributed fairly evenly among all these groups, except those who experience negative conditions for both indexes. In this category is difficult to locate a core concentration area throw the region due to their small number and scattered distribution. In these municipalities, where the threat level is high and the forestry activities are not supported by socio-economic context, it can be expected a little success from forestry projects financed by the RDP. Within the optimum group, a large proportion of forestry land can be found. These, thanks to the RDP intervention, can easily evolve into a multifunctional dimension, safe from any environmental or socio-economic threat. A share of about one third of HNV Forests falls into this "privileged" category. Comparing the forest area which is instead included in the common disadvantage for a single index, it can be stated that the reason of greater risk is due to a poor socio-economic condition. It is therefore desirable that an intervention of the RDP aims to compensate this need.

---

3 The area is locad between the province of Bari, Taranto and Brindisi, called Valle d'Itria and Murgia Tarantina

4 Monte S. Angelo, Mattinata

5 Gargano National Park

5. Conclusions

The increasing integration of environmental policies within the support tools for rural development programming allowed decision makers and program evaluators to approach new socio-economic issues associated with environmental problems. It generated a renewed interest on specific technical and scientific questions. Research on HNV Forests stems from the need to combine environmental instances to socio-economic aspects in the forest sector.

The construction of an analysis system on HNV Forests in Apulia Region affords to deepen a topic of recent introduction, for which there are no previous contributions (the greatest efforts have focused on the homologous agricultural areas). It allowed to develop a methodology for the identification and the characterization of forests, easily reproducible in different regional or national contexts. The identification of HNV Forests can represent a basis for developing further considerations, useful for creating a practical contribution to regional planning and especially for programming, evaluation and monitoring of policy interventions in rural development.

The context analysis performed for the forest systems on a municipality scale highlighted different aspects referred primarily on environmental or territorial threat and socio-economic conditions.

The integrated use of multicriteria analysis and geographic information systems is a valuable analysis tool, being able to answer the questions asked and to reach the stated objectives. The limit of such instruments lies, as known, especially in the availability of precise and up to date statistical and cartographic data. A further weakness of this method is related to the presumable hazard of subjectivity of some phases of the procedure, such as attributes structuring and threshold values assignment. The results obtained can certainly be a starting point for further research aimed to improve the reliability of the results, as well as to represent a first specific reference to the aspects related to the exact calculation of the regional allocation of biodiversity in forests.

The results achieved on the provision of HNV Forests of Apulia, approximately 34% of the regional forests, does not vary considerably from those obtained by INEA (Trisorio 2009) which has implemented the methodological approach suggested by IEEP (2006), arriving at a rough calculation of the forest surface. The research which is not restricted to the estimation of the area, helped to identify areas of greatest diffusion and, moreover, to characterize them by appropriate municipal indexes. The results achieved provide precise evidence of how most of the Apulia HNV Forests is characterized by very different socio-economic conditions. This enabled to outline the framework for intervention measures of the RDP and to highlight the main territorial emergencies. The analysis stressed the need to better calibrate interventions and distribution of resources based on "georeferenced" methodology, in order to operate more effectively and efficiently in the decision making process.

The utility of the research is the main applicative reference in the programming and in the evaluation of programs. The first issue is related mainly to the authority roles of planning interventions, to choose among the most appropriates actions in relation to the context and suitable to meet specific objectives as well as to settle proper allocation of the scarce financial resources. It becomes extremely important especially considering the forthcoming debates on the next programming cycle (2014-2020). As regards purely evaluative issues, the research provides concrete evidence on the ex-ante status and on the reference context, tracing the possible qualitative evolution of the rural development intervention. Hence it follows the logical frame of the baseline indicators as proposed by the Common Monitoring and Evaluation Framework. A foreseeable development of the research will remark the CMEF frame (result indicator n.6; impact indicator n.5) in order to assess the RDP effect in term of hectares incremented of HNV Forests and their percentage variation on the regional and national scale.

References

Adamowicz W. (2003). Economic indicators of sustainable forest management: theory versus practice. *Journal of Forest Economics* 9: 27-40.

Brang P., Courbaud B., Fischer A., Kissling-Näf I., Pettenella D., Schönenberger W., Spörk J., Grimm V., (2002). Developing indicators for the sustainable management of mountain forests using a modelling approach. *Forest Policy and Economics* 4: 113-123.

Bateman I.J., Jones A.P., Lovett A.A., Lake I.R., Day B.H., (2002). Applying Geographical Information Systems (GIS) to Environmental and Resource Economics. *Environmental and Resource Economics* 22: 219-269.

EC. Agriculture and Rural Development (2006). *Common Monitoring and Evaluation Framework. Annex 3. Indicator guidance.* Directorate General for Agriculture and Rural Development.

EEA Report n° 1 (2004). *High nature value farmland Characteristics, trends and policy challenges*. EEA, Copenhagen, Denmark

EEA Report n° 6 (2005). *Agriculture and environment in EU-15. The IRENA indicator report*. EEA, Copenhagen, Denmark IEEP, 2006. Final report for the study on HNV indicators for evaluation.

IEEP (2006). *Final report for the study on HNV indicators for evaluation*.

Gough A.D., Innes J.L. and Allen S.D. (2008). Development of common indicators of sustainable forest management. *Ecological Indicators* 8: 425-430.

Hall J.P. (2001). Criteria and indicators of sustainable forest management. *Environmental Monitoring and Assessment* 67: 109-119.

Han S.-Y. and Kim T.J. (1988). ESSAS: expert system for site analysis and selection. *Computers, Environment and Urban Systems* 12(4): 239-252.

Hobbs B.F. (1980). A comparison of weighting methods in power plant siting. *Decision Sciences* 11: 725-737.

INEA (2009). *Politiche Forestali e Sviluppo Rurale*. Roma, INEA

INFC (2006). *Inventario nazionale forestale e dei serbatoi di carbonio*. Corpo Forestale dello Stato. http://www.sian.it/inventarioforestale/jsp/home.jsp

ISTAT (2009). *Atlante Statistico dei Comuni.* Roma, ISTAT.

Leskinen P., Kangas J. and Pasanen A.M. (2003). Assessing ecological values with dependent explanatory variables in multi-criteria forest ecosystem management. *Ecological Modelling* 170: 1-12.

Malczewski J. (2004). GIS-based land-use suitability analysis: a critical. *Progress in Planning*. 62: 3-65.

Malczewski J., (2000). Review Article On the Use of Weighted Linear Combination Method in GIS: Common and Best Practice Approaches. *Transactions in GIS* 4(1): 5-22.

MCPFE (2011). http://www.foresteurope.org/
Ministero delle Politiche Agricole Alimentari e Forestali, (2006). Piano Strategico Nazionale per lo Sviluppo Rurale. Roma.
Moreno D. and Seigel M. (1988). *A GIS approach for corridor siting and environmental impact analysis*. GIS/LIS'88. Proceedings from the third annual international conference, San Antonio, Texas 2, pp. 507-514.
Mrosek T., Balsillie D. and Shleifenbaum P. (2006). Field testing of a criteria and indicators system for sustainable forest management at the local level. Case study results concerning the sustainability of the private forest Haliburton Forest and Wild Life Reserve in Ontario, Canada. *Forest Policy and Economics* 8: 593-609.
Naesset E. (1997). Geographical information systems in long-term forest management and planning with special reference to preservation of biological diversity: a review. *Forest Ecology and Management* 93: 121-136.
Pereira J.M.C. and Duckstein L. (1993). A multiple criteria decision-making approach to GIS-based land suitability evaluation. *International Journal of Geographical Information Systems* 7(5): 407-424.
Pettenella D. (2010). Le opportunità della multifunzionalità forestale. *Approfondimento forestale RRN* n. 2.
Phua M-how and Minowa M. (2005). A GIS-based multi-criteria decision making approach to forest conservation planning at a landscape scale: a case study in the Kinabalu Area, Sabah, Malaysia. *Landscape and Urban Planning* 71: 207-222.
Regione Puglia, (2006). Programma di Sviluppo Rurale 2007-2013. Bari.
Richard G., Lathrop Jr., Bognar J.A., (1998). Applying GIS and landscape ecological principles to evaluate land conservation alternatives. *Landscape and Urban Planning* 41: 27-41.
Regione Puglia, (2011). Sistema Informativo Territoriale – Puglia. http://www.sit.puglia.it.
Store R. and Kangas J. (2001). Integrating spatial multi-criteria evaluation and expert knowledge for GIS-based habitat suitability modelling. *Most* 55: 79-93.
Strager M.P. and Rosenberger R.S. (2006). Incorporating stakeholder preferences for land conservation. Weights and measures in spatial MCA. *Ecological Economics* 57: 627-639.
Oliveira R.D., Valente A. and Vettorazzi C.A. (2008). Forest ecology and management definition of priority areas for forest conservation through the ordered weighted averaging method. *Forest Ecology and Management* 256: 1408-1417.
Trisorio A., Romano R., De Natale F., Pignatti G., Mariano A., Pompei E., (2009). Aree forestali ad alto valore naturale. Linee metodologiche per la stima delle aree forestali ad alto valore naturale a livello nazionale e regionale. *Rete Rurale Nazionale* 2007-2013.