APPLICATION OF PHYTOSOCIOLOGICAL PRINCIPALS ON THE SPATIAL PLANNING AND SUSTAINABLE USE OF THERMOPHILOUS FOREST VEGETATION

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Abstract. *Dajti National Park (DNP) is one of the most interesting protected areas, Second Category of IUCN, located on the central part of Albania. The vegetation of DNP, especially thermophilous broadleaves forests represent different degradation stages because unsustainable practices, fires, overgrazing and traditional use in the past. Basic part of the study is the ecology and life history of Quercus tree species in the landscape of DNP, which is related to abiotic site factors and human land use. This includes recording of abiotic site factors by field methods, the identification of the vegetation and land use systems of the area plots. A comprehensive analysis on plant communities has been necessary. Combined floristic, ecological site data and human factors, inform us about the landscape history and present situation. Classification of vegetation types defining species groups and plant communities, through principals of Zurich–Montpellier school, have been done. Potential vegetation have been identified, by using Map of the Natural Vegetation of Europe. Statistical analysing, ordination and classification are realised by Turboveg, Juice, Syntax software. As a result, 5 plant associations of thermophilous broadleaves vegetation, belonging to 4 alliances of Querco-Fagetea Class, all related to site factors and human use, are defined.The environmental situations have been correlated with the regeneration ecology of the main canopy species, and particularly of Quercus species. The Quercus forests and their degradation stages has been evaluated by criteria of nature conservation.*

Keywords: *vegetation association, ordination and classification, sustainable use.*

Rezumat. **Aplicarea principiilor fitosociologice în amenajarea teritoriului şi utilizarea durabilă a vegetaţiei forestiere termofile.** *Parcul Naţional Dajti (PND) este unul dintre cele mai interesante zone protejate, Categoria a II-a IUCN, situat în partea centrală a Albaniei. Vegetaţia Parcului Naţional Dajti, în particular pădurile de foioase termofile prezintă faze diferite de degradare datorită practicii eco-nimicitoare, incendiilor, păşunării şi utilizării tradiţionale în trecut. Partea fundamentală a studiului este ecologia şi biologia speciei Quercus în peisajul PND-ului, care sunt legate de factorii abiotici ai mediului şi utilizarea antropică a pământului. Aceasta cuprinde monitorizarea factorilor abiotici prin intermediul metodelor de teren, identificarea vegetaţiei şi modul de utilizare al pamântului. O analiză comprehensivă despre comunităţile vegetale a fost necesară. Au fost combinate datele floristice, ecologice ale terenului şi factorii umani, informându-ne despre istoria peisajului şi situaţia prezentă. Clasificarea tipurilor de vegetaţie este facută prin definirea grupelor de specii şi comunităţile plantelor urmând principiile şcolii Zurich–Montpellier. Vegetaţia potenţială a fost identificată utilizând Harta Vegetaţiei Naturale din Europa. Analiza statistică, ordinea şi clasificarea au fost realizate de către Turboveg, Juice, Syntax software. Ca rezultat, au fost identificate 5 asociaţii de plante ale pădurilor de foioase termofile, aparţinând a 4 alianţe, anume Clasa Querco-Fagetea, toate legate de factorii mediului şi utilizării antropice. Situaţiile ambientale au fost corelate cu regenerarea ecologică a speciilor principale baldachin şi în particular a speciilor genului Quercus. Pădurile de Quercus şi stadiile lor de degradare au fost evaluate conform criteriilor de conservare a naturii.*

Cuvinte cheie: *asociaţie vegetală, ordonare şi clasificare, utilizare durabilă.*

INTRODUCTION

Dajti National Park (DNP) is one of the most interesting protected areas, Second Category of IUCN, located on the central part of Albania, 5 km far from Tirana, Capital city of the country. Due to the high amplitude of elevation, from 860 ft – 4700 ft, a high level of biodiversity take place, not only specific but ecological so far (KALAJNXHIU et al., 2008). The Dajti National Park provides a framework to conserve and enhance the special qualities of the natural values and sets out to secure the varied biodiversity found within its boundaries so that they could be enjoyed by the present and future generations. The vegetation of DNP, especially thermophillous broadleaves forests represent an important vegetation type in different degradation stages because unsustainable practices, fires, overgrazing and traditional use in the past.

Basic part of the study is the ecology and life history of *Quercus* tree species in the landscape of DNP. The occurrence, regeneration and size (growth) of the oak tree is related to abiotic site factors and human land use. This includes recording of abiotic site factors mainly by field methods, and the identification of the vegetation and land use systems of the area and plots.

This study is an effort for the gathering, analyzing and assessment of the aspects concern the concept of natural quality of an ecosystem, and their organisation according to a logical scheme, in order to establish an “expert system” as a tool for the assessment of ecosystems natural quality. The digital systems that use logical models are defined as expert system or knowledge-based systems.

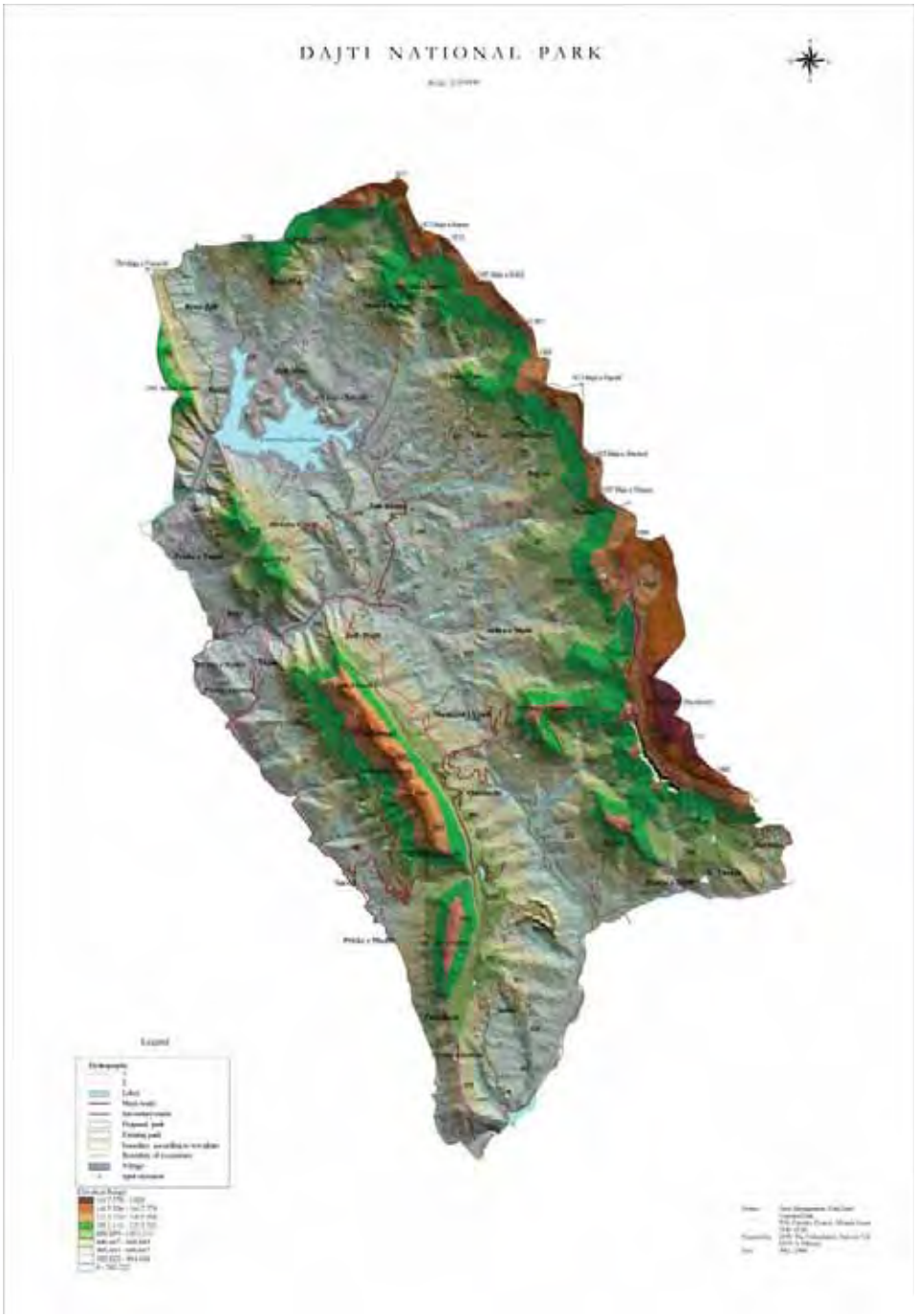

Figure 1. Physic map of DNP.
Figura 1. Harta fizică a PND-ului.

The establishment of an "expert system" to assess the level of biodiversity per plant association and to manage on a sustainable way the natural resources on DNP, represents the innovation aspect of the study.

The identification of the best managerial alternatives of the landscape needs over all the division of territory in homogenous area units and then the inventory of specific biodiversity values per each areas unit. Homogenous units for biodiversity assessment and spatial planning, the principles of SIGMA school are used.

The definition of degradation stages, within vegetation series, and assessment of the biodiversity are the most important steps in managing of natural resources on the areas with specific protection status (NP).

The goal of the paper

The main goal of this paper is to involve the application of phytosociological principle for spatial division, planning and evaluation of the biodiversity, as well as sustainable use of natural resource in DNP.

Objectives:

1. Identification of ecological biodiversity of the broadleaves thermophyllous forests, (richness on plant association) as an important indicator for the sustainable management of DNP;

2. Identification of the overall value of the biodiversity, per each association and then "hot spot", "warmish spot" and "cold spot" in terms of biodiversity;

3. Identification of the degradation stage, within vegetation series, of all derived vegetation types (Braun-Blanquet 1936);

4. Improved information on, and awareness of, biological and landscape diversity issues, and increased public participation in actions to conserve and enhance such diversity.

MATERIAL AND METHODS

For the realization of the study, to perform a comprehensive analysis on plant communities has been necessary. The plant associations based on multivariate analysis, status and distribution of vegetation types, as well as on the abiotic, historical and silvicultural aspects are defined.

For each syntaxon (vegetation type), a representative number of sample plots was recorded. An inventory of site parameters, flora, size and number of woody species, and information about land uses toke place. In total 74 releves are provided, based on the principles of sample design. The size of the plot by "Minimum area" method was defined.

All the plots are registred at TURBOVEG program and the database was created. The computer software package TURBOVEG (HENNKENS, 1995, HENNEKENS & SCHAMINEE, 2001) was used for designing the storage, selection, and export of vegetation data (relevés). The data from TURBOVEG (Vegetation archive) are exported to JUICE for clustering of the similar relevés according to Euclidian Distance.

The analysis included the classification of floristic and forest data, based on computation JUICE and CANOCO. JUICE (TICHY, 2002), a statistical program optimized for use in association with TURBOVEG, offers the possibility for editing, classification and analysis of large phytosociological tables and databases. This software, with a current maximum capacity of 30 000 relevés in one table, includes many functions for easy manipulation of table and header data. Floristic data with ecological data (temperature, rainfall, soil type, relief) and human factors, e.g., frequency and intensity classes of disturbances like grazing, fire, and cutting, were be combined. This can give us, a comprehensive information about the landscape history and present situation. Classification of vegetation types defining species groups and plant communities have been done. The floristic structure of the dataset, was displayed by a synoptic table and by ordination. To identify the potential vegetation, Map of the Natural Vegetation of Europe, has been use too.

The environmental situations and the regeneration ecology of the main canopy species (particularly of *Quercus* species), were correlated (MITCHELL et al., 2002).

The Quercus forests and their degradation stages have been evaluated by criteria of nature conservation. These data have been compared with local community needs and ideas for the development of their region, considering Natural ecosystem (requirements), Economical system (production and profit) and Social system (human needs) as part of the same global system. (SCHULZE, 1996) The result has been a multifunctional sustainable management of the natural resources of DNP that respect the basic criteria of sustainable management "Economically viable-Environmentally sound-Socially just". The development of sustainable management concepts has been a major task of this work (PROKO & DIDA, 2002).

Evaluation of plant communities, associations and habitat types is based on qualitative and quantitative characteristics (GATZOJANNIS et al., 2001). Classification of vegetation types through principals of Zurich–Montpellier school (Braun-Blanquet, 1936), has been done. Statistical analysing, ordination and classification are realised by Turboveg, Juice, Syntax and GIS software. For each plant association levels of potential, real and overall biodiversity are estimated, based on the suitability and relative weight of the external and internal factors. For the standardization the measurement units four interval classes are used and a hierarchical system is established.

The syntheses of the evaluation results along the levels of the hierarchy can only be achieved at a common scale in which all factors could be expressed.

Based on the quality (qi) and the relative weight (gi) of the lower level factor; the quality of an upper level factor can be estimated by the function.

$$N = \sum (qi \cdot gi)$$

Successive evaluation along the hierarchy results to the evaluation of the two aspects of a given function. The assessment of external factors results to the value of the function potential while the assessment of the internal ones gives the suitability class of a vegetation type. (GATZOJANNIS et al., 2001)

Depending on the value of $y = N = \Sigma(qi.gi)$ a function can then be ranked into four classes.

Analyses of floristic data and ecological characteristics attest the studied area as a border between Mediterranean and Sub-Mediterranean vegetation types.

RESULTS

The classification of plant associations

The result is the classification of forest types, regeneration and growth patterns of thermophilous broadleaves forests, all related to site factors and human use.

According to the methodology, data collected from the 74 relevès were archived on TURBOVEG programme. For each relevè, both, general data about the ecology, geo-morphology, etc., and the list of species with A-D index as well as biological forms were collected and registered.

Data from Turboveg are exported and statistical ordinated to JUICE. Twispan analyse is used in this case.

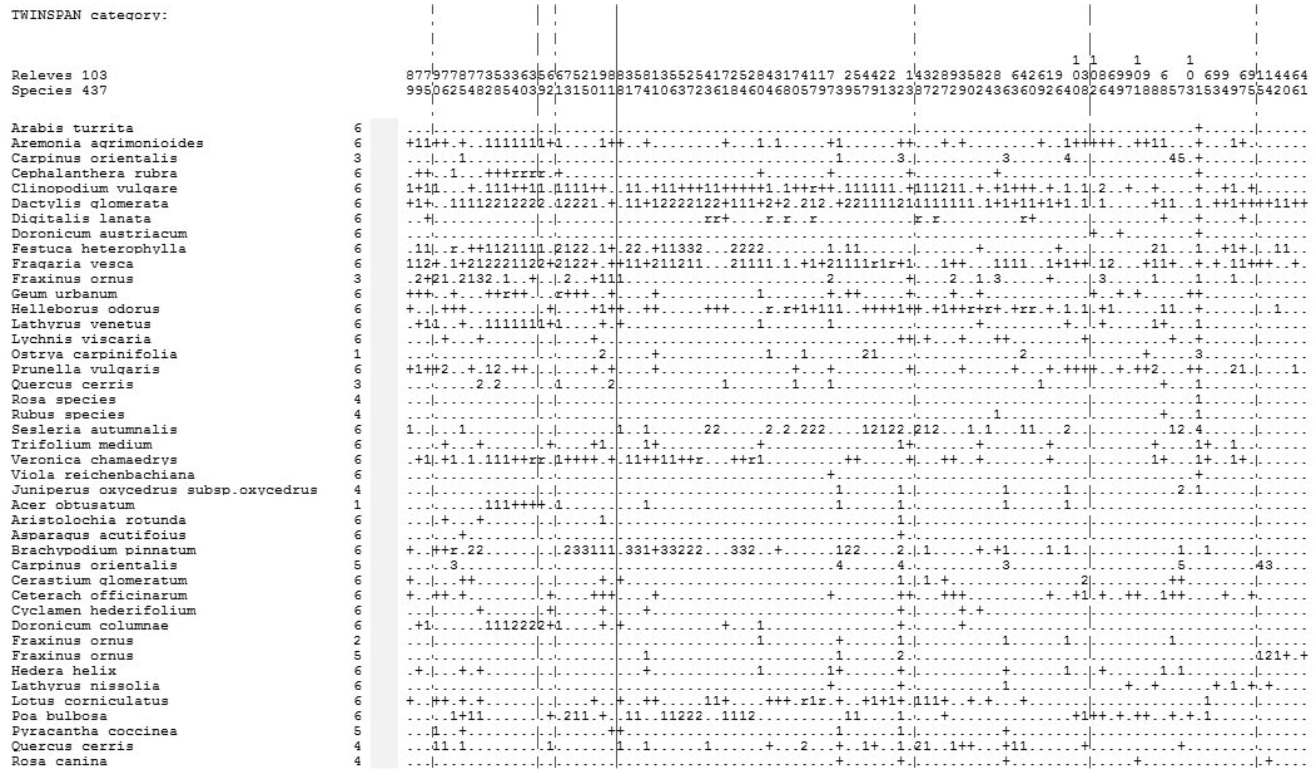

Figure 2. Statistical analyse of the relevès.
Figura 2. Analiza statistică a releveelor.

Identification of Fidel species (significant or characteristic species of association) was based on the synoptic analysis from the synthetic table, just the fist analysing stages of which we have represented in the table below.

Percentage synoptic table with modified fidelity (phi coefficient) (11 columns)

Number of releves:	1	8	2	1	5	1	3	19	14	9	9
releves 72											
Species 332	1	2	3	4	5	6	7	8	9	10	11
Ajuga reptans	58.6	30.2	20.7	---	---	---	---	---	---	---	---
Trifolium pignantii	58.2	---	---	---	---	---	7.9	---	20.5	16.3	---
Rosa species	50.3	---	---	---	8.2	---	26.9	---	---	42.5	---
Epilobium montanum	---	70.6	---	---	---	---	---	---	---	5.6	---
Populus tremula	---	69.0	---	---	---	---	---	---	---	---	---
Doronicum columnae	---	68.9	---	---	---	---	---	6.2	---	1.3	---
Hypericum perfoliatu	---	65.1	---	---	---	---	---	0.3	---	---	---
Trifolium angustifol	---	59.4	---	---	---	---	---	---	---	---	---
Knautia drymeia	---	56.1	---	---	5.7	---	17.9	---	---	---	---
Myosotis sylvatica	---	55.1	24.9	---	16.9	---	---	---	1.9	---	---
Potentilla erecta	---	54.6	41.5	---	---	---	---	---	---	---	---
Campanula persicifol	---	54.6	41.5	---	---	---	---	---	---	---	---
Brachypodium sylvati	---	54.1	---	---	---	---	---	5.8	44.5	---	---
Potentilla micrantha	---	53.3	31.1	---	---	---	---	---	12.1	---	---
Juniperus communis	---	50.2	---	---	---	---	---	---	4.4	33.6	5.1
Hieracium cymosum	---	49.5	37.2	---	---	---	---	---	---	---	---
Cephalanthera rubra	---	48.6	27.6	---	19.2	---	---	---	---	---	---
Primula acaulis	---	---	100.0	---	---	---	---	---	---	---	---
Trifolium species	---	---	97.2	---	---	---	---	---	---	---	---
Galium mollugo	---	---	90.6	---	---	---	---	---	3.5	---	---
Lathyrus nissolia	---	---	82.1	---	6.7	---	---	---	---	---	8.8
Luzula multiflora	---	---	81.5	---	---	---	---	17.3	---	---	---
Ranunculus ficaria s	---	29.7	73.1	---	---	---	---	---	---	---	---
Melittis melissophyl	---	43.1	62.8	---	---	---	---	---	---	1.6	---
Asyneuma limonifoliu	---	---	---	100.0	---	---	---	---	---	---	---
Sedum album	---	---	---	100.0	---	---	---	---	---	---	---
Rubus species	---	---	---	97.2	---	---	---	---	---	---	---
Calamintha grandiflo	---	---	---	97.2	---	---	---	---	---	---	---
Vinca minor	---	---	---	97.2	---	---	---	---	---	---	---
Melica ciliata	---	2.4	---	93.7	---	---	---	---	---	---	---
Digitalis lanata	---	7.7	---	72.3	---	---	---	---	---	24.5	---
Petrorhagia saxifrag	---	---	---	66.1	1.1	---	39.0	---	---	---	---
Saxifraga rotundifol	---	---	---	64.8	32.7	---	11.3	---	---	---	---
Ostrya carpinifolia	---	---	---	60.7	---	---	---	12.0	---	43.6	---
Lathyrus venetus	---	---	16.7	52.5	9.6	---	4.8	---	---	---	---
Ceterach officinarum	---	---	---	47.8	20.3	---	24.9	15.2	---	---	9.6
Ranunculus species	---	---	---	---	61.4	---	---	---	---	---	---
Carex species	---	---	---	---	57.1	---	---	1.8	---	---	---
Hieracium murorum	---	---	---	---	53.1	---	---	---	---	9.7	---
Luzula species	---	1.9	---	---	50.6	---	23.3	---	---	0.5	---

Figure 3. Sintetic table.
Figura 3. Tabel sintetic.

Cluster analysis was performed with SYNTAX 2000. The ecological analysis was an important step for the classification of the vegetation types.

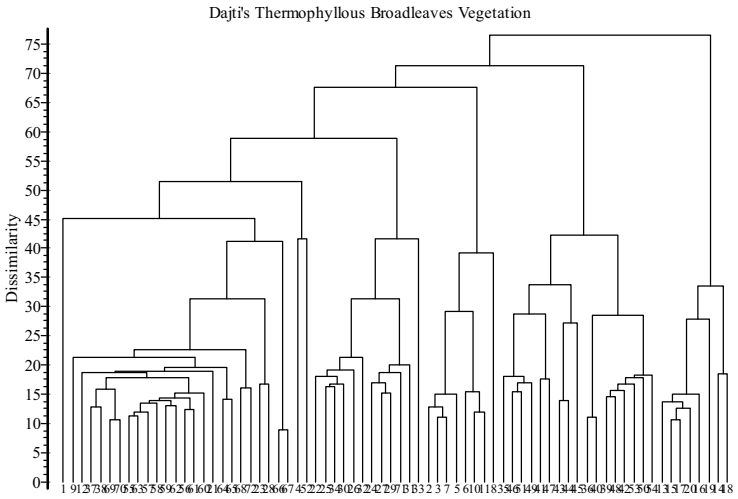

Figure 4. Dendrogram of Dajti's NP Thermophyllous Broadleaves Vegetation.
Figura 4. Dendrograma vegetaţiei de foioase termofile din Parcul Naţional Dajti.

Vegetation types must to be clearly distinguished on the context of ecological factors and historic traditional use. Ellenberg's factors are identified for each vegetation type, temperature, light, moisture and continentally.

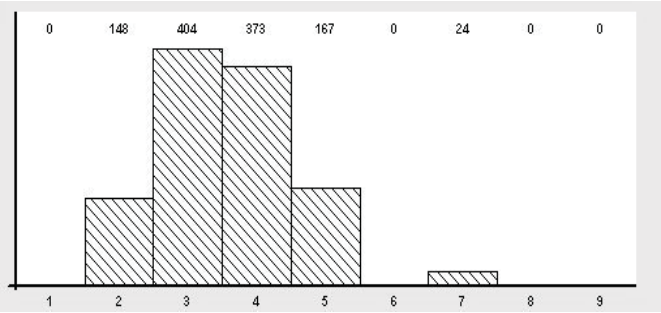

Figure 5. Ellenberg's Factors.
Figura 5. Factorii lui Ellenberg.

As result of statistical ordination of the plots, using update software (Turboveg, Juice) and phytosociological analyze of thermophilous vegetation of DNP, 5 plant associations, Braun Blanquet sensu strictu, belonging to 4 alliances of *Querco-Fagetea* CLASS, are defined.
Here below the synoptic table is represented:
Class: *Queco-Fagetea* BR.-BL. et VLIEGER 37
Order: *Quercetalia pubescentis* BR.- BL. 31
Alliance: *Ostryo –Carpinion orientalis* BR. –BL. 32
Association: *Quercetum–Ostrya carpinifolia* HORVAT 38
Association: *Fraxino–Carpinetum orientalis*
Alliance: *Quercion frainetto-cerris* (HORV. 1939).
Association: *Quercetum frainetto-cerris* OBERD. 48 et HORVAT 59
Order : *Quercetalia robori-petraeae* TX. 31
Alliance: *Quercion robori- petraeae* BR.-BL. 32
Association: *Querco-Castanetum submediterraneum* WRABER 54
Order: *Prunetalia spinosae* TX. 52
Alliance: *Prunion spinosae* FAB. et FUKAREK 68
Association: *Pruno-Juniperetum* FAB. et FUK. 68
All the végétation associations are represented on the végétation Mapp:

Figure 6. Distribution of the plants association on Dajti's NP.
Figura 6. Distribuția asociației plantelor în PN Dajti.

Dynamism of the vegetation

The identification of the degradation stages within vegetation series has been an important aspect of the study considering that this could serve as a basis on choosing the best managerial alternative. (BINDER, 1997)

Based on the floristic list comparison of defined vegetation associations, the regressive stages within this vegetation series (dynamic scheme), as result of perturbations or catastrophes, is provided. (GUALDI et al., 2001)

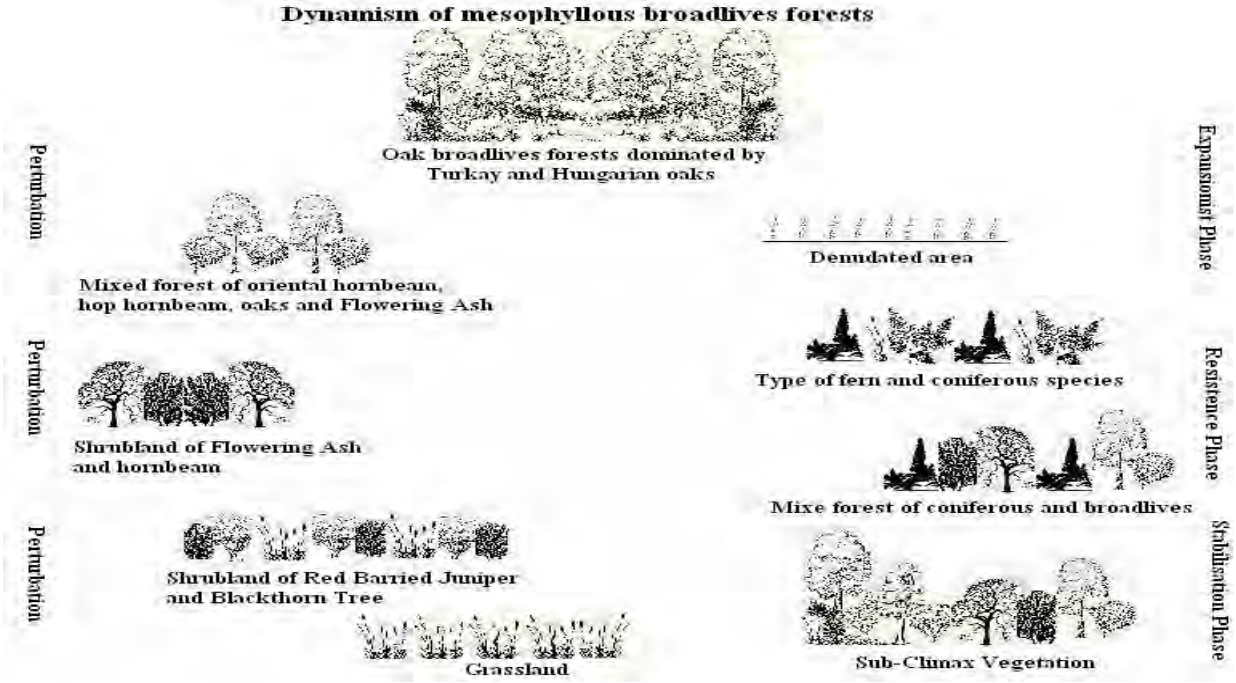

Figure 9. Dynamic stages of thermophyllous broadleaves forests.
Figura 9. Stadiile dinamice ale pădurilor de foioase termofile.

Evaluation of the biodiversity

A. External factors

The target system of the external factors for the biodiversity is standardized. Although the classification of the factors was based on the means-to-objective relationships, possible interdependencies among the factors were examined during the evaluation procedure to avoid double evaluation. The possible values of each factor are classified into 4 categories and a quality of 1, 2, 3, and 4 is assigned to each category. This classification is rather empirical and resulted after consultation of the specialists and biodiversity experts.

Values are assigned to the lower level factors, indicated with two-digit codes in table (e.g. [2.1], [2.2]….). The quality of the next level factors as well as the function class is calculated in succession, by combining the qualities with relative weights of the factors. The relative weights (c_i) of the lower level factors are used for the calculation of the quality of the factors in the next level, while the relative weights (P_i) of the higher level are used for the calculation of the biodiversity class.

Table 1. Evaluation of external factors of biodiversity per Querco-frainetum cerris.
Tabel 1. Evaluarea factorilor externi de biodiversitate la Querco-frainetum cerris.

	ci	pi	ci*pi	Ci	Pi	Ci*Pi
[1]. Rock (Rock Formation	Sum	**100**	**300**	**3**	**8.75**	**26.25**
[1.1] Mother rock	3	100	300			
[2] Soil	Sum	**100**	**273.05**	**2.731**	**20.25**	**55.2926**
[21] Soil type	2	32.25	64.5			
[22] Soil structure	4	18.55	74.2			
[23] Soil deep	2	13.25	26.5			
[24] Humus content	3	15.15	45.45			
[25] Soil moisture	3	12.35	37.05			
[26] Soil compactness	3	8.45	25.35			
[3] Clime	Sum	**100**	**269.45**	**2.695**	**33.25**	**89.5921**
[31] Dry period	2	15.35	30.7			
[32] Vegetation period	3	45.3	135.9			
[33] Average temperature	3	24.15	72.45			
[34] Annual precipitation	2	15.2	30.4			
[4] Landscape	Sum	**100**	**300**	**3**	**14.25**	**42.75**
[41] Phyto-climatic zone	3	47.85	143.55			
[42] Structure of soil cover	3	27.5	82.5			
[43] Altitude	3	24.65	73.95			
[5] Land use	**2**	**100**	**200**	**2**	**23.5**	**47**
					100	**260.885**
C = ∑Ci*Pi / 100 = 2.61 = 3						

B. Internal factors of the biodiversity

The evaluation of the factors within each evaluation unit, by the help of the key in table 2, was done in a similar way to the external factors. The calculations are presented in table 3. What was stated for the relative weights in external factors stands also for the weights of the internal one.

Table 2. Evaluation of internal factors per Quercetum frainetto-cerris.
Tabel 2. Evaluarea factorilor interni la Quercetum frainetto-cerris.

	ci	pi	ci*pi	Ci	Pi	Ci*Pi
[1] Structure of soil cover	Sum	**100**	**200**	**2**	**11.86**	**23.72**
[11] % of forest cover	2	56.5	113			
[12] Soil cover in non forest zones	2	43.5	87			
[2] Forest structure		**100**	**186.8**	**1.87**	**17.65**	**32.97**
[21] Structure type	2	34.7	69.4			
[22] Type (species composition)	2	15.56	31.12			
[23] Cover closure	2	12.34	24.68			
[24] Dynamic stage	2	24.2	48.4			
[25] Vertical structure	1	13.2	13.2			
[3] Surface cover	Sum	**100**	**214.5**	**2.15**	**13.22**	**28.36**

[31] Shrub /density of regeneration	3	57.25	171.8			
[32] Grass cover	1	27.89	27.89			
[33] Deed biomass	1	14.86	14.86			
[4] Management	Suma	**100**	**300**	**3**	**34.73**	**104.2**
[41] Management system	3	100	300			
[5] Harvesting conditions	Sum	**100**	**200**	**2**	**22.54**	**45.08**
[51] Perturbation	2	100	200			
[1] Specific Biodiversity	Sum	**100**	**210.68**	**2.107**	**35.61**	**75.023**
[11] Species richness	3	45.67	137.01			
[12] Family richness	2	6.89	13.78			
[13] Biologic spectrum	2	4.74	9.48			
[14] Chorological spectrum	2	7.71	15.42			
[15] Endemic status	1	22.43	22.43			
[16] Endangerment status	1	12.56	12.56			
[2] Ecologic Diversity	Shuma	**100**	**204.42**	**2.044**	**44.87**	**91.723**
[21] Provenience	2	30.67	61.34			
[22] Origin	1	12.03	12.03			
[23] Rarity	2	17.15	34.3			
[24] Regeneration scale	3	3.36	10.08			
[25] Representativeness	1	7.53	7.53			
[26] Esthetic value	2	8.76	17.52			
[27 Shannon Index	3	20.54	61.62			
[3] Special Factors	Shuma	**100**	**142.24**	**1.422**	**19.52**	**27.765**
[31] Scientific Value	1	25.64	25.64			
[32] Medicinal plants	2	42.24	84.48			
[33] Recreative functions	1	32.12	32.12			
					100	**211.51**
C = ∑Ci*Pi / 100 = 2.11 = 2						

As the conclusion, an average value per external, internal of biodiversity factors and per each vegetation type will be given. In this way we are able to distinguish in a comparative way the biodiversity value per each vegetation type and, as the result, hot spot, worming spot and could spot identification. (See table below)

Table 3. Overall evaluation of the biodiversity.
Tabel 3. Evaluarea generală a biodiversității.

Associations	Extrernal factors	Biodiversity values	Level of Biodiversity
Corylo-Carpinetum	2.61	**2.416666667**	**2**
Fraxino-Carpinetum	2.86	**2.4**	**3**
Pruno-Juniperetum	2.03	**1.76**	**2**
Quercetum frainetto-cerris	2.64	**2.2**	**2**
Ostryo-Carpinetum	2.5	**2.4**	**2**
Querco-Castanetum	2.56	**2.2**	**3**

CONCLUSIONS AND RECOMANDATIONS

Thermphyllous broadleaves forests of DNP, should be considered as an important part in terms of biodiversity, specific and ecologic so far.

Based on the statistical analyse (Juice 6.4), ecological biodiversity is rather rich, consisting of 5 associations, from which *Querco-Castanetum submediterraneum* Wraber 54, and *Fraxino–Carpinetum orientalis* must to be considered as “hot spot”.

Comparing values of the biodiversity per each vegetation association, in general the level of the biodiversity rather potentially high is actually low because the unsustainable use of nature resources on the past as Wild fire, over grazing and intensive harvesting.

The intervention to regenerate the biodiversity is cost effectiveness particularly in *Fraxino–Carpinetum orientalis*, *Quercetum frainetto-cerris* OBERD. 48 et HORVAT 59, and *Querco-Castanetum submediterraneum* WRABER 54.

Dissemination of the results of this study would lead to strengthening the public awareness in protection and rehabilitation of the biodiversity and participatory on decision making process.

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