

LANDSCAPE BIODIVERSITY IN ICP FOREST LEV.II

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Summary

- (a) **Forest: more than an ecosystem**
- (b) **Biodiversity: definition and implications**
- (c) **Landscape ecology: some concepts**
- (d) **Landscape biodiversity in forests: the LaBISV, a new survey method**
- (e) **Landscape biodiversity in forests: the diagnostic evaluation method**
- (f) **Example of application**
- (g) **Conclusion**



What are we going to study?

What a forest is, ecologically speaking?

ICP Forests monitoring concerned

- i. tree vitality (*Level I*) and
- ii. ecosystem parameters on selected plots (*Level II*).

The Forest Focus strategy was of undoubted importance, but the comprehension of the ecological state of forests necessitates more investigations, because **a forest can not be limited to trees and plots.**



A forest is not only an **ecosystem** (*sensu* Odum: “system of community”), it is also a **landscape** (*sensu* Forman: “system of ecosystems”).

And what the concept of biodiversity is?

The concept of biodiversity, defined by U.S. Office of Technological Assessment (1986), depends on two aspects:

- (a) the diversity of the **components** of ecological systems and
- (b) the diversity of their **relations in the organisation** of these systems (2 aspects: (b1) **local** and (b2) **context**);

Biodiversity is also an attribute of an **entire** ecological system. Therefore, to reach a better understanding of the ecological state of a forest, we have to check:

- (a) **species** diversity (e.g. α , γ and β ; Whittaker, 1975) and landscape **elements** diversity (ψ , τ ; Ingegnoli & Giglio, 2005);
- (b1) **ecosystem-community** diversity (e.g. tesserae) and (b2) **landscape** diversity (e.g. landscape unit), **measuring the pattern and the modality of their ecological organisation**.



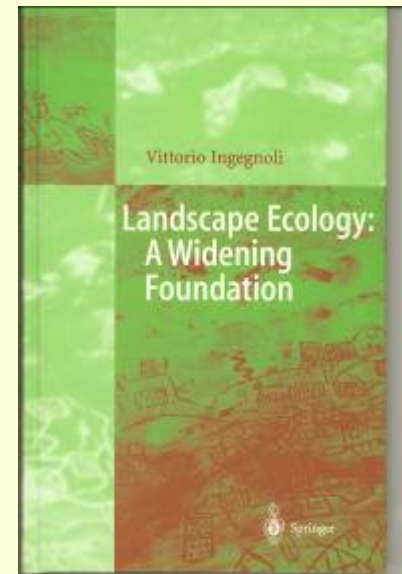
What is the experience on landscape forest biodiversity in the Italian Programme?

The Italian CONECOFOR programme inserted the study of “*landscape biodiversity*” on 12 permanent plots (b1) and for one of these plot extended the research to the entire context, or **Landscape Unit** (b2), following **Landscape Ecology** - more exactly the **Biological Integrated School** of L.E. (Ingegnoli, 2002).

This b2 example will be synthesized here.

This school proposes:

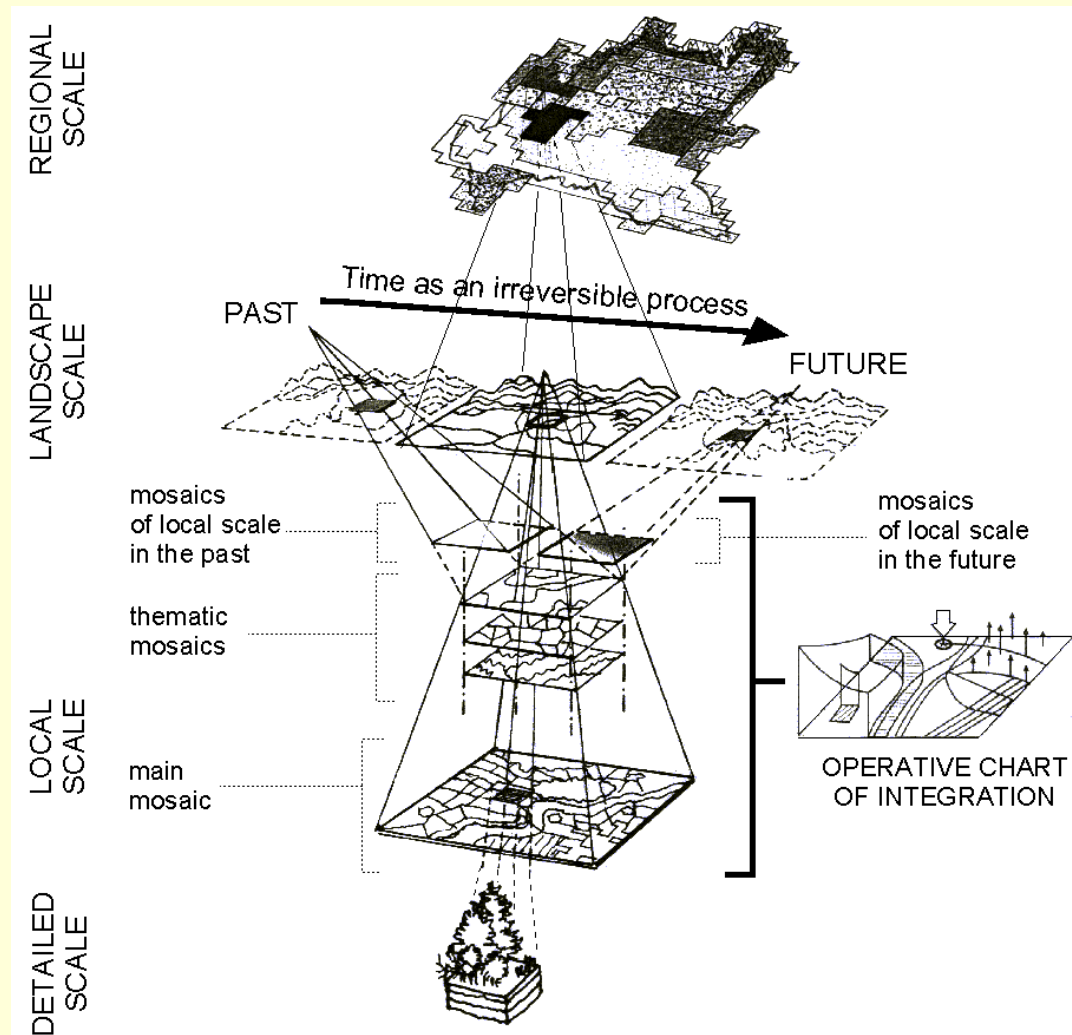
- (a) **a new landscape structural model** (related concepts: ecocenotope, ecotissue),
- (b) **new complex integrated functions** (e.g. biological and territorial capacity of vegetation, BTC),
- (c) **a new method and applications** (e.g. landscape biological integrated survey of vegetation, etc.).



(a) The new landscape structural model

The concept of biodiversity confirms the identification of the landscape as a living entity.

- The **structural model** of such a living entity is represented by a complex **multidimensional** structure built up by
- a main mosaic (generally formed by the vegetation *ecocoenotopes*) and a hierarchic set of correlated and integrated mosaics and information of different temporal and spatial scales: the **ecotissue** concept (or ecological tissue) (Fig.1).
- The **ecocoenotope** is defined as an ecological system, composed by the *community* (biotic view), the *ecosystem* (functional view) and the *microchore* (spatial contiguity characters).



(b) A new complex integrated function

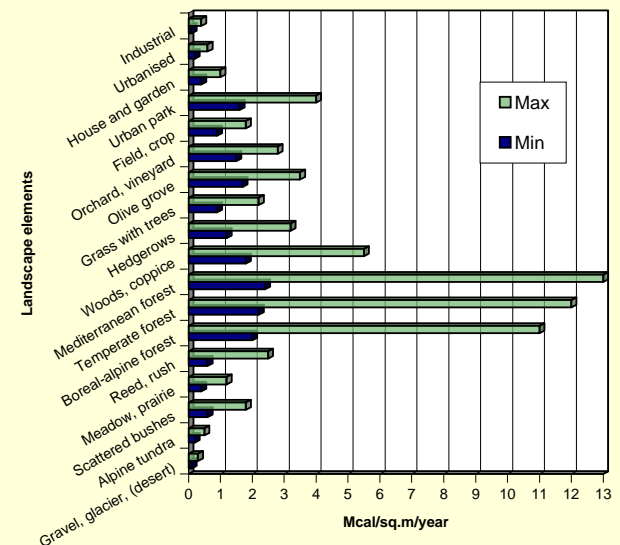
The **biological territorial capacity** or **BTC** (Ingegnoli 1991,1999,2002; Ingegnoli & Giglio 1999) is a synthetic function referred to a **vegetation** ecocoenotope and based on:

- (1) the concept of resistance stability ;
- (2) the principal types of ecosystems of the ecosphere;
- (3) their metabolic data (biomass, gross primary production, respiration, R/PG, R/B).

These data are elaborated to measure the **degree of the relative metabolic capacity** and the **degree of the relative antithermic maintenance** of the principal ecosystems.

This function, measured in $\text{Mcal/m}^2/\text{year}$, can represent the state (the order) of an ecological system and it is proportional to the metastability of the vegetated tesserae. Thus the BTC indexes allow the recognition of *transformation thresholds* in the landscape.

Btc evaluation of main landscape elements in Europe



Landscape evaluation of vegetation: a new method

This method is named: **Landscape biological integrated survey of vegetation or LaBISV**. *The main theoretical bases of the methodology (Ingegnoli, 2002, 2005; Ingegnoli & Giglio, 2995) are:*

- A. the Vegetation as the main bio-system forming landscape,*
- B. the concepts of ecotissue and ecocenotope as multifunctional structures of the landscape,*
- C. the Biological territorial capacity of vegetation or BTC as the main landscape integrative function,*
- D. the vegetation development model (Time/BTC) based on a proper exponential-logarithmic curve,*
- E. the comparability between natural and human vegetation characters,*
- F. the possibility to determine normal (optimal) parametric values in surveying vegetation,*
- G. the availability to measure the second (b) concept of biodiversity*

LANDSCAPE BIODIVERSITY IN FORESTS: A NEW SURVEY METHOD

Main phases of the LaBISV method

I Phase: Identification of the landscape elements and sample choice

- of the **landscape unit (LU)**, of its ecological (structural/functional) subdivisions, recognition of boundaries and ecotopes; identification of the **vegetation tesserae (Ts)** and of their perimeter, identification of the **vegetation types**. Depending on ecological interest, Ts containing permanent plot too.

II Phase: Study of geographical and historical characters

- Collection of **geographical data**, site and local data, e.g. climate, substrate, morphology, etc. Collection and elaboration of **historical and human data**, old maps and books data, main human land uses, main historical changes. Historical methods cover deep importance in the reconstruction of the LU.

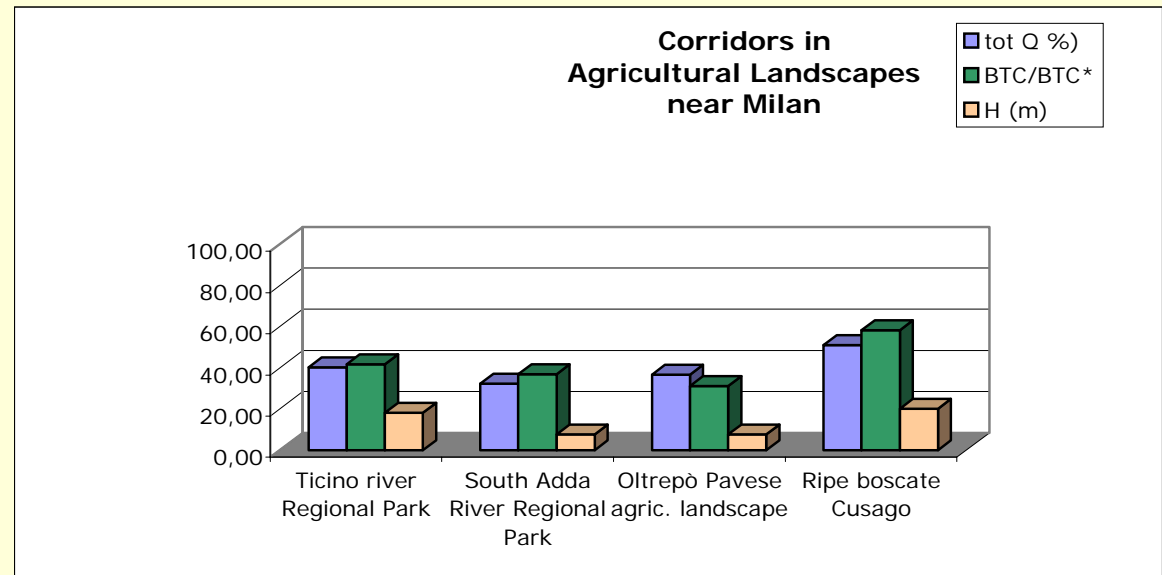
III Phase: Survey of tessera, biomass, ecocenotope and landscape parameters

- Survey of **Tessera characters (TS)**: Vegetation height (canopy) and cover, structure, edge ratio, management, etc. [*Ts as patch or corridor*]
- Survey of **Plant Biomass parameters**, Dead plant biomass, litter depth, biomass volume. [*Above ground biomass*]
- Survey of **Ecocenotope parameters**, Dominant sp., species richness, allochthonous sp., biol. forms, stratification, threatened plants, renewal capacity, dynamic state, etc. [*A Phytosociological frame is needed*]
- Survey of **Ts/LU parameters**, Contiguity, source/sink, functional role, disturbance incorporation, geophysical instabilities, fauna interest, transformations, etc.

LANDSCAPE BIODIVERSITY IN FORESTS: A NEW SURVEY METHOD

IV Phase: **Ordination** and **Evaluation** of main landscape vegetation parameters

- Evaluation of vegetation parameters; Ordination of parameters in four classes in a **standard form**, then evaluation per column (scores depending on vegetation type).
- Evaluation of **vegetation qualities (Q)**; Evaluation (%) per group of parameters and/or the entire Ts
- **BTC Estimation** through equations linked with the development models and BTC theory



LANDSCAPE BIODIVERSITY IN FORESTS: THE DIAGNOSTIC EVALUATION METHOD

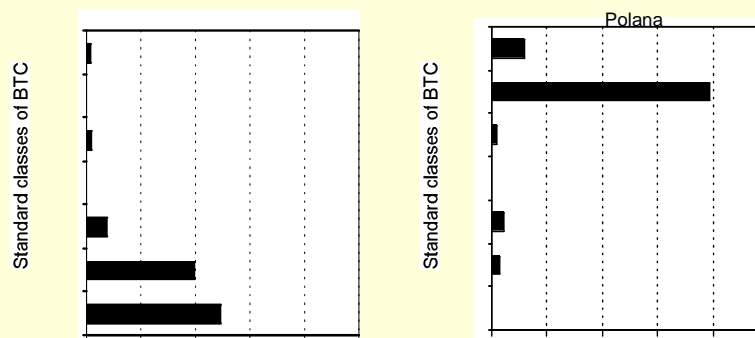
Diagnostic evaluation of vegetation in a landscape unit

Phase A: Examination of parameter/landscape **problems** and comparison with **normal values**

- Comparison among other Tesserae and with the LU. Underline of the altered parameters. Plotting **eco-grams**, exposing **normal values** per set of parameters. Verifying **BTC standard classes**.
- **Integration** with other ecological indicators concerning the LU.

Phase B: Diagnosis and **therapeutic criteria**

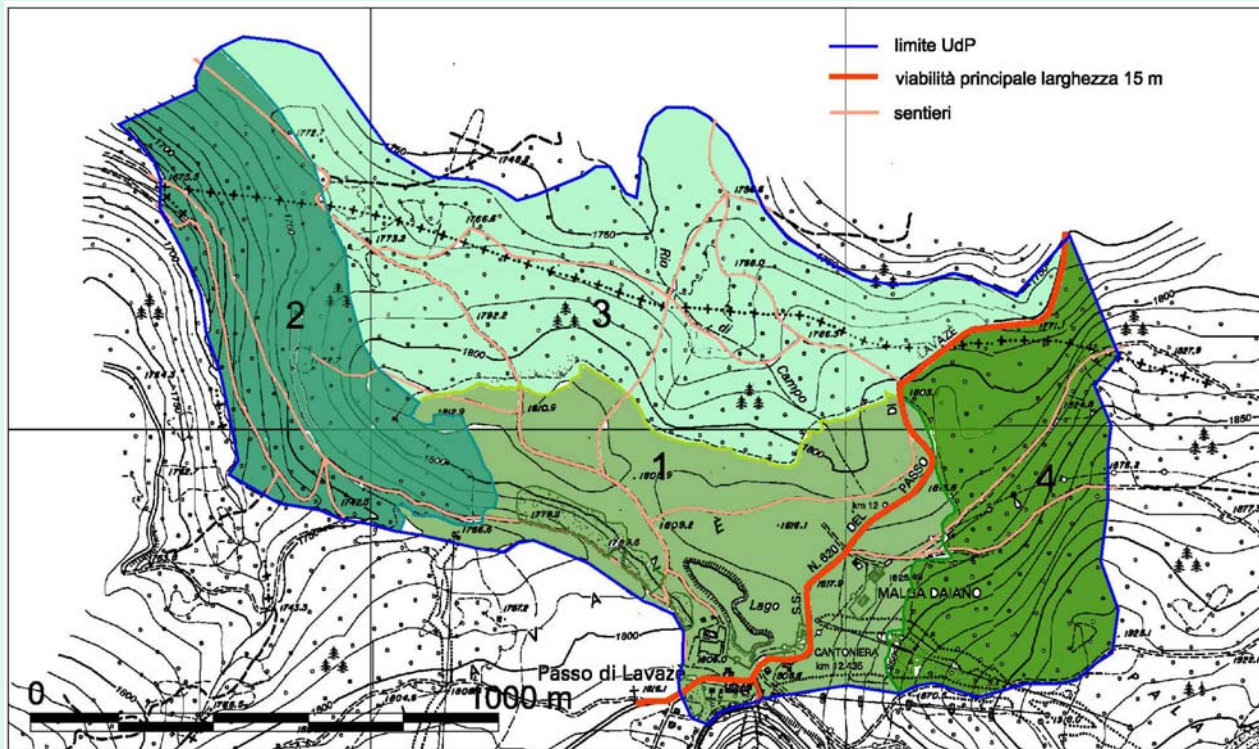
- Diagnostic activities, Measuring **gaps** of **normal values** per set of parameters and/or per specific parameter.
- **Diagnostic index** and evaluations;
- **Therapeutic criteria**: proposals and controls.



The distribution of the standard BTC classes in the forest and in the Polana sub-units. Note the opposite symmetry and the incomplete distribution of each

EXAMPLE OF APPLICATION OF THE LABISV METHOD: THE LAVAZÉ LANDSCAPE FOREST UNIT

I Phase: Identification of the landscape elements



This landscape unit (LU) at an altitude of about 1.800 m asl measures about 175 ha and it is covered (75%) of Spruce forests (*Homogyno-Piceetum*, Zukrigl 1973), with the dominance of *Picea abies* and the presence of *Pinus cembra*. It is composed by 4 ecotopes one of which (n°1) is a pasturage.

EXAMPLE OF APPLICATION OF THE LABISV METHOD: THE LAVAZÉ LANDSCAPE FOREST UNIT

II Phase: Study of geographical and historical characters

Measure of the landscape elements forming the LU of Lavaz, Pass
in 1998 and in 2004

Landscape element	Area (ha)	LU%	Area (ha)	LU%
Forests	117.26	67.9	109.95	63.7
Destroyed patches or clearcuts	0,5	0.3	5.94	3.4
Ski rides	1	0.6	6	3.5
Paths	4	2.3	2	1.2
Bogs	3.66	2.1	3.66	2.1
Grass patches	3.5	2.0	2.37	1.4
Forest areas	129.92	75.3	129.92	75.3
Prairie	27.56	16.0	26.08	15.1
Shrub patches	4.5	2.6	4.5	2.6
Ski rides	2	1.2	2.9	1.7
Paths	2	1.2	2.1	1.2
Lake	1.75	1.0	1.75	1.0
Prairie areas	37.81	21.9	37.35	21.6
Built tesseræe	2.9	1.7	3.31	1.9
Roads and parkings	2	1.2	2.05	1.2
Built areas	4.9	2.8	5.36	3.1
Landscape unit, 1998	172.63	100.0	172.63	100.0



EXAMPLE OF APPLICATION OF THE LABISV METHOD: THE LAVAZÈ LANDSCAPE FOREST UNIT

III Phase: **Survey** of tessera, biomass, ecocenotope and landscape parameters



Forest permanent plot TRE1 (Lavazè Pass, Alps)
Piceion abietis, 1.800 m

T. TESSERA CHARACTERS (Ts)

T1 – Vegetation height (m)	< 9	9.1-18	18.1-29	> 29.1
T2 – Cover of the canopy (%)	< 30	> 90	31-60	61-90
T3 – Structural differentiation	low	medium	good	high
T4- Interior/edge (%)	none	< 30	31-89	> 90
T5 - Management	simple coppice	coppice	wood	natural forest
T6 – Permanence (years)	< 80	81-160	161-240	> 240

F. VEGETATIONAL BIOMASS (ABOVE GROUND)

F1- Dead plant biomass	near 0	> 10	1-5	5-10
F2- Litter depth	near 0	< 1.5	1.6-3.5	> 3.5
F3 – Biomass volume (m ³ /ha)	< 200	201-500	501-950	> 950

E. ECOCENOTOPE PARAMETERS

E1- Dominant species (n°)	> 3	3	2	1
E2- Species richness	< 15	16-30	31-40	> 40
E3- Key species presence (%)	< 5	6-40	41-80	> 80
E4- Alloctonous species (%)	> 10	10-4	< 4	0
E5- Infesting plants %	near all	> 25	< 25	0
E6- Threatened plants	evident	suspect	risk	0
E7- Biological forms (n°)	< 3	4-5	6-7	> 7
E8- Vertical stratification	2	3	4	> 4
E9- renew capacity	none	intense	sporadic	normal
E10- Dynamic state	degradation	recreation	Regeneration	fluctuation

U. LANDSCAPE UNIT (LU) PARAMETERS

U1- Similar veg. contiguity	0	< 25	26-75	> 76
U2- Source or sink	sink	neutral	Partial	source
U3- Functional role in LU	reduced	minor	evident	important
U4- Disturbances incorporation	insufficient	scarce	normal	high
U5- Geophysical instabilities	evident	partial	risk	none
U6- Permeant fauna interest	low	medium	good	attraction
U7- Tranformation modalities of the Ts	strong disturbances	gradual changes	temporal instabilities	fluctuation

IV Phase: Ordination and Evaluation of main landscape vegetation parameters

EXAMPLE OF APPLICATION OF THE LABISV METHOD: THE LAVAZÉ LANDSCAPE FOREST UNIT

Tab. 4: The most characterized Forested tesserae (Ts) at the Lavazé Pass. Their survey utilised the LaBISV method studied by Ingegnoli.

Tesserae	area	Q.T	Q.F	Q.E	Q.U	BTC	BTC/BTC _s	H	vFM
<i>A. Forested Ts</i>	ha	%	%	%	%	Mcal/m ² /yr	%	m	m ³ /ha
Z, Ts (containing Tre1)	4,01	70,7	56	95,6	80,4	8,50	90,0	29,5	739
A, East, q 1880 m	2,25	50	58,7	64,8	58,7	6,19	65,0	24,8	606
B, East, q, 1800 m	4,25	50	32	74,4	71,6	6,15	65,0	26,1	320
C, North-East, q 1780 m	4,40	64,7	56	73,6	67,6	7,48	79,1	25,7	872
D, West di Z, q 1790m	4,18	56	56	74,4	71,6	7,04	74,4	25,6	629
E, North, q 1770 m	4,41	56	56	70,8	62,7	6,93	73,3	25,8	793
F, West, q 1800 m	4,31	78	70,7	82,4	85,3	9,09	96,1	32	1086
G, South, q 1790 m	2,83	57,3	56	78,8	57,8	6,94	73,4	26,7	713
H, South-West, q 1750 m	3,73	57,3	44	78,8	67,6	6,65	70,3	20,7	443
L, West of D, q 1800 m	2,74	44	44	66,4	52,9	5,67	59,9	26,6	525
<i>Forested Ts (average)</i>	<i>37,11</i>	<i>59,4</i>	<i>53</i>	<i>76,6</i>	<i>68,9</i>	<i>7,17</i>	<i>75,8</i>	<i>26,5</i>	<i>686</i>

BTC_s = 0,85 BTC_F where: BTC_s= threshold of maturity, BTC_F= transition phase (see the model);

QT= Ts parameters (Quality), QF= plant Biomass parameters (Quality), QE= ecocoenotope parameters (Quality), QU= LU parameters (Quality)

H= High of the canopy, FM= plant biomass (spiegel relaskope)

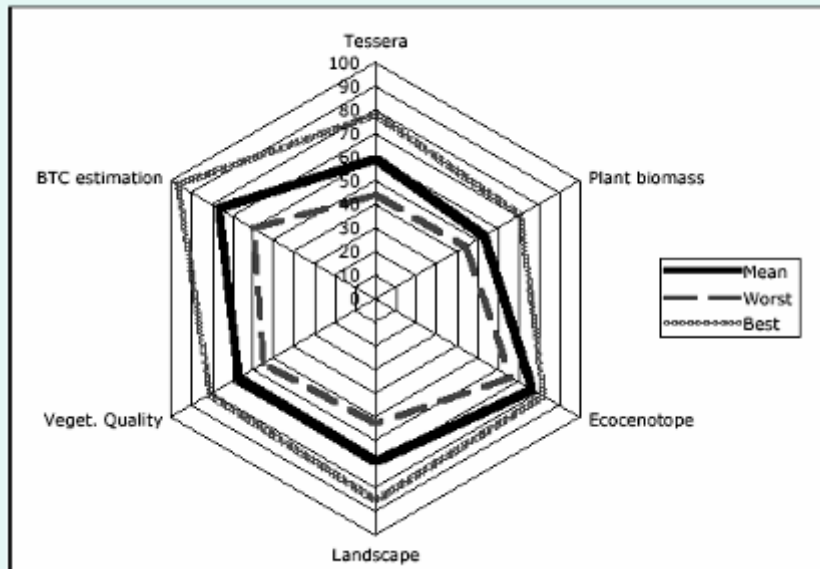
Tab. 5: Other types of vegetation in the Lavazé Pass, surveied with the LaBISV method.

Surveyed Ts	area	Q.T	Q.F	Q.E	Q.U	BTC	BTC/BTC _s	H	vFM
<i>B. Other vegetation</i>	ha	%	%	%	%	Mcal/m ² /yr	%	m	Kg/m ²
a- <i>Juniperus</i> shrubs	1,2	45,5	36,9	78,6	69,8	1,44	65,1	0,7	1,9
b- <i>Nardus stricta</i> grasses	1,6	21,9	12,5	52,8	51,4	0,58	47,5	0,4	0,8
c- Alpine bogs	1,5	62	51	94	72,9	1,22	85,6	0,2-1	1,5
	4,30					1,04			



LANDSCAPE BIODIVERSITY IN FORESTS: THE DIAGNOSTIC EVALUATION METHOD

Phase A: Examination of parameter/landscape problems and comparison with normal values



- Values of the main ecological sets of parameters measured with the mentioned survey schedule in percentage of their normal optimum state. Case study: the landscape unit of Lavazè Pass (Trentino-AltoAdige), after the survey of 11 forested tesserae.



LANDSCAPE BIODIVERSITY IN FORESTS: THE DIAGNOSTIC EVALUATION METHOD

Phase B: Diagnostic evaluation



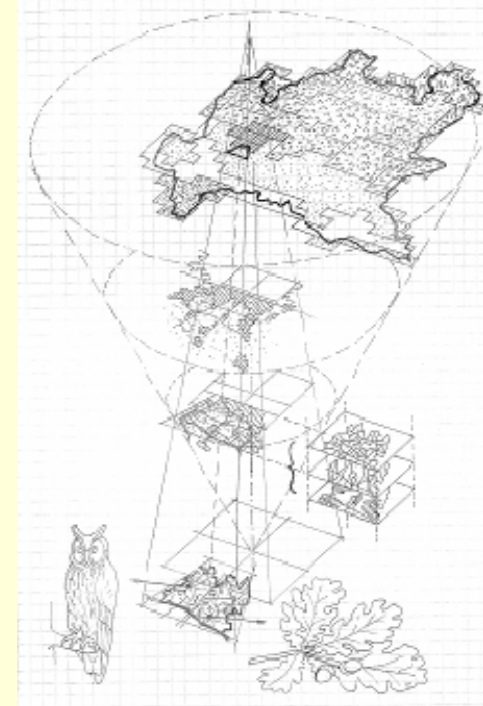
Tab. 6: Synthesis of the ecological diagnostic evaluation of the LU of Passo di Lavaz_z. The ranges of normality (Normal values) are referred to the historical structure of the LU and to its potentiality of forested sub-natural landscape.

Parameters	Normal values*	1935	Gaps %	1998	Gaps %	2004	Gaps %
BTC (Mcal/m ² /yr)	5,57-6,15	5,18	- 7	5,05	-9,3	4,76	-14,5
HU (%)	20-22	20,6	0	21,4	0	26,7	21,4
$\psi = H (3+D)$	5,5-5,7	4,63	-15,8	4,99	-9,3	5,29	-3,8
LM = τ *BTC	29-31	24,27	-16,3	24,16	-16,7	23,09	-17,6
C/F (%)	80-90	80,54	0	77,39	-3,3	64,55	-19,3
Piante alloctone (%)	0-1	0	0	0	0	0,1	0
Area forestale (%)	65-80	68,9	0	67,9	0	63,7	- 2,0
Area agricola (%)	10-20	18,7	0	16	0	15,1	0
$\sigma = HS/HS^*$	3-8	2,9	-3,3	1	-66,7	0,92	-69,3
HCE = (BTC/HU)* σ	70-580	72,9	0	23,6	-66,3	16,4	-76,6
DIAGNOSTIC INDEX	0,85-1	0,85	0	0,75	-11,8	0,60	-40

Distance (%) Evaluation Scores: 0-10 =2; 10-30 = 1; 30-60 = 0,5; > 60 = 0.

DIAGNOSTIC INDEX: 0,85-1 = normal; 0,6-0,85 = alteration; 0,35-0,6 = disfunction; 0,15-0,35 = complex disfunction; < 0,15 near to extinction..

(*)Normal values: according to a sub-natural forest Landscape.



Conclusion

Through this experience, the Italian CONECOFOR programme tried to demonstrate the **necessity** to study forests even with **landscape ecological theory and applications**. In doing this we reached these goals:

- (a) a better understanding of **transformation** processes of a forest landscape unit
- (b) a new capacity for landscape vegetation evaluation and **diagnosis**
- (c) better therapeutic possibilities of **intervention** in nature conservation
- (d) more coherent building of ecological models able to **integrate** vegetation with other landscape parameters
- (e) the possibility to measure the second aspect (b) of **biodiversity** comparing the different levels of organisation and ecological states reached by forests of diverse landscape units