LANDSCAPE ECOLOGICAL METHOD TO STUDY AGRICULTURAL VEGETATION: SOME EXAMPLES FROM THE PO VALLEY

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ABSTRACT – Vegetation is the most important landscape component, as regards to its ability to catch solar energy and to transform it, but also to shape the landscape, to structure the space, to create the fit environment for different animal species, to contribute to the maintenance of a correct metastability level for the landscape, etc. It is a biological system which acts under the constraints of the principles of the System Theory and owns the same properties of any other living system: so, it is a complex adaptive, hierarchical, dynamic, dissipative, self-organizing, self-transcendent, autocatalytic, self-maintaining system and follows the non-equilibrium thermodynamic. Its ecological state can be investigated through the comparison between "gathered data" (pathology) and "normal data" (physiology) for analogous types of vegetation.

The Biological Integrated School of Landscape Ecology provides an integrated methodology to define ecological threshold limits of the different Agricultural Landscape types and applies to agricultural vegetation the specific part of the new methodology already tested to studying forests (the Landscape Biological Survey of Vegetation). Ecological quality, better and worst parameters, biological territorial capacity of vegetated corridors, agricultural field, poplar groves, orchards and woody remnant patches are investigated. Some examples from diverse agricultural landscapes of the Po Valley will be discussed.

KEY WORDS: agricultural landscape, vegetation, landscape ecology, landscape health, Biological Integrated Landscape Ecology, Landscape Biological Survey of vegetation

INTRODUCTION

The Biological-Integrated School of Landscape Ecology (Ingegnoli, 1991b, 1993, 2001b, 2002) underlines that:

– a landscape is a living entity, represented by a system of interacting natural and anthropised ecocoenotopes [eco = ecosystemic properties; coeno = community properties; tope = a definite site and it's chorological and configurational properties] repeated over the land in a recognizable way. This living entity pertains to a specific biological level, situated between the community/ecosystem one and the biome/ecoregional one;

– the structural scheme of this specific living entity is a hierarchical multidimensional tissue (ecotissue), within which temporal dimensions, spatial/configurational dimensions and complex thematic dimensions are intertwisted and integrated on a basic ecomosaic (Ingegnoli, 1993, 1999a, 2002);

– vegetation is the most important landscape component, which acts under the constraints of the principles of the System Theory and owns the same properties of any other living system;

– the importance of vegetation in a landscape is related not only to its ability to catch solar energy and to transform it, but also to the capability of shaping the landscape, of structuring the space, of creating the fit environment for different animal species, of contributing to the maintenance of a correct metastability level for the landscape, etc. So, the mosaic of vegetation coenosis in a landscape (if possible) represents the basic ecomosaic of the ecotissue;

– each biological system (so landscape and vegetation too) is complex adaptive, hierarchical, dynamic, dissipative, self-organizing, self-transcendent, autocatalytic, self-maintaining system and follows the non-equilibrium thermodynamic (Naveh and Lieberman, 1984; Ingegnoli, 1993, 2002, 2005);

– the ecological state (i.e. health) of each biological system can be investigated through the comparison between the 'observed behavior and gathered data' (pathology) and a "normal behavior" and "normal data" (physiology) for this particular type of system (Ingegnoli, 1993, 2002).

So at least all these aspects have to be taken into consideration: thus, a new method in studying vegetation, and agricultural vegetation too, is needed.

AGRICULTURAL LANDSCAPE OR AGRICULTURAL LANDSCAPES?

At first we need to identify how many agricultural landscapes we could find in temperate ecoregion. On a functional basis, the answer is four in the true sense of the world. Table 1 summarizes the different threshold values we propose, concerning:

– the function of active interaction between man and the natural components of the landscape represented by the Human Habitat HH (Ingegnoli, 1993, 1999c, 2001b): that is, the cultural information and the subsidiary energy provided to the ecological system and the following structural and functional modifications;

– the function of energy dissipation carried out by each vegetation community (both natural and anthropic) to maintain a correct degree of metastability; it may be expressed by the Biological Territorial Capacity BTC (Ingegnoli, 1991a, 1993, 1999b, 2002; Ingegnoli and Giglio, 1999);

– the function expressing the relation between the true weight of human individuals on a territory and the minimum space ecologically needed by each of them, depending on human biophysic features and the ecoregion involved: it is called carrying capacity of a landscape (Ingegnoli, 1993, 1999c, 2001b, 2002) and it is expressed by the rate between the Real Habitat Standard pro capita (SH) and the minimum theoretic (SH*);

– the principal configurations of functional systems of elements (i.e. landscape apparatuses) in a landscape, expressed as a combination of the nine most characterising landscape apparatuses with different proportion of them (Ingegnoli, 1993, 2002; Ingegnoli and Giglio, 2005). Remember that a Landscape apparatus is a functional system of tesserae and/or ecotopes arranged in a specific configuration in the landscape. In other words, it is a complex configuration of patches. Each different apparatus is characterised by a specific landscape function (Giglio, 2002).

TABLE 1 - Ecological characterisation of the most important agricultural landscapes of Temperate Ecoregion (from Ingegnoli, 2002; Ingegnoli and Giglio, 2005)

Landscape types	LANDSCAPE APPARATUSES									HH	BTCm	SH/SH*
	GEO	EXR	RNT	RSL	CON	PRT	PRD	RSD	SBS	(%)	(Mcal/m²/y)	
Agricultural-forestal	+ -	+ -	+ -	+ -	+ -	+ -	++	--	+ -	25-50	5.50-3.20	3-10
Agricultural protective	+ -	++	+ -	++	++	++	++	+ -	--	50-70	3.20-1.90	3-10
Agricultural productive	+ -	+ -	--	++	--	+ -	++	+ -	--	65-85	1.90-1.10	3-10
Rural	+ -	+ -	--	+ -	--	+ -	++	+ -	+ -	75-85	1.40-0.90	3-1.75
Suburban	+ -	+ -	--	+ -	--	+ -	+ -	+ -	+ -	*82-92*	*1.00-0.70*	*1.75-0.7*

Note: GEO=geologic; EXR= excretory; RNT= resistent; RSL= resilient; CON= connective; PRT= protective; PRD= productive; RSD= residential; SBS= subsidiary. For explications see below.

METHODOLOGICAL CRITERIA

A landscape ecological fruitful approach subdivides vegetation of agricultural landscapes into the five most important landscape apparatuses (Ingegnoli, 1993, 2002) which it is involved in: productive PRD (agricultural field, orchards, vineyards tesserae and poplar groves *pro parte*); protective PRT (public parks and gardens, sport green tesserae); connective CON (vegetated corridors, hedgerows, poplar groves *pro parte*); resistant RNT (remnant patches of forest or wood); resilient RSL (prairie and shrubs tesserae); excretory EXR (*pro parte*: reeds). Results permits to enhance the adequacy of the vegetation of a tessera to the specific role it plays in the landscape.

Method

A quali-quantitative description (like a phytosociological one) of each type of vegetation coenosis, founded in a given territory, represents the first step. But the order, the health state, the metastability level, the spatial configuration, etc., existing within a vegetation community cannot be shown only through it. Similarly, the contribution of the surveyed coenosis to the order, the health state, the metastability level, the spatial configuration, of the landscape unit (or sub-unit) which it pertains to need a thorough analysis. Moreover, the new vegetation coenosis created in anthropised landscapes by set of alien species which have replaced (or are replacing) autochthonous ones must be considered as well as natural vegetation: especially in agricultural-rural landscapes.

So a specific method has been already tested (Ingegnoli, 1999b, 2001a, 2002, 2005, 2006; Ingegnoli and Giglio, 2004, 2005) named ‘Landscape Biological Integrated Survey of Vegetation’. It is able to check and evaluate the organization degree of each tessera composing the basic ecomosaic and to contribute to define the metastability level of it: the whole for itself and in relation to the upper and lower level of biological organization. In particular, it is able to survey and estimate:

– the ecological quality of each tessera (= ecocoenotope) - or of a group of tesserae - as regards to the maximum of that type of vegetated tessera. It represents the ratio between the measured quality (or medium quality) and the theoretic maximum quality (that is the q. of a tessera in a correct ecological health state) for that type of tessera: it is expressed as the percentage value respect of the maximum (see Ingegnoli, 2002; Ingegnoli and Giglio, 2005).
– the plant biomass volume (above ground) of each tessera as an expression of its capacity of structuring the space;
– the relationships between the investigated tessera and the landscape unit within which it is situated;
– the biological territorial capacity (BTC) estimated value of the tessera. It represents the flux of energy that a system must dissipate during a year to maintain its level of order and metastability (Mcal/m^2/y)(Ingegnoli, 1991a, 2002, 2005);
– almost all the different types of vegetation of the boreal, temperate and mediterranean region, both natural and anthropic. In add, it permits
– to compare different types of vegetation;
– to check inadequate parameters, the whole in a quantitative and reproducible way.

All what previously presented can be gathered through a set of standard forms, one for each type of vegetation, named “ Schedule for the evaluation of (….), applicable also for the estimation of their biological territorial capacity (BTC)” (Ingegnoli, 2002; Giglio Ingegnoli, 2002; Ingegnoli and Giglio, 2005). They present four groups of parameters (concerning: the tessera features, the plant biomass features, the ecocenotopic aspects, the relation between the tessera and its landscape) and four possible classes of evaluation for each parameter. The score related to each of the four evaluation classes had been found on the basis of the specific model of development of the biological territorial capacity of each specific type of vegetation (Ingegnoli, 2002).

As regards as agricultural landscapes, seven types of standard forms are involved. They concern: boreal or temperate or mediterranean forest, vegetated corridors, agricultural fields, urban gardens, prairie and pasture or reed, orchards and poplar groves. An example is shown in Table 2.

Data collected may be displayed through ecograms or other types of diagrams (see Figures 1, 2, 3, 4), and can be elaborated at different degree of details.

What is more: these parametric standard forms permit to test and to measure the positive or negative results of anthropic actions or of changing in management, in terms of biological territorial capacity (BTC) and of the quality of the tessera.

Indeed, this new method must be strictly related to the concept of landscape as an ecological tissue (i.e. ecotissue) (Ingegnoli, 1993, 1999a, 2002): so different thematic, temporal and spatial dimensions have to be integrated and then evaluated in relation to the specific type of agricultural landscape they pertain to.

TABLE 2 - Schedule for the evaluation of agricultural fields, applicable also for the estimation of their biological territorial capacity (BTC) (from Ingegnoli, 2002). Grey cells represent the surveyed characteristics of a Cusago Maize field and bring to the showed final result.

Agricultural fields	1	5	15	31	score
A. TESSERA (Ts) CHARACTERS					
A1 - Vegetation height (m)	< 0.5	0.51-1	1.01-2	> 2.01	weighted av.
A2 - Field form	geometric	polygonal	near -irreg.	near-natur	of Ts
A3 - Tree or shrub presence	None	one	few	scattered	within Ts
A4 - Management	industrial	paraindus.	traditional	biologic	cultivations
A5 - Permanence (years)	< 10	11-50	51-100	> 100	age of Ts
B. VEGETATION AL BIOMASS (ABOVE GROUND)					
B1 - Dead plant biomass	None	low	medium	high	on ground
B2 - Litter depth of the Ts	near 0	< 1.5	1.6-3.5	>3.5	cm
B3 - Plant biomass (kg/m²)	< 1.0	1.01-2	2.1-3	> 3.1	above gr.
C. ECOCOENOTOPE PARAMETERS					
C1 - Diversity	< 10	*11-20*	21-30	> 30	n°sp./Ts
C2 - Sp. of natural phytocoen.	None	sporadic	marginal	patchy	
C3 - Genetic characters	transgenic	allochth.	current	traditional	of cultivars
C4 - Chemicals	> 2	2	1	0	types
C5 - Allochtho noussp. (%)	> 10	10-2	< 2	0	not regional
C6 - Threatened plants	evident	suspect	risk	0	even acidr.
C7 - Soillimiting factors	big patch	small pat.	marginal	none	
C8 - Land capability classes	IV	III	II	I	Table 8.1
D. LANDSCAPE UNIT (LU) PARAMETERS					
D1 - Contagion (semi-nat. Ts)	0	< 10	11-50	> 50	% perimeter
D2 - Margin around cultivation	0	< 50	> 50	complete	% perimeter
D3 - Irrigation type	technical	near tech.	canals	near nat.	
D4 - Role in the landscape unit	reduced	minor	evident	important	
D5 - Type of tillage	technical	mixed	marginal	none	soil
D6 - Geo-physical instability	evident	partial	risk	none	physiotope
D7 - Hedgerows network	no	marginal	partial	complete	presence
D8 - Faunal micro-habitat	none	medium	near good	attraction	Ts/ key sp.
D9 - Landscape pathology interference	extremely serious	near chronic	easy to recover	none	surrounding ecotopes
D10 - Permanence (years)	<25	26-100	101-200	>200	age of LU
E. RESULTS OF THE SURVEY					
E1 - Total score Y (= a+b+c+d)	**a= 9**	**b= 20**	**c= 75**	**d= 348**	**Y= 352**
E2 - Quality of the Ts			**Q=Y/80 6 = 0,43**		

Note: For the explication concerning the italic underlined values, see: Conclusions.

RESULTS AND DISCUSSION: SYNTHETIC INVESTIGATIONS

Some examples from the Lombardy part of the Po valley are shown. Each case study regards an operative landscape unit within an agricultural landscape: two are localized west of Milan (Besate and Cusago), one south of Milan (Oltrepo pavese) and one is East of Milan (Trezzo s.A.-Solza). The two L.U. of Besate and Trezzo s.A.-Solza are situated within Natural Regional Parks (respectively Ticino River Regional Park and Northern Adda River Regional Park) while the Cusago municipality lies within the South Milan Agricultural Park! Dimensions of the studied L.U. are: 616 ha (Besate); 1157,40 ha (Cusago, the municipality perimeter); 3906,40 ha (Trezzo s.A.-Solza); 1029,5 ha (Oltrepo pavese). On the basis of its proper landscape ecological behaviour, we may attribute each studied L.U. to a specific agricultural landscape type (see Tab.1): agricultural productive l. (Besate L.U.); rural-agricultural l. (Cusago and Oltrepo pavese L.U.); suburban l. (Trezzo s.A.-Solza) (Giglio Ingegnoli, 2006).

After the investigation of about 305 vegetated tesserae, the first synthetic results we can show (Tables 3, 4, 5, 6) concern the medium biological territorial capacity value and two evaluation values: the medium ecological quality and the medium BTC development level (Ingegnoli, 2005)

– for each group of different types of vegetated tesserae,
– for the four most important landscape apparatuses (Resistent, Protective, Productive, Connective) of the four examined L.U.,
– as a preliminary indication for the agricultural landscapes of Lombardy Region plain.

Concerning the Resistant (RNT) and Protective (PRT) apparatuses (Table 3) they cover an infinitesimal part of the different L.U. surfaces: this is a pity, because remnant woody patches (RNT) (from a phytosociological point of view, we find *Querco-Carpinetum* and associations pertaining to *Salicion albae* and *Populion albae*) show an acceptable quality and a positive BTC development level both in Besate and Cusago L.U. (remember that they pertain to Regional Parks); on the contrary, Oltrepo pavese L.U. is lacking of woody patches and within the North Adda River L.U. their quality and their BTC development level are around the 38% of their possibility. The evaluation of tesserae composing the protective PRT apparatus show values around the third part of the possible maximum, with the positive exception of the castle garden of Trezzo on the Adda River, probably because of its good plant biomass volume. In the same time, the best ecological quality pertains to house gardens (even if it reach only 38,43%!), while the worst pertain to sports green: both might be improved.

The resilient RSL apparatus (Table 4) shows a great difference among the ecological quality and BTC development level of permanent grasslands (the phytosociological coenosis of reference pertain to *Arrhenatheretalia*), with the worst situation in the Ticino River L.U. (Besate) with only 25,7 % of quality as regards as 48% of ecological quality and 55% of BTC development level of Cusago L.U.

TABLE 3 - Medium biological territorial capacity value, medium ecological quality and medium BTC development level of the resistent RNT and protective PRT landscape apparatuses of three L.U.

Resistent L. Apparatus		% Medium Tot. Quality	BTCm (Mcal/m²/y)	% BTCm/BTC*	% Surface on the total LU. area
Besate	Wood remnant patches	53,73	6,21	60,88	7,5
Cusago	Wood remnant patches	64	7,48	73,33	1,13
Trezzo s.A.-Solza	Wood remnant patches	39	3,79	37,16	5,57
Indicative medium L. Appar. values		**52,24**	**5,83**	**57,12**	
Protective L. Apparatus					
Trezzo s.A.-Solza	Castle garden	31,6	3,18	49,88	0,04
Cusago	House gardens	36,9	2,45	38,43	2,73
Trezzo s.A.-Solza	Sports green	28,4	1,8	28,23	0,06
Cusago	Sports green	26	1,69	26,51	0,29
Trezzo s.A.-Solza	Golf course	37,06	1,34	21,02	1,34
Trezzo-Solza Land. App. Md values		32,35	2,11	33,04	
Cusago medium Lands. App. values		31,45	2,07	32,47	
Indicative medium L. Appar. values		**31,99**	**2,09**	**32,8**	

Notes: **BTCm** = the medium BTC estimated value represents the medium flux of energy that the examined tesserae dissipate during a year to maintain their level of order and metastability (Mcal/m²/y).
% Med. Tot. Quality = the ecological quality of the examined group of tesserae represents the percentage ratio between the medium measured quality and the theoretic maximum quality (that is the q. of this specific type of tesserae in a correct ecological health state) for the examined type of tesserae.
% BTCm/BTC* = The BTC development level represents the percentage ratio between the surveyed BTC and the theoretic threshold value of BTC* proper of each vegetation type (Ingegnoli, 2005).

TABLE 4 - Medium biological territorial capacity value, medium ecological quality and medium BTC development level of the resilient RSL landscape apparatuses of four L.U.

Resilient L. Apparatus		% Med. Tot. Quality	BTCm (Mcal/m²/y)	% BTCm/BTC*
Oltrepo pavese	Permanent grasslands	31,14	0,41	34,45
Besate	Permanent grasslands	25,71	0,35	29,41
Cusago	Permanent grasslands	48	0,65	54,6
Cusago	Shrubland	27	1,83	53,82
Trezzo s.A.-Solza	Shrubland	35	1,07	31,5
Indicative medium L. Appar. values		**33,37**	**0,86**	**40,76**

Actually, this type of vegetation in the Po Valley is disappearing: usually, it is so impoverished and altered that it is very difficult to assign the different tesserae to a phytosociological association. The proposed method permits us to evaluate them and to propose improving actions even if we do not exactly know their phytosociological association of reference.

Concerning the Productive PRD apparatus, as you can see (Table 5), even the best of the four examined L.U. (Cusago) presents medium quality values worse than the minimum acceptable threshold value, that is 60%: in add, while soybean fields, cornfields, rice-fields, barley fields shows a medium quality value higher than 50%, the worst vegetation type tessera are maize fields, forage and poplar groves. In this L.U. the last two one types show the worst values concerning the BTC development level too. What is more, the two L.U. pertaining to the Regional Parks present medium total quality and BTC development level quite similar, between 30 and 40% of the optimum values: the same range of values may be utilised as a preliminary indication of the medium values for the Lombardy plain agricultural landscapes.

TABLE 5 - Medium biological territorial capacity value, medium ecological quality and medium BTC development level of the productive PRD landscape apparatuses of four L.U.

	Besate			Oltrepo pav.			Cusago			Trezzo sull'Adda-Solza		
Productive apparatus	**% Med. Tot. Quality**	**BTC m**	**% BTC m/ BTC***	**% Med. Tot. Quality**	**BTC m**	**% BTC m/ BTC***	**% Med. Tot. Quality**	**BTC m**	**% BTC m/ BTC***	**% Med. Tot. Quality**	**BTC m**	**% BTC m/ BTC***
Soybean fields	–	–	–	26,18	0,94	58,45	55	0,87	53,87	25,8	0,48	29,72
Cornfields	44,66	0,76	47,06	27,54	0,49	30,5	51	0,86	53,25	35,36	0,59	36,53
Maize fields	35,66	0,71	43,96	28,78	0,60	37,15	44,3	0,88	54,49	31,3	0,61	37,77
Rice fields	35,3	0,61	37,77	–	–	–	52,5	0,89	55,11	–	–	–
Tomato fields	–	–	–	33,72	0,49	30,34	–	–	–	–	–	–
Bairley fields	–	–	–	–	–	–	50	0,84	52,01	–	–	–
Sugar beet fields				28,29	0,42	26,01	–	–	–	–	–	–
Forages	–	–	–	28,77	0,42	26,01	35	0,48	40,34	34	0,49	41,18
Orchards	–	–	–	13,96	0,42	26,01	–	–	–	33,8	0,65	16,99
Vineyards	–	–	–	11,14	0,42	26,01	–	–	–	–	–	–
Hazel plantation	–	–	–	–	–	–	–	–	–	–	3,79	37,15
Poplar groves	31,33	3,65	35,8	–	–	–	32	3,52	34,51	27	3,27	32,06
Tot. PRD app.	36,69	1,43	41,15	24,8	0,75	37	45.69	1,19	49,08	31,21	1,41	41,9
Indicative medium I.Appar. values	*% Med. Tot. Quality = 34,6*			*BTCm = 1,2 Mcal / m² / y*			*%BTCm / BTC* = 42,28*					

RESULTS AND DISCUSSION: MORE DETAILED INVESTIGATIONS

To check the principal reasons of these results, it is possible to make a thorough analysis of the problem, with the help of ecograms (Figures 1, 3, 4). A first analysis concerning maize and wheat fields has been already presented (Giglio Ingegnoli, 2006). Fig. 1 shows an example concerning the surveyed values of the four different groups of parameters for the Sugar Beet fields of the Oltrepo pavese L.U. The upper part shows an ecological quality medium value of 28% with a BTC development level of 26,01%: the worst values concern Plant biomass parameters (remember that we consider plant biomass characteristics above ground: in this case only foliage), but Tessera parameters are low too, while the ecocoenotopes ones are a little better, even if they reach only 40% of the maximum.

The lower part of Fig. 1 allows a more detailed investigation as it shows the quality values of each of the 26 evaluated parameters: as you can check, the only nine fairly positive parameters are related: six to the ecological characteristics of the territory (absence of geophysical instabilities, age of permanence of this territory as an agricultural one and of the tessera as an agricultural field, absence of soil limiting factors, rather adequate soil capability class); two to the chosen cultivar type (genetic characters, almost absence of threatened plants) and only one (low level of allochthonous species) can be interpreted as an indication of the ecological quality of the tessera itself !

A deeper analysis is possible if we consider in detail each one of the 26 examined parameters: for each parameter we counted the % subdivision of collected data among the four evaluation classes of the Survey parametric schedule (Table 2) and then represent them through an histogram. The "a %" concerns the worst evaluation class, the "d %" the best evaluation class. So, for example, with regards to sugar beet field tesserae (Fig. 2), we can observe that about 55% of the surveyed tesserae do not present dead plant biomass, while the last 45% had a low quantity of it; or that 40% of the sugar beet field tesserae contain less than 10 species, while the other 60% doesn't overcome 20 species; among them, within about 70% we found only sporadic species of natural phytocoenosis while about 40% had more then 10% of allochthonous species, about 30% had from 2% to 10% and about 20% had no allochthonous species!; or that only less than 10% of the fields of this type of cultivation are in touch with tesserae of seminatural vegetation and with a complete hedgerows network, about 12% are near a marginal hedgerows network and around the other 78% no hedgerows network is found.

RESULTS AND DISCUSSION: SOME NOTES ON THE CONNECTIVE LANDSCAPE APPARATUS IN AGRICULTURAL LANDSCAPES

In this paper it is impossible to deal with the complex problem of the hedgerows network in the agricultural landscape, but we have to remember that hedgerows and vegetated corridors compose the Connective Landscape Apparatus CON (Table 6). Let us show briefly some discussion points:

– comparing Besate and Oltrepo pavese situation, the first show a higher BTC but a worse ecological quality;

– vegetated corridors of Cusago L.U. are better than the others as a great part of them concern the so called “Fontanili”, that is they arise around and along natural resurgence, that are typical of a specific belt of the Po plain;

– poplar groves play an important role within the Connective apparatus, as linkages (not as nodes), so their bad ecological quality reduces the medium total quality of the l. apparatus, even when vegetated corridors quality and BTC development level is acceptable (see Cusago, Table 6);

– a more complete description of CON apparatus need to refere to more specific data on the ecological network connectivity and circuitry, as through the indexes α and γ (Forman and Godron, 1986)(Table 6). Note that the same number of nodes or vertices (87) for Besate and Cusago bring to very different linkage numbers (respectively 123 vs. 73) and to a negative circuitry value (-0,07) for Cusago, only because of the different spatial disposition and prevailing direction of corridors (Fontanili lengthen NW-SE);

– the synthetic evaluation of vegetated corridors within the three examined L.U. (Fig. 3) can be supported by detailed ecograms (Fig. 4) concerning the structural aspects, the functional aspects and the landscape basic aspects of the examined tesserae (note that parameters are the same of the Vegetated corridors Standard Survey Schedule - Ingegnoli, 2002 - but here they have not been grouped in Tessera char., Plant biomass ch., Ecocoenotope ch., L.U. ch., as usual, while in structural, functional and landscape basic characters, as an help in understanding how the considered tessera is able to react to its territorial basic conditions and human management). So even if the medium ecological quality of the basic territorial and human management parameters seem to be better in Oltrepo pavese L.U. (47,35%) vs. Besate L.U. (44,67)(as, in the first, corridors are more curvilinear and they present a more correct quantity of dead plant biomass), the structural quality and the functional quality of the first (respectively 23,33 and 27,8%) are worse than that of the second (43,98 and 34,8). Indeed, vegetated corridors of Besate are more structured but less functioning while in Oltrepo L.U. it is the opposite.

– Figure 4 give us specific and clear indications on better and worse parameters.

TABLE 6 - Medium biological territorial capacity value, medium ecological quality and medium BTC development level of the Connective landscape apparatuses of three L.U.

Connetive L. Apparatus	**Besate**	**Cusago**	**Oltrpo pav.**	**Tot. apparatus**
Veg.Corridor% Med.Tot.Quality	40,06	51,00	36,69	**38,20**
Popolar grove % Med.Tot.Quality	31,33	32,00	–	
Vegetated Corridor %BTCm/BTC*	41,66	58,17	31,11	**40,25**
Popolar grove %BTCm/BTC*	35,80	34,51	–	
Vegetated corridor BTCm	3,00	4,20	2,24	**3,32**
Popular grove BTCm	3,65	3,52	–	
Apparatus % Med.Tot:Quality	35,7	41,3	36,69*	
*Apparatus % BTCm/BTC**	38,73	46,34	31,11*	
Apparatus % BTCm	3,32	3,86	2,24*	
Ecolog. Network Connectivity index (γ)	0,48	0,28	0,27	
Ecological network Circuity (α)	0,22	-0,07	-0,1	
Lincages/Nodes/V	1,4	0,84	0,7	

Conclusions

The goal of this paper is to briefly point out some of the principal possibilities given us by the presented methodology concerning agricultural landscapes.

The Standard Survey Schedules summarise the most important questions concerning the analysis and evaluation of natural and anthropised vegetation coenosis in a quantitative and reproducible way, especially as regards to the ecological quality of each tessera in relation to the maximum of that type of vegetated tessera; the relationships between the investigated tessera and the landscape unit within which it is situated; the biological territorial capacity (BTC) of the tessera; inadequate parameters. The use of ecograms, as suggested by Pignatti, let us to compare different vegetation types within the same landscape unit and the same vegetation type among different landscape units.

First results underline that ecological vegetation quality is not only a value *per se*, but it has a fundamental importance for the functioning of the landscape. What emerges is that vegetation quality in studied cases is around 1/3 of its possibilities in all the examined Landscape Apparatuses (with the exception of the resistant l.a.) and the Biological Territorial Capacity development level does not overcome 40%. It is a very negative impressive result and highlights the urgency for actions to improve natural and anthropic vegetation quality in agricultural landscapes and to turn about the development direction.

Following such an evaluation, the last - but not the least - exploitation of the Standard Survey Schedules (as the one of Table 2) enables us to decide

– what kind of parameters need to be improved in quality (e.g. ecocoenotopes parameters or tessera parameters, structural or functional ones),
– on what of the specific characteristic we have to act (e.g. the field form or tree presence for agricultural fields or the strong presence of allochthonous species or the absence of water for corridors) and to
– estimate in a quantitative way the possible increasing values.

For example, see the modifications shown in Table 2 (italic underlined cells) changing to near-irregular field form, to a traditional management, to a medium value of dead plant biomass on the ground, to a higher diversity and presence of natural phytocoenosis species, to only one type of chemicals, to slighter tillage activities and to a marginal presence of a hedgerows network and of a minimum faunal micro-habitat. They give us 87 score points in add, bringing the total score of the future examined tessera to 439 and the Ecological quality from 0,43 to 0,545, the medium BTC from 0,84 to 1,01 and the BTC development level to 62,35%: a little improvement step.

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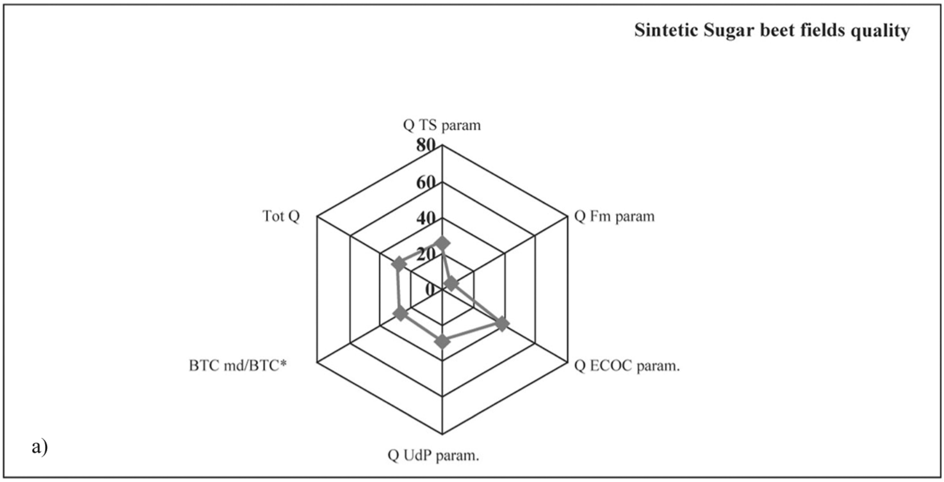


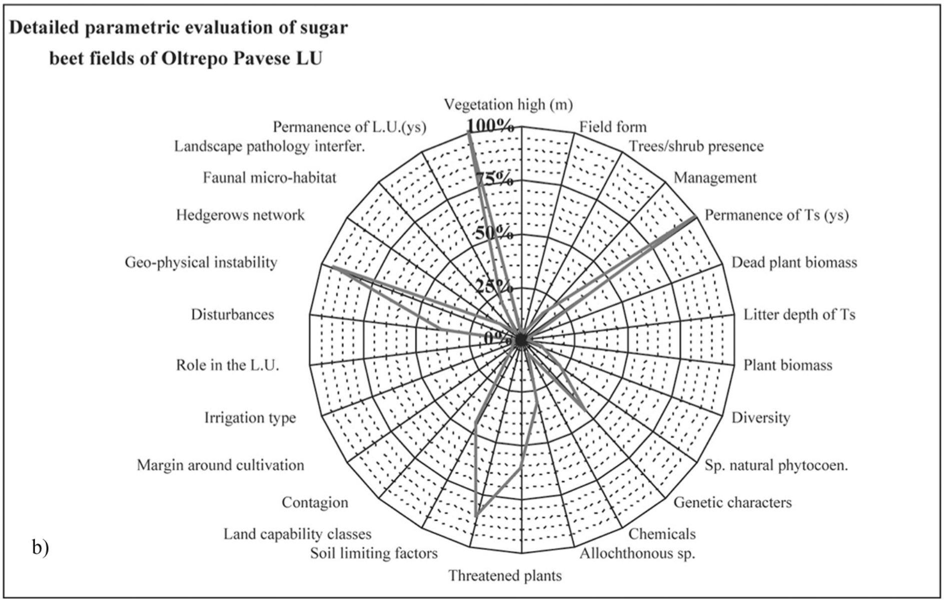
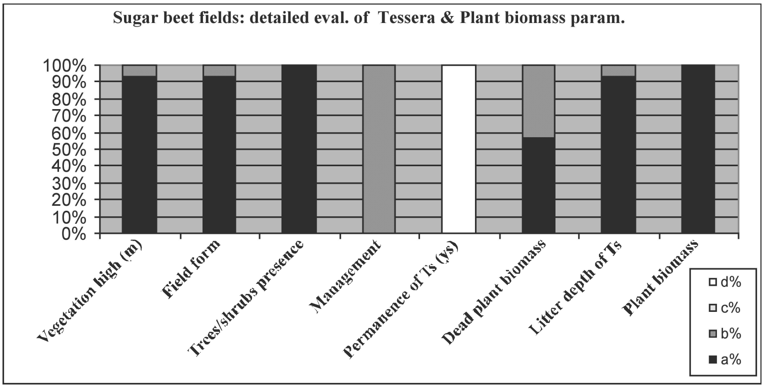
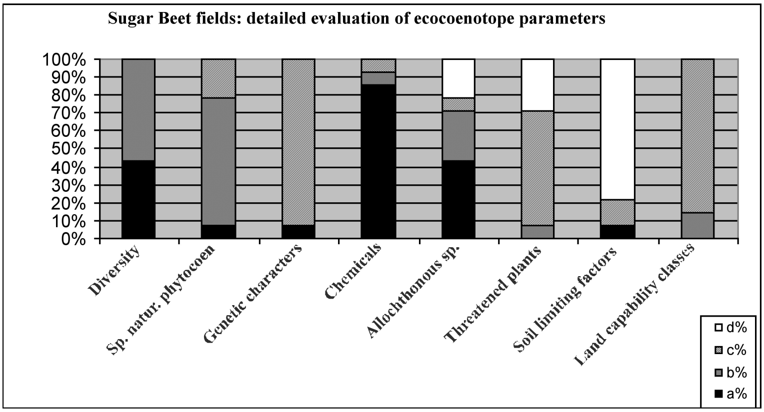


FIGURE 1 - (a) Sintetic diagnostic evaluation of surveyed Sugar Beet Fields of Oltrepo pavese L.U.: it shows the specific quality values of each of the four groups of parameters of the Survey parametric schedule (see Table 2). Q TS= medium quality of the Tessera parameters; Q FM= medium quality of the plant biomass parameters; Q ECOC= medium quality of the ecocoenotope parameters, that is of the tessera as a proper biological level; Q LU= medium quality of the Landscape Unit parameters, that is of the relationship between the tessera and the L.U. within which it lies.

(b) Detailed diagnostic evaluation of each of the 26 evaluated parameters (see Table 2).





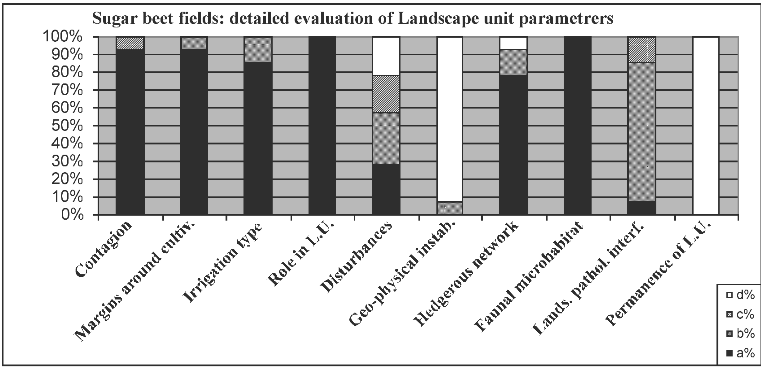


FIGURE 2 - Detailed evaluation of specific parameters of Sugar beet fields in Oltrepo Pavese L.U. For each parameter the percentage amount of surveyed data divided among the four evaluation classes is shown: going from the left to the right of the Standard Survey Schedule evaluation classes (Table 2) black represents the worst (score 1), white represents the best (score 31).

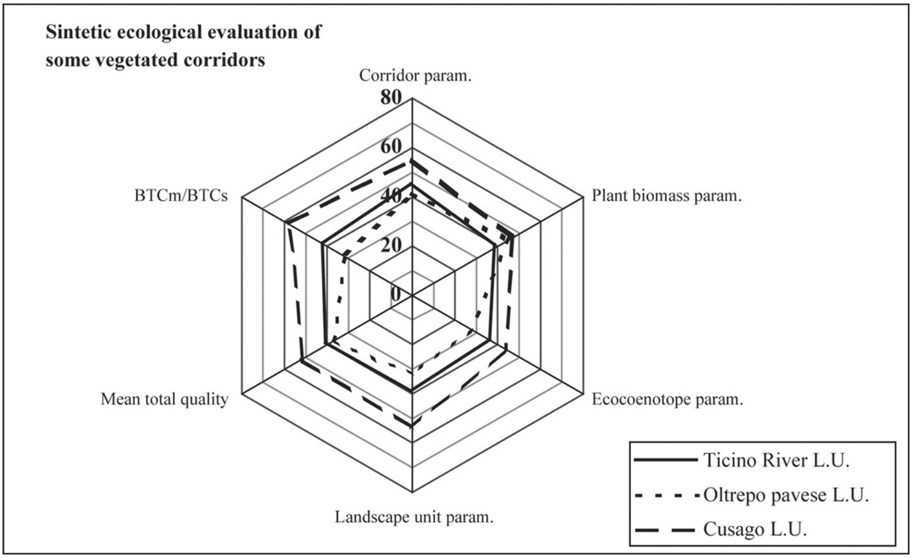
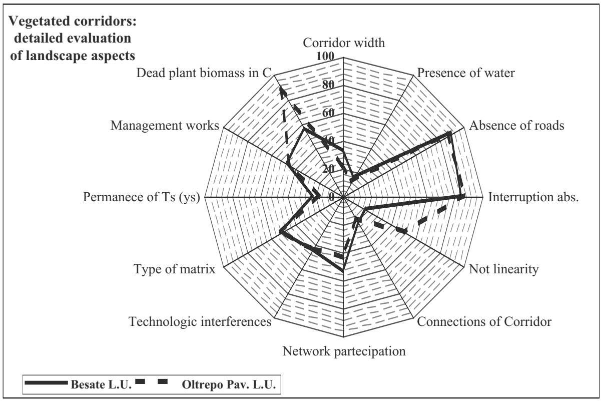
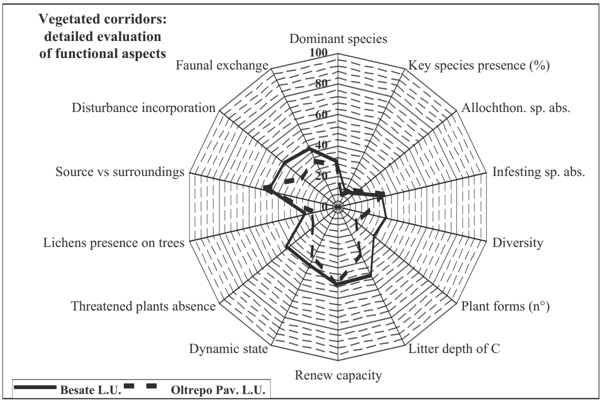


FIGURE 3 - Synthetic evaluation of vegetated corridors in accordance with the six groups of parameters already presented in Fig. 1. Ticino River L.U. is the same of Besate L.U.





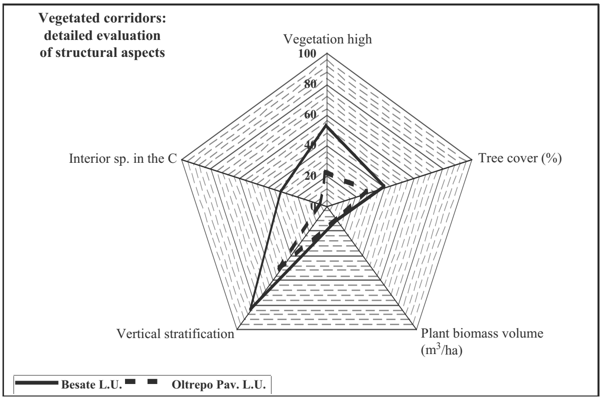


FIGURE 4 - Detailed parametric evaluation of vegetated corridors of two L.U. Here, the 31 parameters (see the proper Schedules in Ingegnoli, 2002) have been assembled in a different way, to highlight the tesserae structural and functional quality level in relation to the territorial characteristics and human management. Remember that "quality" is expressed as the percentage ratio between gathered values and the optimal value for each parameter.