The EMAS Recognition of the Livenza Furniture District in the Province of Pordenone (Italy)

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Abstract

The EC Regulation No 761/2001, known as EMAS II, provided the possibility of obtaining the EMAS recognition also by industrial districts. As a consequence, the Livenza furniture district obtained the EMAS recognition in 2006 as the first industrial district in Italy. The Livenza district includes several manufacturing enterprises which carry out their activity in 11 municipalities of the province of Pordenone, Italy. Industries of wood, wood and cork products, straw articles, weave materials and furniture take part in the district. A Territorial Environmental Analysis was drawn up to obtain the recognition, by collecting data and information from questionnaires compiled by more than 100 firms and by the 11 municipalities of the district. For the EMAS registration renewal, obtained by the district in 2016, the Territorial Environmental Analysis was updated by revising in particular the methodology of evaluation of environmental impacts. More specifically, Ecological Footprint (EF) (that is, the quantitative evaluation of consumption of raw materials and energy and of waste production) was compared with Carrying Capacity (CC) (that is, the quantitative evaluation of the area able to assure the availability of the resources required and to absorb waste produced). In this way, it was possible to put in light that the EF of the district is much greater than the corresponding CC. The main actions which might be chosen to reduce EF have been pinpointed, with the aim of warranting a better sustainability of the district activities.

Keywords: EMAS, Livenza furniture district, Territorial environmental analysis, Ecological footprint, Carrying capacity

1. Introduction

The bound between enterprises and environment is strong. Water footprint (Zhao et al., 2009; Chen et al., 2017), carbon footprint (Wiedmann and Minx, 2008; Høgevold, 2011), ecological footprint (Herva et al., 2008), Life Cycle Assessment (LCA) (Bulian et al., 2014) are used as recent indicators of environmental sustainability, in the perspective of sustainable development goals (Agenda 2030, 2015).

The European Community chose the EMAS regulation as one of the tools to reduce environmental impacts of firms (Merli et al., 2016). In Italy, the EC Regulation No 761/2001, known as EMAS II, enabled small and medium enterprises to improve the competition on the market (Citterio and Pizzurno, 2005), anyway in some European countries, like Germany, there was a decrease in the number of registrations (De Leo et al., 2003).

Many papers were published on EMAS registration in different sectors: in wood furniture enterprises (Gordic et al., 2014; Høgevold, 2011), in Italian organizations (Merli et al., 2016), in Italian clusters (Battaglia et al., 2010, Daddi et al., 2012; Merli et al., 2014; Pezzillo et al., 2011; Provincia di Lucca, 2006).

In 2006, the Livenza furniture district, located in the province of Pordenone (Italy), was the first Italian industrial district that obtained the EMAS registration. The "Rapporto di Analisi Ambientale Territoriale del Distretto del Mobile di Pordenone (Report of Territorial Environmental Analysis of the Furniture District of Pordenone), published in 2006, described the methodology adopted for the EMAS obtainment. A network of institutional subjects, ARPA FVG (Regional Agency for Environmental Protection of the Friuli Venezia Giulia region), Industrial Union of Pordenone, with the involved municipalities and the Friuli Venezia Giulia region, developed some ideas about the environmental impact of the local productive furniture chain, starting from the environmental matrices and their pollution (Consorzio del Mobile Livenza, 2006).

The EC No 1221/2009 Regulation, the so called EMAS III, gives more importance to the environmental performances of the organizations in all economic sectors (Hrebicek et al., 2011; Unioncamere Piemonte, 2011); in 2009 and 2010, the more restrictive rules for obtaining the registration caused a decrease of EMAS registration in Italy (Ispra, 2017).

Because of the global crisis, since 2015, many organizations, in particular small firms operating in the South of Italy, decided not to renew the EMAS registration (Preziosi et al., 2016).

Anyway, in 2016 the Livenza furniture district obtained the renewal of the EMAS registration, and during the month of June 2017, one of the checks, periodically foreseen by the registration, ended with success (ARPA FVG, 2017).

This work not only proposes a methodology for understanding where and how the industrial productions of the Livenza furniture district exceeds the available natural resources (Borucke et al., 2013), but also provides significant information about what can be improved for a sustainable future of the involved environment.

2. Methods

In 2005, data and information were gathered by questionnaires sent to the enterprises and to the municipalities of the District, and by interviews with the main stakeholders of the territory.

In 2015, environmental data and information which ARPA FVG had already collected by the enterprises for its institutional purposes were employed. Data and information relative to enterprise characteristics were taken from the Registro Imprese database by Infocamere (registroimprese.it, 2015).

3. Case Study Presentation

The Italian Law No 317/1991 defined industrial districts as territorial systems, geographically limited and constituted by close areas, characterized by a high concentration of small and medium enterprises with the same productivity specialization. An industrial district is an optimal ambit for the integrated growth of competitiveness, since it is possible to exploit the same infrastructure to manage environmental impacts (wastewater treatment plants, waste production, etc.). In this area, public administrations have an important role, promoting the sustainability culture and financing local enterprises to achieve a high environmental level, contributing in this way to maintain and improve working and human resources (Citterio and Pizzurno, 2005).

With the Act No 457 of March 3rd, 2000, the Friuli Venezia Giulia region identified the territory typified by the economic category “furniture manufacturing” according to ISTAT classification 36.1 - ATECO 2002 (Sistema Statistico Nazionale, 2002) in the municipalities of Azzano Decimo, Brugnera, Budoia, Caneva, Chions, Fontanafredda, Pasiano di Pordenone, Polcenigo, Prata di Pordenone, Pravisdomini and Sacile. Actually, the production chain involves also enterprises settled in the Veneto region, in the municipalities of Mansuè, Motta di Livenza and Oderzo.

The Livenza district production includes different types of home/office furnishing, like kitchen units, livingrooms, bedrooms, bathrooms, office furniture and seats, complements. Furthermore, several components of the furniture chain, like shutter doors, drawers and semi-manufactured articles, are produced by some enterprises of the same area, leader at the national and international levels.

Furniture production chain follows three main process flows: preparation of wooden blocks, for furniture or parts of it, made in solid wood; production and melamine coating of panels, for furniture or parts of it, made in chipboard; and production and preparation of wood veneer and coats, for melamine coating of panels.

In Table 1, the distribution in 2005 and 2015 of the furniture chain production companies, according to ATECO divisions, in the District municipalities is reported (Sistema Statistico Nazionale, 2009). Only active companies (a subset of the companies registered in the Companies Register) were considered. ATECO divisions involved are: C16 "Wood and wooden and cork products (furniture excepted) industries and manufacturing of straw and interlacement materials products" and C31 "Furniture manufacturing".

Table 1. *Distribution of furniture chain production companies (active enterprises), according to ATECO divisions, in the District municipalities, in 2005 and 2015 (personal elaboration from Consorzio del Mobile Livenza, 2006 and registroimprese.it, 2015).*

	Year 2005			Year 2015		
Municipality	ATECO C16 division	ATECO C31 division	Total	ATECO C16 division	ATECO C31 division	Total
Azzano Decimo	23	38	61	15	33	48
Brugnera	24	76	100	14	58	72
Budoia	7	8	15	5	3	8
Caneva	6	13	19	1	8	9
Chions	7	14	21	2	9	11
Fontanafredda	24	27	51	16	18	34
Pasiano di Pordenone	23	68	91	20	42	62
Polcenigo	3	4	7	2	8	10
Prata di Pordenone	15	71	86	10	50	60
Pravisdomini	23	26	49	14	20	34
Sacile	27	52	79	19	38	57
Total	182	397	579	118	287	405

For each manufacturing category, total District companies decreased in the decade 2005-2015. In Tables 2 and 3, total numbers of companies are divided in industrial companies and artisan companies for 2005 and 2015, respectively; the number of employees is associated to the number of manufacturing units.

Table 2. *Distribution of furniture chain production companies (active enterprises) and related employees in the District municipalities in 2005 (personal elaboration from Consorzio del Mobile Livenza, 2006).*

	Whole District	Azzano Decimo	Brugnera	Budoia	Caneva	Chions	Fontanafredda	Pasiano di Pordenone	Polcenigo	Prata di Pordenone	Pravisdomini	Sacile
Industry, active companies												
Industrial business number	210	18	48	7	5	7	20	31	2	34	19	19
Employees number	7889	408	2.042	182	229	142	634	999	75	2406	401	371
Employees per establishment	37.6	22.7	42.5	26.0	45.8	20.3	31.7	32.2	37.5	70.8	21.1	19.5
Artisan business, active companies												

Artisan business number	177	23	21	3	5	4	12	36	1	21	26	25
Employees number	1152	173	102	3	23	23	66	247	2	137	193	183
Employees per establishment	6.5	7.5	4.9	1.0	4.6	5.8	5.5	6.9	2.0	6.5	7.4	7.3
Industrial and artisan business, total active companies												
Total companies	387	41	69	10	10	11	32	67	3	55	45	44
Total employees	9041	581	2144	185	252	165	700	1246	77	2543	594	554
Employees per establishment	23.4	14.2	31.1	18.5	25.2	15.0	21.9	18.6	25.7	46.2	13.2	12.6

Table 3. *Distribution of furniture chain production companies (active enterprises) and related employees in the District municipalities in 2015 (personal elaboration from registroimprese.it, 2015).*

	Whole District	Azzano Decimo	Brugnera	Budoia	Caneva	Chions	Fontanafredda	Pasiano di Pordenone	Polcenigo	Prata di Pordenone	Pravisdomini	Sacile
Industry, active companies												
Industrial business number	214	17	49	4	3	6	15	36	5	37	15	27
Employees number	7159	436	1515	39	103	97	523	1344	83	2033	395	591
Employees per establishment	33	26	31	10	34	16	35	37	17	55	26	22
Artisan business, active companies												
Artisan business number	191	31	23	4	6	5	19	26	5	23	19	30
Employees number	1133	207	138	10	37	36	90	136	7	144	155	173
Employees per establishment	6	7	6	3	6	7	5	5	1	6	8	6
Industrial and artisan business, total active companies												
Total companies	405	48	72	8	9	11	34	62	10	60	34	57
Total employees	8292	643	1653	49	140	133	613	1480	90	2177	550	764
Employees per establishment	20	13	23	6	16	12	18	24	9	36	16	13

In Table 4, the number of companies settled in the District and the number of employees (in absolute and in percentage values) in the years 2005 and 2015 are reported.

In both years considered, companies belonging to the furniture chain production constituted the production fabric characterizing the territory of the 11 Municipalities examined. Nevertheless, in the whole District there was a reduction over time of the number of active companies and of the number of employees, both in absolute and in percentage values: the number of active companies decreased from 253 (43.1% of total industries settled in the territory) to 214 (39.7% of total industries settled) and the number of employees decreased accordingly from 10249 (56.6% of total employees of the industrial sector) in 2005 to 7159 units (51.1% of total employees of the industrial sector) in 2015.

Table 4. *Occurrence of furniture sector over total industries present in the District (personal elaboration from Consorzio del Mobile Livenza, 2006 and registroimprese.it, 2015).*

Municipality	Active industries		Employees	
	Year 2005	Year 2015	Year 2005	Year 2015
Azzano Decimo	27 (14.8 %)	17 (23%)	739 (24.6%)	436 (28.6%)
Brugnera	31 (64.5%)	49 (4%)	1.921 (73.8%)	1.515 (70.9%)
Budoia	6 (50.0%)	4 (4%)	212 (59.0%)	39 (41.1%)
Caneva	16 (37.5%)	3 (25%)	372 (70.7%)	103 (46.6%)
Chions	19 (31.6%)	6 (1%)	694 (25.9%)	97 (10.4%)
Fontanafredda	34 (32.4%)	15 (30.4%)	1.970 (21.3%)	523 (23.2%)
Pasiano di Pordenone	28 (64.3%)	36 (57.4%)	1.208 (70.7%)	1.344 (81.0%)
Polcenigo	5 (40.0%)	5 (31.3%)	156 (47.4%)	83 (31.1%)
Prata di Pordenone	38 (63.2%)	37 (58.8%)	2.065 (88.1%)	2.033 (85.1%)
Pravisdomini	8 (87.5%)	15 (50.7%)	226 (96.0%)	395 (59.7%)
Sacile	41 (19.5%)	27 (31.5%)	686 (36.6%)	519 (31.7%)
Total	253 (43.1%)	214 (39.7%)	10.249 (56.6%)	7.159 (51.1%)

Within the municipalities, variables followed the global trend on average. Despite this fact, it is still clear that, to understand the sustainability of the territory, it is necessary to analyze the chain production processes, not only in their specific aspects, but especially in interconnections among different productive units, inside the District but also outside its boundaries.

4. Results and Discussion

4.1. Obtainment of the EMAS recognition in 2006

The revision of the EMAS regulation (EC Regulation No 761/2001) provided the possibility of EMAS registration also by industrial districts. Consequently, in 2005 the Ecolabel Eco-audit Committee supplied the indications for the application of the EMAS Regulation in "homogeneous productive fields" in Italy. Therefore, to obtain the EMAS registration, the Livenza furniture district followed the procedure proposed by the Committee for the application of the regulation to industrial districts. Practically, a Territorial Environmental Analysis was drawn up and allowed an overall evaluation of the environmental problems, which are joined with the productive activities of the furniture district by:

- The characterisation of the environmental scenario where the District is located;
- The analysis of the furniture chain, by identifying the activities characterizing the productive processes;
- The identification and assessment of the environmental aspects and relative impacts deriving from the activities of the firms of the District;
- The identification of the support processes for the enterprises of the furniture chain and of their environmental aspects;
- The identification of the legislative rules for the furniture chain firms;
- The identification of the activities of the municipalities and of the other local authorities of the District area;
- The evaluation of the relationships among the environmental aspects, in terms of technical and managerial organization, both of public and of private authorities, present in the District.

Therefore, in the Territorial Environmental Analysis data and information were reported:

- Related to the territory of competence of the District;

- About the environmental aspects and impacts of the furniture chain;
- About the environmental aspects and impacts of the local authorities of the territory in which the District is located.

Data and information required for the drawing up of the report were gathered by questionnaires compiled by more than 100 firms and by the 11 municipalities of the District. The two questionnaires cannot be reported in the paper, in consideration of the limited space available for the full text, but can be required to the corresponding author by all interested people.

By combining the data relative to the Significance of the Environmental Aspects (SEA) of the District enterprises with the criticalities put in light by the analysis of the activities arranged by the local authorities, the priorities of interventions of environmental improvement were identified. More in detail, the pressures of the enterprises on environmental matrices (water resources, air, soil, etc.) were taken into consideration and, on the other hand, the situation of the environmental matrices, in terms of quality of water, air, soil, etc., were assessed. The goal was to underline possible elements of criticality by comparing the pressure data of the District firms and the indicators of the environmental state. Furthermore, the perception of local people about the environmental problems (air pollution, health protection, vehicular traffic, etc.) had a relevant weight for the determination of the intervention priorities.

A sequence of the SEA was defined by the following parameters:

- Social and Territorial Sensitivity (STS), which in turn is represented by

a) Territorial Sensitivity on the quality of the environmental matrices,

b) Social Sensitivity of the population with respect to environmental and health themes;

- Importance of the Environmental Aspects (IEA) by the chain firms.

Specific schedules were prepared for the objective evaluation of the SEA. The schedules organized to evaluate the level of Territorial Sensitivity were compiled on the basis of the indicators describing the state of the environmental matrices of the territory, related to the 11 municipalities taken into consideration.

Social Sensitivity was evaluated both by a press review of the main national and local newspapers, and by a proper questionnaire, given to the involved parts of the District.

The study “Impatto della direttiva solventi sulle aziende industriali della filiera del legno nelle Province di Pordenone e Udine” (“Impact of the solvent directive on the industrial firms of the wood chain in the provinces of Pordenone and Udine”) of 2002 was utilized as the starting basis to determine SEA (Bulian and Tiberio, 2003). Furthermore, the indications provided by the study were updated with a questionnaire about environmental indicators connected with the phases of the process of the furniture chain. The questionnaire was proposed to more than 100 sample firms of the District.

Finally, to define the complete picture of the priorities of intervention, the level of significance of each environmental aspect was compared with the corresponding Criticality of Local Authorities, that is, the level of suitability and efficacy of the answers given by local authorities (region, province, municipalities and ARPA FVG), in terms of planning, control and allocation of resources and infrastructures, connected with the national and local rules, that foresee fulfilments in the environmental field.

The main criticalities coming out from the investigation were:

- No firm declared to buy electric energy in accordance with the scheme of Green Certificates;
- No interest towards environmental impacts (as deforestation and modification of eco-systems), generated by the provision of wood raw materials;
- Insufficient use of water paints;
- Vehicular traffic by heavy trucks;
- Emissions of organic solvents into the atmosphere;

- Insufficient use of renewable energy sources as solar and photovoltaic panels.

4.2. Renewal of the recognition in 2016

For the EMAS registration renewal, obtained by the District in 2016, a fundamental step was the updating of the Territorial Environmental Analysis. In fact, during the previous years the environmental rules, as well as the District productive structure, substantially changed. Therefore, in particular the calculation methodology of SEA and the quantification procedure of REA were revised. More in detail, the Territorial Environmental Analysis involved the aspects related to:

- Monitoring,

- Scenario definition,

- Planning and perspective monitoring.

4.2.1. Monitoring of the environmental aspects due to firms' activities

The environmental aspects due to the firms' activities (consumption of raw materials and energy, waste production, etc.), were assessed by a new tool, more complete and systematic/analytical, Ecological Footprint.

4.2.1.1. Ecological Footprint

Ecological Footprint (EF) is an indicator proposed by Wackernagel and Rees in 1996, based on the comparison between the consumption of resources by human activities and the availability of resources within the eco-system. The comparison is an instrument for understanding the right ways of economic and environmental management of a territory, and for formulating the proper administrative tools. The analysis represents a form of environmental accounting finalized to the respect of the ecologic limits of the Earth and of its geographic areas. The comparison aims at understanding whether the processes, involving consumption of resources, can be acceptable in the perspective of sustainable development, and can be applied at different levels: single activities, processes, organizations, productive sectors, entire regions or continents, or the whole planet. The EF fundaments are represented by the idea that every unit of raw material or energy consumed is joined to a specific size of territory, guaranteeing the relative supply of resources and the absorption of waste produced (Wackernagel and Rees, 1996). This calculation tool allows to convert into the same measure unit different parameters, as consumption of electric power, wood, raw materials, etc., and the necessity of waste absorption, by transforming them in "surface of corresponding productive territory".

It is necessary to preliminarily estimate consumed resources and produced waste, and then to convert these resource fluxes into the corresponding biologically productive area, necessary to guarantee them (Moran et al., 2008). The informative sources, useful for the calculation of this indicator, are available in the National Footprint Accounts and are constantly updated by the Global Footprint Network (Global Footprint Network, 2018).

4.2.1.2. The environmental matrices

After the quantification of the environmental aspects of the District firms, it is necessary to identify the environmental matrices on which the effects of the environmental aspects show themselves. Air, water, soil and physical agents (electromagnetic fields, noise, etc.) were the environmental matrices considered. By taking into account and by combining the environmental aspects and the matrices of impact, Relevance can be calculated, which is expressed by a numeric sequence, useful for the subsequent phases of planning and perspective monitoring. Inside the Relevance concept, the level of Significance is present,

the lower limit under which actions of modification are not considered as necessary. For these purposes, Relevance was divided into two variables: Consumption Sustainability and Operational Sustainability.

4.2.1.3. Consumption Sustainability

Consumption Sustainability (CS) represents the comparison between EF and Carrying Capacity (CC), that is, the sustainability level of the consumption of natural resources, caused by the enterprises' activities. Since human activities have huge consequences on environment, Earth can sustain a limited sociodemographic and economic load capacity, because it has finite dimensions (Bagliani et al., 2005). If CC represents a limit, human activities' weight has to be defined to understand its external or internal position with respect to the limit. Single consumptions are transformed into a measure unit which can be compared with the availabilities (Wackernagel and Rees, 1996). This approach was considered by Bagliani et al. (2005) to put in evidence that the speed of the taking phase of resources cannot be higher than that of their regeneration.

To compare the CC with the corresponding EF, both can be expressed by a common measure unit, global hectare (gha), representing the surface able to produce resources and adsorb waste. The comparison between CC and EF can put in evidence whether a population or a productive activity need more resources than those offered by the occupied territory (Pearce and Barbier, 2000). In this way, the Institutions have the possibility to understand the goal necessary to be achieved at the territorial level.

To calculate Relevance, CS was quantified by considering two variables: the ratio between EF and CC was corrected by taking into account the trend during time of the specific consumption type, as well.

4.2.1.4. Operational Sustainability

Operational Sustainability (OS) represents the environmental aspects considered as negative externalities caused by productive activities. OS was calculated for each polluting agent considered within the environmental aspects, by taking into account and quantifying several parameters (dangerousness, geographic and/or temporal extension, sensitivity of the receptor, probability of the event).

Dangerousness was defined on the basis of the REACH (CE Regulation No 1907/2006) and CLP (CE Regulation No 1272/2008) European regulations and quantified as indicated in Table 5.

Table 5. *Properties of the considered pollutant agents and related assigned value for each class of dangerousness.*

Toxicological properties	Eco-toxicological properties	Chemical-physical properties	Assigned value
Lethal, carcinogenic, mutagenic, toxic for reproduction	PBT, vBvT, damaging substances for stratospheric ozone	Explosive, extremely flamable	2
Toxic, noxious	Toxic or noxious with long time effects (acidification, eutrophication, ozone precursor)	Comburent, potentially explosive, highly flammable	1.75
Irritant, potentially noxious	Toxic or noxious	Flammable, easily flammable	1.5
Potentially irritant	Potentially noxious, synergic	Potentially flammable,	1.25

		potentially corrosive for metals	
Absent	Inert	Inert	1

The importance of an environmental aspect is greater when the associated geographic and/or temporal extension increase. Therefore, the geographic and temporal variables were quantified according to the intrinsic characteristics of the impact, as indicated in Table 6.

Table 6. *Values assigned to the geographic and temporal variables related to environmental impacts.*

Area/ Indicative length of the impact (hours)	Punctual	Areal	District	Inter-regional
<1	1.25	1.5	1.75	1.75
<6	1.5	1.75	1.75	2
<24	1.75	1.75	2	2
>24	1.75	2	2	2

Furthermore, to evaluate the impact linked to the diffusion of the environmental aspect over the territory, the "extrinsic extension" variable, obtained by the ratio between the number of enterprises responsible for the environmental aspect considered and the total number of enterprises of the District, was taken into account. The extrinsic extension was combined with the intrinsic one to obtain a synthesis table of the considered parameter.

Table 7. *Mix of the intrinsic and extrinsic extensions.*

		Intrinsic extension			
		1.25	1.5	1.75	2
Extrinsic extension	0-0.25	1.25	1.5	1.75	2
	0.25-0.50	1.5	1.5	1.75	2
	0.50-0.75	1.75	1.75	1.75	2
	0.75-1	2	2	2	2

Sensitivity of the receptor is the variable that allows to weight the potential impact of the environmental aspects on the quali-quantitative characteristics of the environmental matrices interested by the danger. For each environmental matrix, a sensitivity scale was built to describe the characteristics of the receptor.

Probability of the event represents the parameter on which enterprises show a greater capacity of incidence, and then is the most sensitive to the variations generated by the activities of continuous improvement of the firms' performances. As a consequence, this parameter has to be quantified with criteria of flexibility, by taking into account several aspects (evaluation of the Best Available Technologies, of legislative limits, of specific procedures adopted by enterprises, etc.).

4.2.1.5. Relevance of the environmental aspects

In this way, Relevance was quantified, and consequently it is possible to compare its numeric values to define a priority order in the assignation of resources for the improvement of firms' performances. In practice, a significance sequence, or better a set of intervals, was established to separate the Relevance values into homogeneous groups on the basis of the priorities of

interventions. Furthermore, it is possible to decide the value corresponding to the lowest limit of significance, under which actions of intervention are not arranged. The significance sequence was applied to both the OS and the CS. The significance sequence adopted for the two variables, together with the indication of the lowest limit of significance, is shown in Table 8.

Table 8. *Division into intervals of the Relevance variable expressed as Operational Sustainability and Consumption Sustainability, and indication of the corresponding order of priority.*

Operational Sustainability		Consumption Sustainability	
Intervals	Order of priority	Intervals	Order of priority
0 → 0.16	n.s.	0 → 0.9	n.s.
0.16 → 1	1	0.9 → 1	1
1 → 2	2	1→ 1.5	2
2 → 3.5	3	1.5 → 2	3
3.5 → 5	4	2→ 2.5	4
> 5	5	> 2.5	5

n.s.=not significant; 1=of little importance; 5=overriding

The quantification of the significance sequence and of the lowest limit of significance are useful during the subsequent step of scenario definition.

4.2.2. Scenario definition

The calculation of Relevance and the corresponding definition of the significance sequence allow to indicate the environmental aspects with a "potential" merit of intervention. However, particularly in a contest of limited resources, it is necessary to evaluate the measures that can be "really" put in act. Therefore, the calculation of Relevance represents only a part of the necessary information to outline a planning that can be started by taking into consideration the reliable scenarios, the goals that can be achieved and the related use of resources. The consequent actions of environmental improvement can be focused either on the level of natural resources taken from the environment, or on the negative externalities generated by the industrial activities. Anyway, every action is evaluated on the basis of the related efficacy and efficiency, that is, of Environmental Incidence (EI) and of Cost Incidence (CI). This allows to put in light whether an action has the characteristics necessary for the implementation and to define a list of possible actions. Furthermore, it is possible to establish a limit over which the action can be considered as implementable, and under which it has not the characteristics to be put in act. Anyway, it is sufficient that only one of the two parameters (EI and CI) is not satisfied to block the implementation of the action.

EI is represented by a percentage multiplied by the level of initial significance; in practice, efficacy of the action taken into account is established by quantifying how much the importance of an environmental aspect can be reduced by implementing the action itself, and by defining the level from which the reduction starts. CI is represented by a percentage; an action shows the cost characteristics to be efficiently implemented as the value gradually approaches 100%.

In the choice of the action to be carried out, a District action has the priority with respect to an action relative to a single productive unit, coherently with the principles of an Ecologically Equipped Productive Area, which evaluate the strategies foreseeing a sharing of goals as priorities.

4.2.3. Planning and perspective monitoring

The phases of Monitoring and Scenario definition give the informative basis for the activities of planning and perspective monitoring, which represent the punctual definition of the activities that enterprises have to realize to achieve the expected goals with the available resources. In particular, Planning means the phase starting from the actions identified by the Scenario definition, and gives the punctual characteristics to each of them. Perspective monitoring is the organisation of tools, activities, strategies and numeric values in order to compare the results of the implementation of actions with which Planning had defined. Therefore, planning and perspective monitoring are interdependent and allow to practically translate the chosen actions, by arranging the criteria for the evaluation of the actions themselves.

The three phases just described, even if separated, are interconnected, and describe an iterative way that, at its conclusion, re-starts from the obtained results, in the perspective of continuous improvement.

4.2.4. Application of the methodology to the case study

The described methodology was applied to the District in order to identify at an early stage, during the monitoring phase, the Relevance of environmental aspects towards the considered environmental matrices. EF of the District is shown in Table 9.

Table 9. *Ecological Footprint of the District.*

	2005		2015	
Indicators	Footprint (gha)	%	Footprint (gha)	%
Energy consumption	27577.6	7.2	25770.4	2.6
Wood consumption	330388.8	85.9	910991.6	91.0
Transport of workers	10.7	0.0	8.78	0.0
Paints and glues	9314.2	2.4	30736.9	3.1
Plants and building materials	2092.8	0.5	2092.8	0.2
Water consumption	0.01	0.0	0.05	0.0
Waste	15331.7	4.0	31330.9	3.1
Total	384715.8	100.0	1000931.4	100.0

The most relevant aspect is the fact that consumption of wooden raw materials largely represented the main responsible of total EF of the District in both years considered.

To calculate CC of the District, we employed the data relative to soil consumption (Table 10) elaborated by ARPA FVG for the Friuli Venezia Giulia region (Consorzio del Mobile Livenza, 2006).

Table 10. *Soil consumption in the municipalities of the District (ha).*

Municipality	Artificially shaped areas	Agricultural areas	Woodland areas and half-natural environments	Humid areas	Water bodies
Azzano Decimo	820.38	4060.65	188.39		65.55
Brugnera	754.53	2104.92	39.49		22.23
Budoia	201.66	935.57	2638.07		0.00
Caneva	480.90	1396.95	2290.41		16.34
Chions	363.79	2704.37	265.38		15.55
Fontanafredda	787.67	3660.31	151.89	4.57	8.71
Pasiano di Pordenone	562.59	3795.96	131.38		65.17

Polcenigo	240.48	1047.92	3652.68		1.52
Prata di Pordenone	528.34	1691.81	14.12		54.47
Pravisdomini	222.16	1284.56	102.03		0.00
Sacile	925.81	2210.00	71.80		51.59
Total	5888.31	24893.02	9545.64	4.57	301.23

CC of a territory can be calculated according to the formula

CC=Σ(A*Equivalence Factor*Yield Factor)

where A represents the area considered. Equivalence Factors and Yield Factors are calculated annually by Global Footprint Network, but their utilization requires the payment of a fee. Therefore, to estimate CC in the case considered, values (reported in Table 11) from literature sources were used, which approximated at the best extent the informative need (Global Footprint Network, 2010; Scotti, 2009) yielding the data reported in Table 12.

Table 11. *Equivalence Factors and Yield Factors per area type, according to National Footprint Accounts, 2010 and Scotti, 2009.*

Area type	Equivalence Factors (gha/ha)	Yield Factors (gha/ha)
Artificially shaped areas	2.51	1.5
Agricultural areas	2.51	1.5
Woodland areas and half-natural environments	1.26	1.3
Humid areas	1.08	0.9
Water bodies	0.37	0.8

Table 12. *CC of the District territory (gha).*

Municipality	Artificially shaped areas	Agricultural areas	Woodland areas and half-natural environments	Humid areas	Water bodies	Total
Azzano Decimo	3088.73	15288.35	308.58		19.40	18705.1
Brugnera	2840.81	7925.03	64.69		6.61	10837.1
Budoia	759.26	3522.42	4321.16		0.00	8602.8
Caneva	1810.59	5259.51	3751.70		4.84	10826.6
Chions	1369.67	10181.96	434.69		4.60	11990.9
Fontanafredda	2965.58	13781.07	248.79	4.45	2.58	17002.5
Pasiano di Pordenone	2118.15	14291.79	215.20		19.29	16664.4
Polcenigo	905.40	3945.42	5983.09		0.45	10834.4
Prata di Pordenone	1989.20	6369.66	23.13		16.12	8398.9
Pravisdomini	836.43	4836.38	167.13		0.00	5839.9
Sacile	3485.67	8320.65	117.61		15.27	11939.2
Total	22169.49	93722.22	15635.76	4.45	89.17	131621.6

Finally, the calculation was corrected, since CC at a global level has to be reduced by 12%, to subtract an area necessary to the maintainment of ecosystem diversity and healthiness, and consequently not submittable to human needs and activities (Wackernagel and Rees, 1996, Wackernagel and Rees, 2008). The application of such correction to the District territory reduced CC to the value of 115827.0 gha.

The comparison between EF and CC put in light that EF is much greater than CC of the territory. In fact, the ratio between the two indicators showed a value greater than 3 in 2005 and greater than 8 in 2015. Therefore, reduction of the EF of the District activities seems a proper action of political, economic and environmental planning. However, significant Relevance conditions were found only in the case of air and soil matrices. Moving to the phase of scenario definition, EI and CI of possible actions were evaluated to set a ranking of priorities. In Table 13, possible identified actions, and environmental aspects that could be improved as a result of the implementation of the actions themselves, are presented.

Table 13. *Possible actions and related environmental aspects that could be improved in the District.*

Actions	Environmental aspects
Covering of car parks by photovoltaic panels	Replacing conventional energy sources with renewable energy
Carsharing among companies	Reduction of carbon dioxide emissions
Creation of a consortium for recovery of wooden residues as panels	Reduction of consumption of wooden raw material and of carbon dioxide emissions
Varnishing automation in small companies and use of water based paints	Reduction of emissions of volatile organic solvents
Recovery of disused production plants	Reduction of soil consumption
Relamping	Reduction of energy consumption

4.2.5. Some proposals for improving EF of the Livenza district

Two actions proved to be overriding to reduce the EF of the District and to employ the best available practices, in line with the definition of eco-innovation (Rennings, 2000). Regarding the air matrix, the action that could be implemented is technological improvement in manual varnishing and use of water paintings, in order to reduce atmospheric emissions of volatile organic compounds. Technological improvement is represented mainly by a modern system of manual painting and the use of the carousel, a specific tool for painting. Regarding soil consumption criticality, the most effective action that could be implemented is the recovery of disused production plants.

Other actions were identified, as well.

Use of certified wood. Several species of wood are employed by the enterprises of the Livenza furniture district: pine, red fir, toulipier, beech, ayous, oak and cherry are the most used. In 2005, 111,010 tons of wood were consumed, while 381,333.5 tons in 2015. Because of their provenience, the management of some woods presents criticalities (Greenpeace, 2016). Sustainable forest management is the goal of the European Forest Action Plan (2007-2011), balancing the three dimensions of sustainability. Even if, at present, about 40% of the firms of the district exploits certified wood coming from forests managed in a sustainable way (Bianco, 2016), the situation could be improved further on.

Sustainable workers' mobility. Even if the transport of employees has a small "weight" on the district EF (10.7 gha in 2005, 8.78 gha in 2015), it is possible to improve this aspect. Most workers use their private cars to reach the workplaces, and workers' habits can be hardly changed. Possibly, a modern an efficient bus service, for workers' transport, could be arranged. Alternatively, the building of car parkings, with the roofs covered by photovoltaic panels, could be the easier solution to be adopted. Furthermore, a future integration between photovoltaic panels and electric vehicles could reduce carbon footprint (Brenna et al., 2014) and consequently EF (Dias de Oliveira et al., 2005). Otherwise, sustainability of transportation could be improved by car sharing; this modern system of transport could positively affect not only environmental conditions, but also traffic, allowing a reduction in the number of accidents, and improving social relations among people. Anyway, the figure of Mobility Manager will suggest the advantages and the opportunities deriving from every strategy to be adopted.

Burning of wood waste. One of the possible initiative for reducing EF of the District is represented by the construction of a co-generation plant, which could burn the wood waste coming from at least part of the District enterprises. Some years ago, such a project was taken into consideration, but not realized, because of concerns for environmental and human health problems, and lack of cooperation among the enterprises of the District (Bianco, 2016). Currently, small incineration plants, burning the scraps of the production of single enterprises, are present in the District; they allow production of hot water for internal use by the firms themselves (ARPA, 2017). However, the combustion of wood waste of the furniture activities can give problems owing to possible contaminations by organic solvents, adhesives and paints (Khalfi et al., 2000; Lavric et al., 2004; ARPAV and Provincia di Treviso, 2012).

The most interesting perspective is represented by the construction of a co-generation plant for the production of electric energy and heat, by using wood waste coming from the district activities and biomasses produced as by-products by agricultural and zoo-technical farms of the territory. In 2007, the Ministero delle Politiche Agricole, Alimentari e Forestali (Ministry of Agricultural, Food and Forestry Policies) issued a number of decrees which fixed the incentives payable for the production of energy from biomasses in Italy (e.A.PR.a.L., 2014). At the regional level, an example of virtuous region is represented by Emilia Romagna (LEAP, 2008). The Regional Law No 39 of 28 December 1999 already envisaged a measure, included in 2000-2006 regional Rural Development Plan, which provided for economic benefits to make electricity and/or heat generation plants fed by vegetable matrices derived from crops. Incentives were strengthened in the programming period 2007-2013 (Marangon and Jodice, 2008).

Production of wood panels. As an alternative to thermoexploitation, another possibility is represented by the building up, inside the District area, of a plant for the production of wood panels by employing wood waste of previous workings, in the perspective of circular economy.

5. Conclusions

In 2006, the Livenza furniture district was the first Italian industrial district that obtained the EMAS registration. In 2015, the Territorial Environmental Analysis was deeply revised in view of the renewal of the recognition, which was obtained by the District in 2016. More specifically, EF was calculated to quantify the environmental impacts of the District, and then compared with the corresponding CC. In this way, it was possible to put in light that EF is much greater than CC of the territory. Some possible actions which could be implemented to reduce EF were indicated, and their possibility to be carried out was taken into account both from the technical and from the economic points of view. Finally, the methodology proposed could be applied also to other industrial districts with a different production with respect to that of the Livenza one, with the aim of improving the environmental performances of the enterprises, in line with the principles of sustainable development.

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