Promoting environmental strategies: a framework for territorial assessment

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Abstract: This paper aims to describe an operative framework developed to assess a geographical region for understanding the actual level of environment and its potential evolution in the future, through a specific set of indicators. These indicators take into account the current environmental condition (in terms of quality of water, air and soil, the production of wastes) and the potential impact in the future (it is related to firms' industries and concentration). Moreover specific and additional factors have been considered (as number of parks, hydro-geological instability and so on); these are linkable to the peculiarities of the territory. An application of the framework has been carried out in Lombardy Region, in the northern part of Italy.

Keywords: territorial assessment, environmental indicators, sustainable strategies

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1. Introduction

Recently, due to the growing relevance of sustainable development and to the commitment of national and international organisms (governmental organisations and non), several environmental voluntary tools (from EMAS to Ecolabel, from LCA to ISO14001, from Environmental Reporting and Accounting to Green Public Procurement) have been provided. Yet, on the practical side, the adoption of these instruments is far

from been optimal and widespread. To increase the adoption of these systems, policy makers and public administrations in general play a fundamental role, in promoting pro – active green strategies towards enterprises which, obviously, have a strong implication on the territory, regarding the quality of the environment and of citizens' life (relevant social aspect). To accomplish effectively the support of green strategies, the policy maker requires to be aware of the environmental status and potential development in the area of reference, in order to act (i) primarily where a critical situation has been pointed out and (ii) with specific actions in relation to the features and industries of the firms situated in the area, addressing its effort in the most efficient way.

2. State of the art

As a consequence of the evolution of environmental policies (Prakash and Kollman, 2004), which are shifting form the traditional "command and control" to different approaches, decision makers asked more and more for a reliable and highly condensed information (OECD, 2002) that can shed the light on the most relevant aspects of complex environmental issues and they requires to be aware of the environmental status and potential development in the territory within their competence.

In this way, environmental priorities could be identified and, consequently, mechanisms embedded in policy instruments to create incentives for firms to comply (Baumol and Oates, 1988). In addition could be defined the institutional contexts, in which policy instruments were created and are sustained, where some firms adopt environmental management practices (as environmental voluntary tools) beyond regulatory compliance (Prakash and Kollman, 2004).

The influence of the public policies on the adoption of these instruments has been largely proved (Fiorino, 1999). Among the others, Prakash and Kollman (2004) show how different environmental policy types impact firms and how do they respond. Moreover Glachant et al. (2002) discussed specifically about the European Union's Eco-Management and Audit Scheme; EMAS was viewed as emblematic of a new policy approach involving more flexible and market-based environmental instruments. But, few years after coming into force, EMAS does not appear to be a tremendous success in terms of industrial participation, the authors argue that the most powerful participation leverage has been the granting of regulatory relief for registered companies. The possibility and scope for a lighter regulatory touch are primarily nationally specific since they are related to the national regulatory traditions. Also, Delmas and Toffel (2004) show that the institutional pressures can drive firms in adopting proactive environmental strategies (in terms of certification of the EMS, collaborative interaction with stakeholders and other voluntary tools). Standing this opportunity, the policy maker has the chance to act in order to endorse this dynamic. In this context, to address effectively emerged requirements, policy makers ask for a set of indicators (Bell and Morse, 2004) which allow to assess the area of reference in order to:

- individuate environmental priorities and the features of the industrial system;
- develop proper (and so effective) environmental policies to act where necessary and designing specific dedicated strategies.

The topic concerning set of indicators of sustainability and environmental assessment systems has been largely debated (Steinzor, 1998; Segerson, 1999; Spangenberg, 2004). According to McCool and Stankey (2004) the role of the science is fundamental to support the understanding of the linkages between human activities and environmental impacts and these are useful in describing the current conditions and performance of a system. Consequently, a set of indicators has to be based on credible and scientific principles. Moreover, as highlighted by Edvardsson (2004), features of the environmental assessment systems should contain principles, objectives, interim targets, strategies, and follow-up mechanisms, which together provide a solid ground for increased efficiency and improved prioritization in environmental policies. Despite this ambitious approach, several inconveniences can emerge. As showed by the same author, in the Swedish Parliament, the system of environmental objectives suffers from certain shortcomings. Some of the objectives are imprecise and difficult to evaluate, and there are no rules or principles that may be used to solve goal conflicts and to prioritize between different objectives.

From a different viewpoint, Spangenberg et al. (2002) illustrate that, in the course of evaluating the progress in implementing Agenda 21, the "Commission on Sustainable Development" began developing a set of indicators of sustainable development, resulting in a final version published in 2001. The indicators are divided up into for issue areas: economic, environmental, social, and institutional. The further conceptual separation into driving force, state, and response indicators.

In the OECD report, a review over environmental methodologies and indicators in use (2002), point out as:

- a major function of environmental indicators is to convey clear and simple messages about what is happening to the environment to non-expert decision makers (…);
- environmental indicators are often seen as tools that make this complex issues more tractable (…);
- they (indicators) are further often seen as a part of the effort to integrate economic and environmental decision-making.

3. The methodology

The objective of this study is to develop an approach and a framework able to individuate a “target area”. The target area is defined as a small subset of a wider region, where the environment shows critical features. On this area, during the decision-making processes at the strategic level (i.e. the formulation of policies, plans and programmes), policy maker has to focus primarily. So the area will be chosen because it is characterised by a high level of pressure of pollution on the environment, both at the present state and, potentially, in the future. The framework has to allow to obtain this result under specific constraints:

- established on a sound scientific basis;
- using existing data, without new data survey and further researches, available on public databases.
- the decision maker has to find the area in a limited time and budget.

In addition, the framework has to focus prevalently on the manufacturing activities, excluding explicitly all the other human activities as, for example, agriculture, commerce, automotive traffic and residential area related factors. According to the concept of sustainable development the framework has to combine both concerns about a range of environmental issues as well as economic issues (Hopwood et al., 2005).

To respond effectively to these detailed requests, a specific framework has been developed; the target area will be determined through three main objectives:

- dimensions of environmental quality;
- level of human activities pressure (manufacturing activities);
- additional factors, not included before, to be considered.

To develop the framework, it has been applied the methodology represented in figure 1, composed by several phases. Each one of these phases will be described, in details, in the following paragraphs. The methodology has to be considered as a part of the framework itself, in fact the methodology support the decision maker in all phases of the process which precede and follow the real application of the framework.

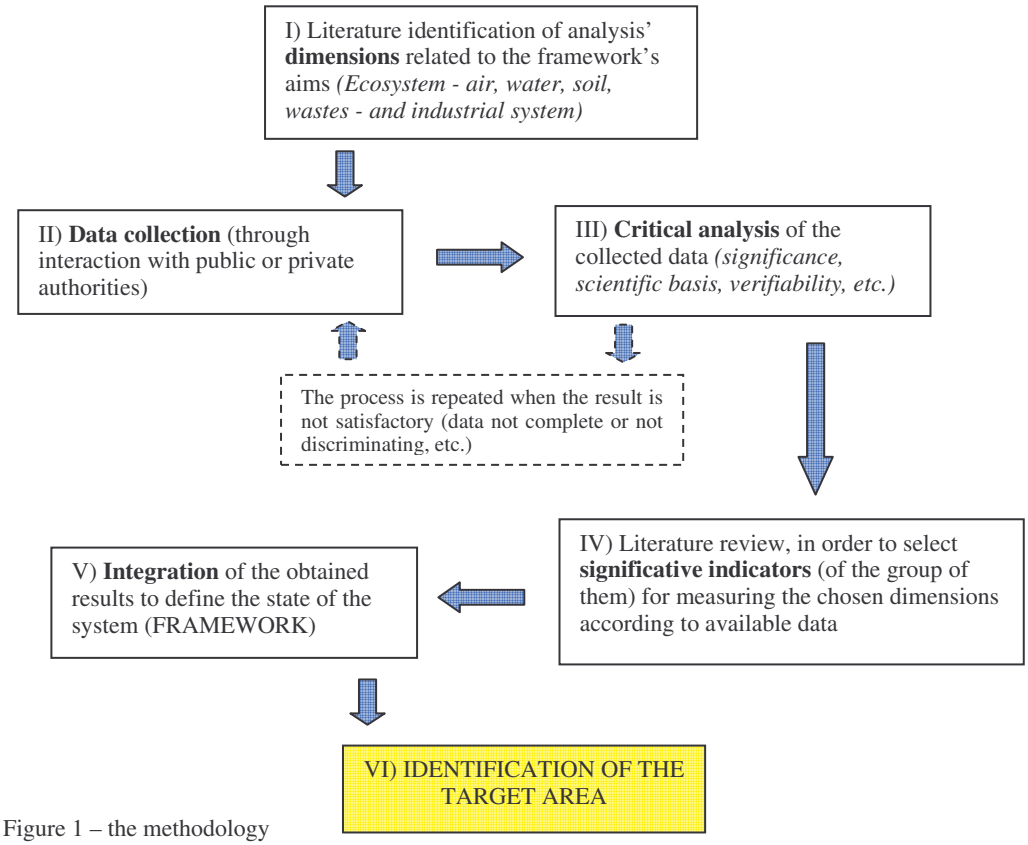

Figure 1 – the methodology

4. The framework for territorial assessment

From the analysis of the existing relationships between environmental quality, industrialization factors and exposed population, it is possible to develop a first frame of which regions are subjected to higher pressure (real and potential) from an environmental point of view.

Inside this process, the critical steps could be:

I. identification of analysis dimensions: that is the conversion of objectives into quantifiable and analytically investigable features;

II. data retrieval through interaction with public or private authorities: these are external variables and so the outcome and the time for ending this step have to be considered uncertain;

III. finding of the target area: it is one of the most critical aspect because it is the phase of interpretation of indicators and analysis of the results.

4.1 Evaluation of the system of reference and dimensions of analysis

The identification of the ambit of analysis (defined as the minimum territorial unit of analysis) is essential to find which is the optimal system of reference (that is the level of investigation required for the characterization of the area).

The dimensions of the analysis have been chosen considering the aim of the research, which is the definition of an area characterized by critical environmental aspects related to the industrial system.

The territory has been analysed from two different points of view:

1. *static view*: that is the picture of the state of the ecosystem. The ecosystem is defined as "a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit" (European Environment Agency, 2005). Considering the aims of the research, the state of the ecosystem is the characterization – "reasonable" detailed – of the current situation of fundamental components explaining the environment (air, water, soil, wastes as pressure indicator of productive activities). Each element has different level of criticism, related to the intrinsic vulnerability and the sensitivity to disturbing agents (prevalently of human source), i.e. air pollution or ground water quality.

The contributions on each specific field concerning pollution and impact on the ecosystem of human activities have been widely developed, relating to consolidated awareness of dangerous impact of many elements on human health. At the end of this iterative process, the following dimensions could be explored; their relevance in evaluating the environment has based on rigorous scientific principles as well this information are available in public databases:

- air quality: that is considered by several author as extremely relevant. The air must be clean enough so as not to damage human health, flora, fauna and cultural damages, as explained by Edvardsson *et al*. (2004) whose describe the indicators of sustainability by the Swedish Government;

- freshwater quality: that is affected by a wide range of human activities in areas with a high population density, concentrated industrial activity and intensive agriculture, and consequently analysed in different studies (European Statistical Laboratory, 2005);
- soil: understanding soil quality means assessing and managing soil so that it functions optimally now and is not degraded for future use. More specifically, soil quality is the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation (among the others, US Department of Agriculture, 2005);
- waste: that is predicted to continue rising unless remedial action is taken and so it is a topic widely discussed in literature. The sixth environment action programme of the European Community (2001) gives the direction on waste prevention and management that will be a key element of an integrated product policy approach.

2. *dynamic view*: the indicators related to industrial system that could be considered as a proxy of the state of environment in a long term perspective; several research has looked at the role of the manufacturing system and on its role on potential evolution of the level of pollution.
These indicators have been selected consequently, neglecting the consequences of the territorial expansion not related to productive activities; the considered activities are:

- manufacturing,
- mining industry,
- production and distribution of gas, water and electrical energy,
- building firms.

The environmental pressures that business activities have on ecosystem's components, have been considered related to (i) industry, (ii) concentration and (iii) size of each one.

4.2 Data collection and critical analysis

Once specified the dimensions of the analysis, the following step is the data retrieval. It is a particularly critical phase, because it represents the informative support which the analysis is based on; it has to be significant and representative as regards the dimensions of the analysis.

For each dimensions, sources and data that better characterize them, have to be identified. The main critical factors are:

- restricted availability of data;
- availability of data in heterogeneous type (not comparable);
- not-accessibility of data;
- data not discriminating for the aims of the study.

After the phase of information retrieval for each aspect, the data base useful for the study has to be chosen, basing on considerations about:

- data scientific base;
- data gathering methods;
- data updating;
- the Institution which releases data (source);
- aggregation level;
- covering rank;
- availability.

If a database don't respond effectively to all these requirements it has to be rejected.

4.3. The selection of significative indicators

This phase consists in selecting (through review of: literature, scientific researches, Institutional documents, etc.) concise indicators, that will be afterwards standardized and combined into a single index. This phase is strictly related with the previous one; in fact among all possible indicators have to be chosen those which a database is available.

Indicators can be useful as proxies or substitutes for measuring conditions that are so complex that there is no direct measurement. It is the best way to show a trend or a phenomenon that is not immediately perceptible. Indicators have to:
1. be relevant and representative regarding to the associated aspect;
2. have a concrete scientific foundation;
3. be quantifiable, in other words the information has to be available or accessible through a reasonable cost, reliable and repeatability in calculation;
4. show a trend during a period;
5. be sensitive to changes in environment or related human activities.

The indicators: (i) measure information, so that its meaning could be understandable and clear to everyone and (ii) simplify data related to more complex phenomena, promoting communication and comparisons.

The selection of indicators is based on the purpose of identify, between all the potential indicators, the ones more suitable for illustrating and monitoring the environmental context, taking into consideration also the numerousness of the system.

The identification of significant aspects for the development of the ecosystem and the assessment of available data for a correct representation are the base on which choose the indicators.

4.4 Integration of the results

In order to standardize the indicators, the Likert scale has been applied; it is well-known and useful because of its easiness. Typically the utilized scale is divided into five levels and the method gives a value, related to the dimension, within the identified range.

To find the indicator that best characterize the state of the ecosystem for each dimension, applying the "norm method[1]", combining the environmental aspects and assigning them a value of weight (w_i) equal to 1 (because it is not possible to establish which aspect is more critical considering the relative environmental pressure).

Applying the Likert scale to the identified indicators (five classes, from 1 to 5), the quality of the ecosystem has been classified (indicator n.6); following the same approach and joining indicator n.6 and indicator n.5 (weight equal to 1), the final result is the "total indicator" that represent the "level of environmental load" (see figure 2).

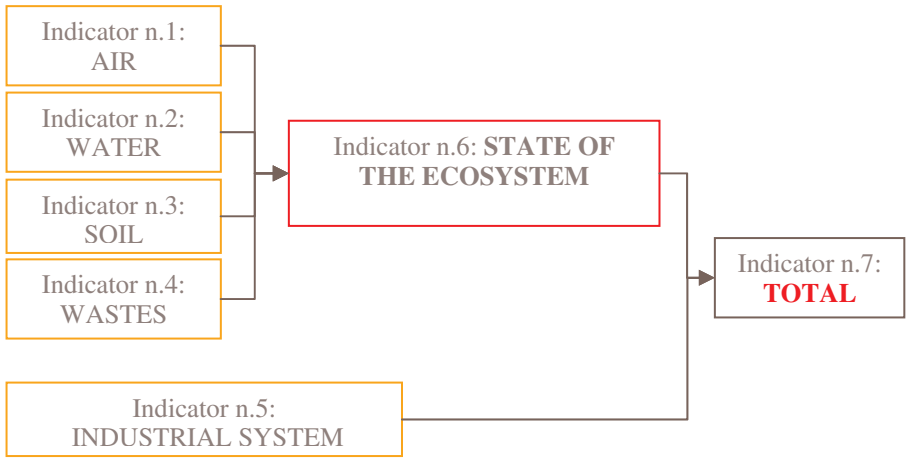

Figure 2 – The framework

4.5 Identification of target area

With the described methodology, all the dimensions have been mapped and the areas potentially interesting for the purpose of the research have been identified. In order to select the target area it is necessary to introduce supplementary factors that consider additional aspects related to environment as well as to industrial system and could be discriminating for the choice.

These supplementary factors give:

- a more detailed description about the state of the environment in the area;
- an illustration of the potential industrial and infrastructural development, in order to find, in a perspective way, the relevance of planned initiatives.

Close to these indicators, other aspects have to be considered, for selecting the target area:

- the territorial dimension, that has to be restricted;

[1] Norm $N = \sqrt{\sum_{i=1}^{n} w_i x_i^2}$

- the economical structure, that has to be various, with different industrial aptitudes;
- the possibility of implementing an integrated and shared process for the development of the area.

After all these considerations, the target area can be selected, bearing in mind also the experience of local authorities and policy makers for the purpose of the study.

5. Application of the framework to the Lombardy region

Following all the steps described in the paragraph 4, the framework has been applied to a territory in the northern part of Italy, the Lombardy region, during 2003.

The final purpose of the study was the definition of sustainable strategies addressed to enterprises; it requires not only the improvement of the environment quality (pollution reduction and territory vulnerability) but also the introduction of eco-efficient productive process through the optimization of natural resources use and the decrease of industrial risks. This strategic planning is a complex process, that involves public authorities in managing the trade-off between ecosystem protection and defence of enterprises' competitiveness.

To achieve this final objective the policy makers require a "pilot area" in which a new strategic approach has to be tested. In this context the framework and the methodological steps has been applied as follow.

STEP 1: Evaluation of the system of reference and dimensions of analysis

Within the Lombardy region, there are three alternatives for identifying the system of reference: (i) provinces, (iii) industrial districts, (iii) municipalities. The optimal dimension has been considered the third one (1.547 municipalities), because the Provinces are a too extensive units of analysis for the purpose of the study and the industrial districts cover only a limited portion of the considered territory.

The dimensions of analysis are the same explained in paragraph 4.1, that are air, water, soil, wastes and industrial system.

STEP 2: Data collection and critical analysis

In table 1 are presented all the data bases found. To select data have been used the criteria explained in paragraph 4.2. Several different data bases have been reject because not responding to the criteria. More specifically:

- data scientific base: largely consolidated;
- data gathering methods: largely consolidated;
- data updating: after 1995;
- the Institution which releases data (source): University – Government – International, National or Regional Institutions;
- aggregation level: municipality;
- covering rank: total on the Lombardy region (partial under specific conditions);
- availability: easy (Web Sites or documents directly accessible)

ANALYSIS DIMENSIONS	Information typology	Source	Completeness		Availability
			Aggregation level	Covering rank	
AIR	Measures of pollutants concentrations	Lombardy Region Authorities	Municipalities	Partial[1]	High (directly on the website)
	Emissions estimate	Lombardy Region Authorities	Municipalities	Total	High (directly on the website)
WATER	Index of groundwater quality	Lombardy Region and Provinces Authorities; Polytechnic of Milan	Municipalities	Partial[2]	Medium
	Presence of wastewater treatment plants	Provincial Authority	Municipalities	Total	High
SOIL	Number of brownfields	Lombardy Region Authorities	Municipalities	Total	Medium (authorization required)
WASTES	Quantity of produced wastes	Lombardy Union of chambers of commerce	Municipalities	Total	Medium
INDUSTRIAL SYSTEM	Number of production units	ISTAT	Municipalities	Total	High (directly on the website)
	Number of employees per production unit	ISTAT	Municipalities	Total	High (directly on the website)
	Level of environmental risk	Polytechnic of Milan	Industrial sectors	Total	High
	Index of industrial specialization	Polytechnic of Milan	Municipalities	Total	High

Table 1 – Critical analysis of data

[1] [2] These data haven't been applied directly, however they have been useful as check factor

STEP 3: The selection of significant indicators

Coherently with the available data bases the following indicators has been effectively developed and exploited for the analysis. These are divided in *indicators of status* (representing the Ecosystem) and *indicators of pressure* (representing the potential future status related to the density of firms and industries).

- indicators of status, that describe "synthetically" and "numerically" the state of the environment for each municipality and for each aspect (air, water, soil, wastes);

ENVIRONMENTAL ASPECT: AIR	**SOURCE**	**AGGREGATION LEVEL**	**UPDATING[1]**
quantity of NO_x (t/year)	Lombardy Region Authorities	Municipality	1997 - 2002
quantity of SO_2 (t/year)	Lombardy Region Authorities	Municipality	1997 - 2002
quantity of VOC (t/year)	Lombardy Region Authorities	Municipality	1997 - 2002
quantity of CO (t/year)	Lombardy Region Authorities	Municipality	1997 - 2002
quantity of TSP (t/year)	Lombardy Region Authorities	Municipality	1997 - 2002
quantity of PM10 (t/year)	Lombardy Region Authorities	Municipality	1997 - 2002
Total indicator: summation of values per surface unit, referred to the maximum level of concentration allowed by the law	**Elaboration by the authors**	**Municipality**	**2003**

Table 2 – Indicators related to the environmental aspect AIR

ENVIRONMENTAL ASPECT: WATER	**SOURCE**	**AGGREGATION LEVEL**	**UPDATING**
index of groundwater quality	Lombardy Region Authorities and Polytechnic of Milan	Municipality	2001
presence of wastewater treatment plants	Province Authorities	Municipality	Between 1997 and 2001
Total indicator: average and norm of index of groundwater quality and presence of wastewater treatment plants	**Elaboration by the authors**	**Municipality**	**2003**

Table 3 – Indicators related to the environmental aspect WATER

[1] The indicators are related to two different data bases, updated to 1997 and 2002

ENVIRONMENTAL ASPECT: SOIL	SOURCE	AGGREGATION LEVEL	UPDATING
number of brownfields	Lombardy Region Authorities	Municipality	1998
Total indicator: number of brownfields referred to number of production units	**Elaboration by the authors**	**Municipality**	**2002**

Table 4 – Indicators related to the environmental aspect WASTES

ENVIRONMENTAL ASPECT: WASTES	SOURCE	AGGREGATION LEVEL	UPDATING
quantity of non hazardous special wastes	Union of chambers of commerce	Municipality	2000
quantity of hazardous special wastes	Union of chambers of commerce	Municipality	2000
Total indicator: total quantity per surface unit	**Elaboration by the authors**	**Municipality**	**2002**

Table 5 – Indicators related to the environmental aspect WASTES

- indicators of pressure: that characterize, in a perspective way, the intensity of the "strength" of the industrial system on the territory, depending, in a first approximation, by the environmental danger referred to the industrial typology and by the numerousness of related enterprises.

INDUSTRIAL SYSTEM	SOURCE	AGGREGATION LEVEL	UPDATING
number of production units divided into macro-sectors per technology similarity	ISTAT	Municipality	1996
number of employees at production units divided into macro-sectors per technology similarity	ISTAT	Municipality	1996
level of industrial risk related to macro-sectors	Elaboration by Polytechnic on Industrial Pollution Projection System	Sector	-
index of specialization referred to regional average	Elaboration by the authors	Municipality	1996
Total indicator: index of industrial pressure	**Elaboration by the authors**	**Municipality**	**2002**

Table 6 – Indicators related to the industrial system

STEP 4: Integration of results

Processing all the information collected and grouping them into the indicators explained in the abovementioned tables (see figure 2), using the norm method and the Likert scale, the methodology has established the level of environmental load for each of the 1.547 municipalities in Lombardy region (see figure 3). In particular:

- n.62 municipalities are classified with the total indicator equal to 1 (low level of environmental load);
- n.422 with 2 (moderate level);
- n.426 with 3 (relevant level);
- n.558 with 4 (high level);
- n.79 with 5 (very high level).

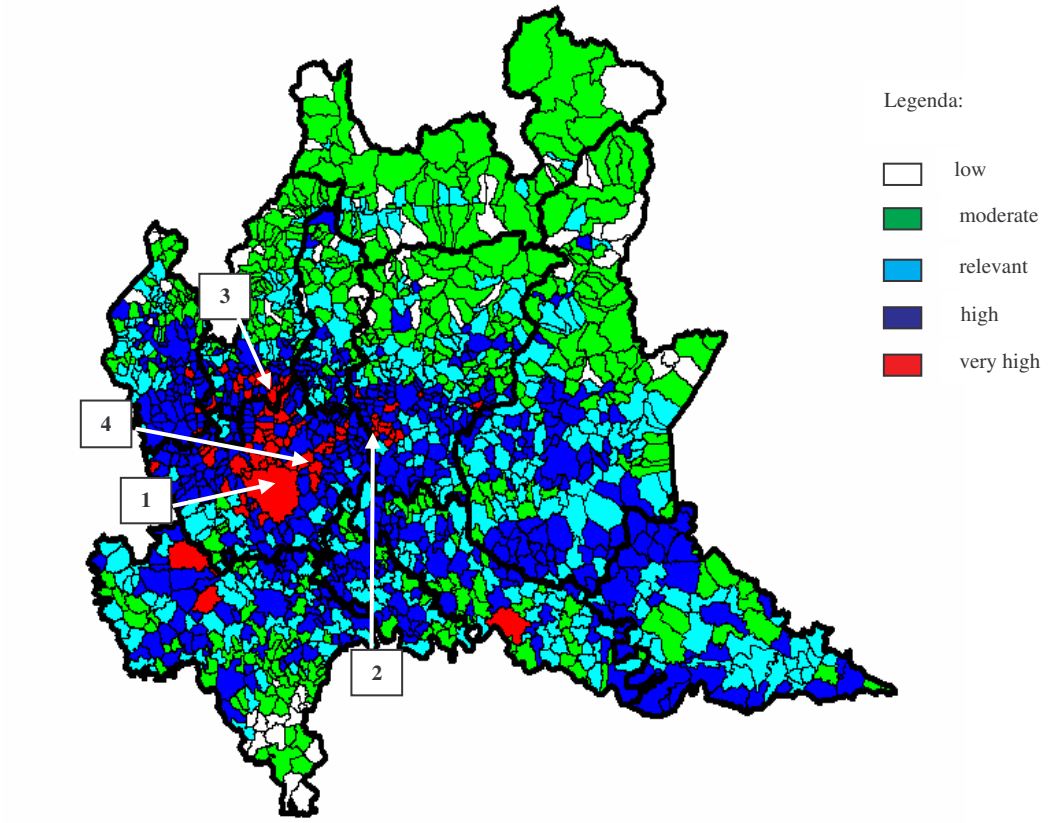

Figure 3 – Level of environmental load

At the end of this analysis, considering all the municipalities characterized by a "very high" level of environmental load, it is possible to identify (eliminating isolated cases) the areas of potential interest for the purpose of the study.

As illustrated in figure 3, from the application of the methodology at Lombardy region, four areas are emerged:

1. Milan and hinterland;
2. West Bergamo;
3. Brianza Comasca – Milanese;
4. East Milan.

STEP 5: Identification of target area
In table 7 supplementary factors used for the study are illustrated.

SUPPLEMENTARY FACTORS	SOURCE	AGGREGATION LEVEL	UPDATING
Parks	Lombardy Region Authorities	Park	2002
Plants potential causing of relevant incidents	Italian Ministry of Environment	Plant	October 2002
Industrial districts	Lombardy Union of Chambers of Commerce	District	2002
Hydro-geological instability	Italian Ministry of Environment	Province	2000
Composting plants	Regional statistical yearbook	Plant	1997
Special wastes treatment plants	Regional statistical yearbook	Plant	1997
Special wastes incineration plants	Regional statistical yearbook	Plant	1997
Dumping	Italian agency for the protection of territory - APAT	Plant	1999
Number of quarries	Report on the state of environment in Lombardy	Province	1997
Index of environmental quality	Lega Ambiente	Province	2001

Table 7 – Supplementary factors

Considering the supplementary factors and all the initiatives (from both the environmental and infrastructural point of view) in act in the four areas identified in the previous analysis, according to the existent planning tools at local and regional level, it has been decided (with also the policy makers involved into the process) that the target area is West Bergamo.

This territory is characterized by:

- high potentiality in industrial growth, considered as elevated capacity of industrial system expansion, related to the (i) morphological characteristics of the territory (the index of industrial density is relatively low) and the (ii) actual planned investments for the transportation system. The territory is not included in parks so that they are not subjected to city planning bonds;
- high level of environmental load (a shown in figure 4);
- heterogeneous and defined industrial aptitudes;
- a geographically limited area, within a single Province.

For the homogeneity of the territory, not only the municipalities with a “very high” level of environmental load are taken into consideration, but also neighbouring ones characterized by an “high” or “moderate” level.

The area is illustrated in figure 4; the identifies municipalities are: Boltiere, Bonate Sopra, Bonate Sotto, Bottanuco, Brembate, Calusco d'Adda, Canonica d'Adda, Capriate San Gervasio, Carvico, Chignolo d'Isola, Ciserano, Dalmine, Filago, Levate, Madone, Medolago, Osio Sopra, Osio Sotto, Pontirolo Nuovo, Presezzo, Solza, Suisio, Terno d'Isola, Treviolo, Verdellino, Verdello.

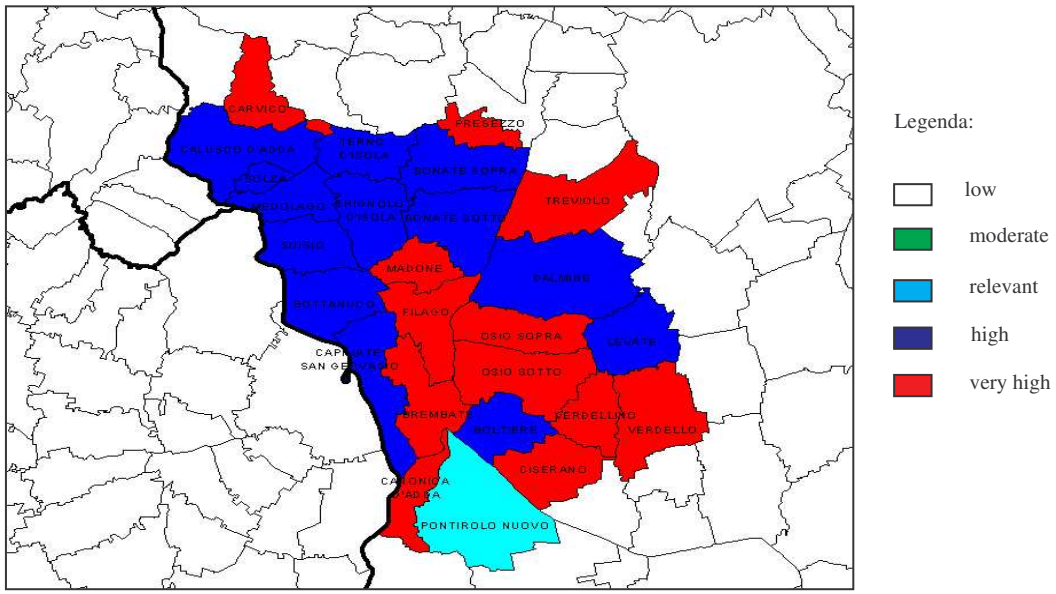

Figure 4 – The target area (specifying the level of environmental load)

6. Further developments

In the field of territorial assessment, the new framework presented in this paper is innovative and simply, compared to the existent methodology. Moreover it focuses the attention on the aims the evaluation has to achieve, so that it could concentrate the efforts of data retrieval and indicators choice on a limited territorial area of interest.

The selection of the target area has to face problems related to availability and uniformity of information and also to political decision; so it is important that policy maker and local authorities give their contribution (from the beginning) at the assessment process, giving support (derived by their experiences) during all the phases.

The power of the framework is that it could be applied at different territories, of various sizes; the presented application has been completed on 1.547 municipalities, and it has been easily manageable using a geographical information system (software GIS) for identifying, illustrating and organizing all the data and information about each dimension.

The indicators identified for the application in Lombardy region could be duplicated in other region/territory or modified adding other indicators, considering the existing data

base. Changing the purpose of the assessment, the framework could be utilized with different indicators and/or environmental dimensions.

7. Note and references

This paper is the result of the joint work of the authors. However Annalisa Citterio wrote sections 3 and 5; Giuliano Noci section 1; Emanuele Pizzurno sections 2 and 4. The section 6 has been written jointly

1 ANPA, (2001). Atlante degli indicatori del suolo.

2 ANPA, (2001). Verso l'annuario dei dati ambientali.

3 ARPA Lombardia, (2001). Relazione sullo stato dell'ambiente della Lombardia 2001.

4 Azzone G., Bertelè U., (1996). La dimensione ambientale nella strategia e nella gestione di impresa. Consorzio MIP – Politecnico di Milano

5 Azzone G., Bertelè U., Noci G. (1997a). Developing business policies for environmental management. Long Range Planning Vol. 30 N. 4, 562-571

6 Azzone G., Bertelè U., Noci G., (1997b). L'ambiente come vantaggio competitivo. ETAS

7 Azzone G., Cigolini R., Noci G., Turco F., (1998). Linee guida per la pianificazione di interventi a monte sul rapporto impresa – ambiente in Provincia di Milano.

8 Barnett V., (1991) Sample Survey principles and methods. Oxford University Press, New York

9 Baumol W. J., Oates W. J. (1988). The theory of environmental policy. Cambridge University press: Cambridge

10 Bell S., Morse S. (2004). Experiences with sustainability indicators and stakeholder participation: a case study relating to a 'blue plan' project in Malta. Sustainable Development 12, 1–14

11 Cashmore M. (2004). The role of science in environmental impact assessment: process versus procedure versus purpose in the development of theory. Environmental Impact assessment review, 24, 4, 403 – 426

12 Commission of the European Communities (2001). Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions on the Sixth Environment Action Programme of the European Community. "Environment 2010: Our future, Our choice"

13 Cun-kuan B., Yong-sen L., Jin-Cheng S. (2004). Framework and operational procedure for implementing strategic environmental assessment in China. Environmental Impact assessment review, 24, 1, 27 – 46

14 Delmas M., Toffel M. W. (2004). Stakeholders and environmental management practices: an institutional framework. Business Strategy and the Environment, 13, 4, 209-222

15 Edvardsson K. (2004). Using Goals in Environmental Management: The Swedish System of Environmental Objectives. Environmental management 24, 2, 170 - 180

16 Fiorino D. J. (1999). Rethinking environmental regulation: perspective on law and governance. Harvard Environmental Law Review, 23, 2

17 Glachant M., Schucht S., Bültmann A., Wätzold F. (2002). Companies' participation in EMAS: The influence of the public regulator. Business Strategy and the Environment 11, 4, 254-266

18 Hettige H., Martin P., Singh M., Wheeler D., (1994). The Industrial Pollution Projection System. Policy Research Working Paper #1431, World Bank

19 Hopwood B., Mellor M., and O'Brien G. (2005). Sustainable Development: Mapping Different Approaches. Sustainable Development 13, 38–52

20 Liou M. L., Yu Y. H. (2004). Development and implementation of strategic environmental assessment in Taiwan. Environmental Impact assessment review, 24, 4, 337 – 350

21 McCool S. F., Stankey G. H. (2004). Indicators of sustainability: challenges and opportunities at the interface of science and policy. Environmental Management, 33, 3, 294-305

22 Milner J. S., Baily C., Deans J., Pettigrew D. (2005). Integrated impact assessment in the UK – use, efficacy and future development. Environmental Impact assessment review, 25, 1, 47 – 61

23 Ministero dell'Ambiente (2001). Relazione sullo stato dell'ambiente.

24 Noble B. F. (2004). A state-of-practice survey of policy, plan, and program assessment in Canadian provinces. Environmental Impact assessment review, 24, 3, 351-361

25 Organisation for Economic and Co-operation and Development – OECD (2002). Aggregated environmental indices: review of aggregation methodologies in use. www.oecd.org

26 Pauline D., Gibbs D. (2004). Eco-industrial development and economic development: industrial ecology place promotion? Business Strategy and the Environment 13, 347–362

27 Pope J., Annadale D., Morrison – Sanders A. (2004). Conceptualising sustainability assessment. Environmental Impact assessment review, 24, 6, 595 – 616

28 Prakash A., Kollman K. (2004). Policy modes, firms and the natural environment. Business Strategy and the Environment, 13, 2, 107-128

29 Regione Lombardia (1999). Rapporto sullo stato dell'Ambiente in Lombardia 1999.

30 Regione Lombardia (2001). Acque sotterranee in Lombardia – gestione sostenibile di una risorsa strategica.

31 Regione Lombardia (2002). Inventario delle frane e dei dissesti idrogeologici della Regione Lombardia.

32 Segerson K. (1999). Guiding principles for efficient environmental policies. In: Better Environmental Decisions, Sexton K., Marcus A. A., Easter K. W., Burkhardt T. D. (eds). Island: Washington; 133-154

33 Spangenberg J. H. (2004). Reconciling sustainability and growth: criteria, indicators, policies. Sustainable Development 12, 74–86

34 Spangenberg J. H., Pfahl S., Deller K. (2002). Towards indicators for institutional sustainability: lessons from an analysis of Agenda 21. Ecological Indicators 2, 1-2 , 61-77

35 Steinzor R. I. (1998). Reinventing environmental regulation: the dangerous journey from command to self – control. Harvard Environmental Law Review, 22, 1

36 Strategic Environmental Assessment (ANSEA)

37 Vaze P., (1997). Environmental Input-output Tables for the United Kingdom. Economic Trends, 587.

38 http://dataservice.eea.eu.int

39 http://esl.jrc.it

40 http://soils.usda.gov

41 www.ambiente.regione.lombardia.it Lombardy Regional Government

42 www.istat.it Italian National Statistic Institute

43 www.regione.lombardia.it Lombardy Regional Government

44 www.ring.lombardia.it Lombardy Regional Government

45 www.sinanet.anpa.it Italian Environmental Agency

46 www.taugroup.com/ansea Strategic Environmental Assessment (ANSEA)