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Alessandra Oppio[1], Stefano Corsi[2], Sergio Mattia[1], Andrea Tosini[2]

[1] *Dipartimento di Architettura e Studi urbani (DAStU), Politecnico di Milano, Milan, Italy*
[2] *Dipartimento di Economia, Management, Metodi quantitativi (DEMM), Università degli Studi di Milano, Milan, Italy*

E-mail: *alessandra.oppio@polimi.it*
stefano.corsi@unimi.it
sergio.mattia@polimi.it

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Exploring the interdipendence among local conflicts and territorial vulnerability: the case study of Lombardy Region

This paper aims to explore the existence of a potential interdipendence among the level of territorial vulnerability and the distribution of local conflicts in the Lombardy Region (Italy), through an empirical analysis based on the overlay mapping of different informative layers. In order to explore this kind of relationship, a Vulnerability Index has been calculated according to the most recent conceptual and analytical frameworks developed in the research literature. The outputs of the vulnerability assessment has been put into thematic maps with the aim of providing a comprehensive overview of the environmental and socio-economic state of the Lombardy Region and tackling questions such as which provinces are most vulnerable to the localization of new infrastructures.

Introduction

The various interactions between people and environmental quality is a field of research deeply explored since the second half of the last century due to a growing public awareness about the negative consequences of human actions on the natural landscape. Thus, many theoretical perspectives and methodological approaches for understanding, evaluating, and providing options for the land use to ensure a better fit with human habitation according to the sustainability principles has been developed (Ndubisi, 2002). The most relevant threat to the fulfillment of those goals is the loss in ecological value of environmental resources and the resulting decrease of human wellbeing, caused by environmental and socio-economic vulnerability too often neglected by the decisions regarding territorial and/or urban redevelopment interventions, as shown by the large number of local communities' oppositions against infrastructures, perceived as a danger (Mattia and Oppio, 2008).

The potential negative impacts of infrastructure on environmental, economic and social systems should be considered a further pressure factor (Bradley and Smith, 2004) especially for those territories highly vulnerable according to their susceptivity to harm or hazard (Menoni e Margottini, 2011) or to their capacity to cope with external events (Cutter *et al*., 2003; Turner *et al.,* 2003; Berry *et al.,* 2006; Metzger *et al*., 2006; Smith *et al.*, 2008).

Although the many definitions of the notion of vulnerability highlight different faces of the same concept, they focus on the following concepts: i) the vulner-

ability is an intrinsic feature of a system, which can be described by the use of a specific set of indicators; ii) the notion of vulnerability is multidimensional as it affect not only the environmental aspect of a territory, but also the economic and social ones and they mutual relationships.

Starting from this conceptual framework, the paper aims to explore the existence of a potential interdipendence among the level of territorial vulnerability and the distribution of local conflicts due to the realization of infrastructures, which cause relevant changes in land use patterns and mid/long term effects on environmental, social and economic systems, through an empirical analysis based on the overlay mapping of different informative layers.

The NIMBY (Not In My BackYard) syndrome, as it is called the opposition of local communities against the proposal for a new development, has been widely examined by both the international scientific literature (Groothuis and Miller, 1994; Darly and Torre, 2013) and the daily local press (Nimby Forum® Observatory, 2013). Only a few, however, are the studies that seek to investigate and to understand the reasons of these protests.

The vulnerability assessment combined with the spatial analysis of local conflicts highlights the criticism of complex decision making processes and suggests relevant insights for better understanding those events.

Thus, a Vulnerability Index has been calculated according to the most recent conceptual and analytical frameworks developed in the research literature. Since a broadly shared model does not exist, the Vulnerability Index developed by Toro et al. in 2011, concerning the environmental and socio-economic impact assessment in a colombian case study, has been chosen as the authors have deemed it more complete and meaningful. The outputs of the vulnerability assessment has been put into thematic maps with the aim of providing a comprehensive overview of the environmental and socioeconomic state of the Lombardy Region. In addition to the general degree of vulnerability, the maps show the local conflicts surveyed by Nimby Forum, an italian research project on the phenomenon of territorial disputes better known as NIMBY (Not In My Back Yard) syndrom, managed by non-profit Aris - Agency of Research and Information Society. The maps provide a means of: i) putting forward some hypothesis about the conflicts emerged around the localization of infrastructures and the vulnerability of the Lombardy region assessed at the province level; ii) tackling questions such as which provinces are most vulnerable to the localization of new infrastructure and which fields are the most vulnerable in a certain province.

The paper is divided in four parts. The first section provides a brief overview of the concept of vulnerability, mainly focusing on its multidimensional meaning. The second section describes the analytical path that has been followed in order to overlay the outputs of the vulnerability assessment with the data about local conflicts in the Lombardy Region. The sources of data and the methodology are critically discussed. The third section shows the result of the previous analysis by the use of graphs and maps. The four section is then dedicated to the discussion of the issues emerging by this first attempt of combining the vulnerability assessment and the spatial analysis of local conflicts.

The multifaceted concept of vulnerability

Actually planning processes even more call for procedures, such as sustainability assessment, (strategic) environmental impact assessment and Environmental and Social Impact assessment (ESIA), aimed to stress the importance of the environmental issue within decisions regarding high impact interventions with reference to the size of the territory affected and to the duration of the effects (Ndubisi, 2002). Changes in land use, socio-economic characteristics, biodiversity, atmospheric composition and climate reduct the capability of a territory, meant as an ecosystem, to provide vital services for people and society as biodiversity, food, fibre, water resources, carbon sequestration and recreation (Costanza *et al.,* 1997; De Groot *et al*., 2002).

In this context the concept of vulnerability has been increasingly considered as it reveals the degree to which a system is likely to experience harm due to some threat with the aim of providing reliable information for policy and decision making (Golobič and Breskvar Žaucer, 2010). Furthermore, vulnerability is the susceptibility of a given population, system, or place to harm from exposure to the hazard and directly affects the ability to prepare for, respond to, and recover from hazards and disasters (Cutter *et al.*, 2009): on one hand it focuses on the state of a territory described by specific set of indicators, on the other it refers to how the natural and human environment can respond to external events (Toro *et al.*, 2011), that could become worse (Bradley and Smith, 2004). According to the ecosystem approach (Millenium Assessment, 2005), vulnerability is a multidimensional notion as it regards not only the environmental and physical issues, but also the systemic, social/community/institutional and economic ones and their relationship (Cutter *et al.,* 2003; Menoni *et al.*, 2012).

The vulnerability of the territory with respect to the realization of works can be also associated with land consumption and impacts on the agricultural system (Mazzocchi *et al.*, 2013). Since this notion has been studied in several fields, many complementary definitions has been developed according to different conceptual models and frameworks with different methods of measurement (Tran *et al.*, 2010).

The general vulnerability is a key concept, whose assessment could support decision makers to achieve the sustainability targets, since it allows to verify whether an intervention is consistent to the goal of protecting territorial resources and to the fulfillment of fair distribution of costs and benefits both in space and in time.

Materials and methods

The analysis was performed at the provincial level because most of the conflicts refers to linear or punctual works that have effects and impacts on a large scale.

The Vulnerability Index (VI) was structured through the selection of environmental and socio-economic factors, measured by specific indicators. From the study of Toro *et al.* 2011 the following topics with the relative indicators have been identified:

Factor	Acronym	Indicator	Source	Year
Diversity of wildlife	WD	Number of threatened species	Centro Flora Autoctona (Lombardy Region)	2008
Diversity of flora	FD	Number of threatened species	Centro Flora Autoctona (Lombardy Region)	2008
Air Quality	AQ	Air Quality Index	ARPA Lombardia: Regional agency for environmental protection	2011
Land use	LUC	Percentage of natural areas	DUSAF 2.1 (Destination of Use of Agricultural and Forest Soils) Lombardy Region	2010
Quality of surface water	SWQ	Sewage treatment channeled into the drainage system	ATO (Ambito Territoriale Ottimale) Lombardy Region	2007
Social Security	SS	Quality of Life Index	ILSOLE24ORE (annual survey)	2012
Population	Pp	Population density	ISTAT (population survey)	2013
Employment	Ep	Unemployment rate	ISTAT (labor force survey)	2012
Education system	Edu	Average years of education of the population over 15 years	ISTAT (population census)	2001

In the original study the levels of vulnerability were established, whereas in the development of this paper it was decided to develop the work of Toro et al., by the acknowledgement of different social and environmental conditions in the two case study regions (Lombardy and Colombia). The sum of the nine normalized values gave the value of the VI on a provincial scale, so that the level of vulnerability is directly related to the state of environmental and socio-economic factors. In this sense, the ability to assign one objective and comparable level of vulnerability is lost but the comparison between the provinces appears to be more effective and less arbitrary.

The analytical framework of the Vulnerability Index (VI) as proposed by the research literature (Toro *et al.*, 2011) has been adjusted in order to better represent the distribution of values of each character observed in the Lombardy Region.

More precisely, the results have been normalized on the basis of the minimum and the maximum value of each variable according to the following formula:

$$N_i = (X_i - X_{\min}) / (X_{\max} - X_{\min})$$

where N_j are the normalized data, X_i are the data to be normalized, X_{min} is the minimum value assumed by the variables and X_{max} is the maximum one. Thus

the Vulnerability Index is given by the sum of the vulnerability value of each factors:

$$VI = I_{WD} + I_{FD} + I_{LUC} + I_{SWQ} + I_{AQ} + I_{SS} + I_{Pp} + I_{Ep} + I_{Edu}$$

where I_{WH} is the vulnerability value of wildlife habitat; I_{WH} of the flora diversity; I_{LUC} of the land use change; I_{SWQ} of the surface water quality; I_{AQ} of the air quality; I_{Ep} of the employment; I_{Pp} of the population; I_{Edu} of the educational system; I_{WH} of the social security (see figure 1). Since at the current step of the research each factor has the same importance, the index's values reflect the level of vulnerability of each factor with reference to a neutral scenario. It should be relevant to introduce a weighting systems for the criteria on the basis of both technical analysis of strengths and weaknesses of a specific territory and on the involvement of local communities. The assignment of weights could support the analysis of the state of a territory in a more dynamic way by taking into account the effects of policy measures developed with the aid of vulnerability assessment.

Figure 1. The calculation of the vulnerability value of each factors.

PROVINCES	WD	FD	LUC	SWQ	AQ	Ep	Pp	Edu	SS
VARESE	0,33	0,17	0,56	0,8	0,46	0,88	0,33	0,64	0,89
COMO	1,00	0,53	0,73	0,1	0,85	0,00	0,20	0,67	0,38
LECCO	0,39	0,42	0,73	0,2	0,26	0,30	0,18	0,70	0,77
SONDRIO	0,44	0,38	1,00	0	0,00	1,00	0,00	0,62	0,05
BERGAMO	0,28	0,43	0,62	0,2	0,43	0,28	0,17	1,00	0,41
BRESCIA	0,67	1,00	0,56	0,8	0,59	0,25	0,10	0,99	0,21
MILANO	0,22	0,15	0,05	1	0,84	0,62	0,93	0,00	0,00
MONZA E BRIANZA	0,22	0,15	0,09	1	1,00	0,61	1,00	0,00	0,00
PAVIA	0,56	0,05	0,15	0,8	0,31	0,63	0,06	0,63	0,86
LODI	0,06	0,05	0,03	0,2	0,48	0,85	0,11	0,62	1,00
CREMONA	0,00	0,05	0,00	0	0,53	0,26	0,07	0,69	0,67
MANTOVA	0,11	0,00	0,00	0,2	0,52	0,53	0,06	0,84	0,32

To locate the fauna and flora by the official lists were considered (LR No. 10 of March 31, 2008) which allow specify and quantify the presence of threatened species at the provincial level. The ranges of threatened species have been tested and identified the region by the center of Monte Barro Native Flora. The species of which there is no certainty of existence in recent years have not been included in the study.

Land use of the study area was assessed through the Corine Land Cover database that allows the detection and monitoring of the characteristics of land cover and use, with particular attention to the needs of environmental protection. The territory is distinct and represented by 5 main classes (Class 1: Artificial areas, Class 2: Territories agricultural, Class 3: Forests and semi-Class 4: Wetlands, Class 5: Water Bodies). The percentage of natural soil in this study was calculated for

each province. The five above mentioned classes have been combined in function of the naturalness of soils based on the presence of the human factor and the consequent modification of the territory in comparison to its original and natural condition.

The following 3 classes derive from the combination of the five previous:

- Populated areas (Class1): areas where human presence has drastically changed the original layout of the area.
- Semi-natural areas (Class 2): agricultural areas where intensive cultivation of the soil takes precedence over the natural component.
- Natural Areas (Class 3, 4, 5) are the areas that are closest to the natural condition of the land. In these areas it is expected that biodiversity is high.

The quality of surface water was evaluated considering how waste water is purified and channeled into the drainage system at the provincial level (coinciding with the classification of the coverage of sewerage services in Optimal Territorial Area). The methods of purification apply to all provincial municipalities with more than 2000 inhabitant equivalents. The degree of waste treatment is a percentage of the provincial load. The data extracted by the First Report on the infrastructure (Regione Lombardia, 2008) refer to the year 2007 (ARPA, 2012).

The air quality index is constructed on the basis of a partial value for each of the following air pollutants: PM10, carbon monoxide (CO), nitrogen dioxide (NO2), sulfur dioxide (SO2) and ozone (O3) recorded by stations in 2011. The air quality index is calculated using the equation:

$$AQI = \frac{100 \bullet PC}{PL}$$

where AQI = Air Quality Index, PC = concentration of the pollutant, PL = the permissible limit value of the pollutant.

In the case study we adopted the approach based on the allocation to the AQI of the worst sub-index value because it is the most widely used approach in the international literature, it is sufficient that a sub-index is above the legal limit because the overall index takes a value higher than 100, it is more easily used in the field of forecast. The data required for the calculation of the Air Quality Index were collected and analyzed using ARPA Lombardia monitoring stations.

The unemployment rate is the percentage ratio of the population aged 15 and over in search of employment and the labor force. The ISTAT Labour Force Survey is the main source of statistical information on the labor market. The data refer to the year 2012.

The indicator on population corresponds to the density of population (ISTAT, 2012). The indicator for education was calculated as the percentage of residents with qualifications of secondary school and beyond (Istat, 2001)

The indicator on social security has been assimilated Index of Quality of Life. Il Sole 24 Ore and IPR Marketing publish an annual ranking of the quality of life in the Italian provinces based on 36 indicators in six areas (Il Sole 24 Ore, 2012).

It should finally be noted that in the absence of some data of the Province of Monza and Brianza (created in 2009) were considered those relating to the Province of Milan.

The data relating to conflicts come from the database of Nimby Forum. Through a system of media monitoring, the Permanent Media Observatory of Forum Nimby identifies news related to territorial disputes and it makes an inventory of the plants under opposition. The collected data are statistically analyzed and discussed providing an updated view of the phenomenon. An annual report is published that shows the evolution of the phenomenon in Italy.

The data used, related eighth edition of the report Nimby® Forum for the year 2012, show at the national level 354 plants contested (almost 7 percentage points higher than the previous edition), and of these 151 are new outbreaks born in 2012. In Lombardy the dispute to plants are 54.

In order to make more understandable the representation of territorial conflicts, the data have been grouped into 5 groups:

1. Infrastructure: mainly highways, ring roads and road, as well as the expansion of the airport of Malpensa,
2. Energy plants: both for the production and for the distribution and storage of electrical energy
3. Waste landfills and which includes centers for the treatment of special waste
4. Incinerators
5. LNG terminals.

Results

As shown by the graph 1, most of the provinces has a VI over the average value. At the higher positions of the rank there are the provinces of Brescia (VI=1) and Varese (VI=0,96), while at the lower ones there are Lodi (VI=0,39), Mantova (VI=0,11) and Cremona (VI=0). The others present values that go from 0,42 to 0,62 (Sondrio, Milano, Bergamo, Lecco, Monza e Brianza, Pavia).

Although the distribution of values appears quite homogeneous, the analysis of each vulnerability factor show a varied picture. The radar graphs below highlight the weakness for all the provinces and their intensity. Aside from two cluster of provinces – Mantova/Cremona/Lodi and Milano/Monza Brianza – whose vulnerability interests the same axis with a comparable level of importance, for the other provinces the different shape assumed by the graphs reveal the peculiarity of the territory analyzed (see figure 2).

In most of the provinces the vulnerability is higher for the group of environmental factors (WD, FD, LUC, SWQ, AQ) than for the socio-economic ones (Ep, Pp, Edu, SS) except for the provinces of Lodi, Mantova and Cremona, although the important presence of rural areas.

The analysis of the vulnerability combined with the spatial distribution of local conflicts shows a relationship among the value of general vulnerability (VI) and the number of oppositions. More precisely, the provinces of Brescia and Var-

Graph 1. The Vulnerability Index of the provinces of the Lombardy Region. The red line shows the average value of the VI (0,54).

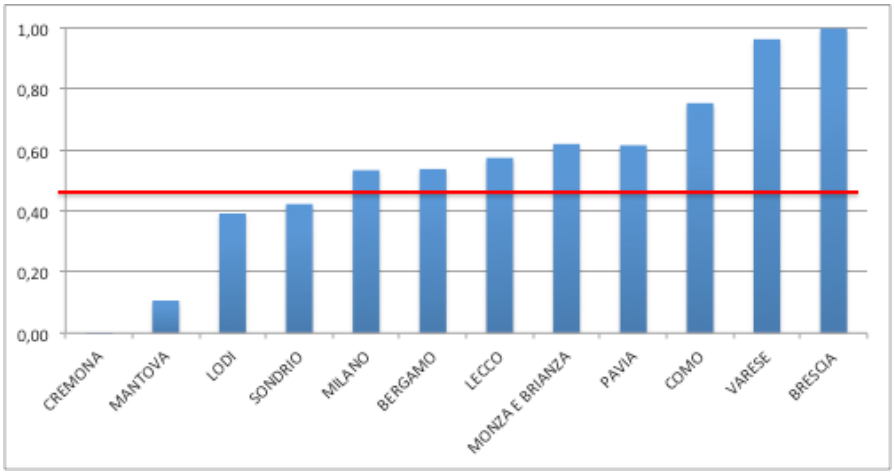
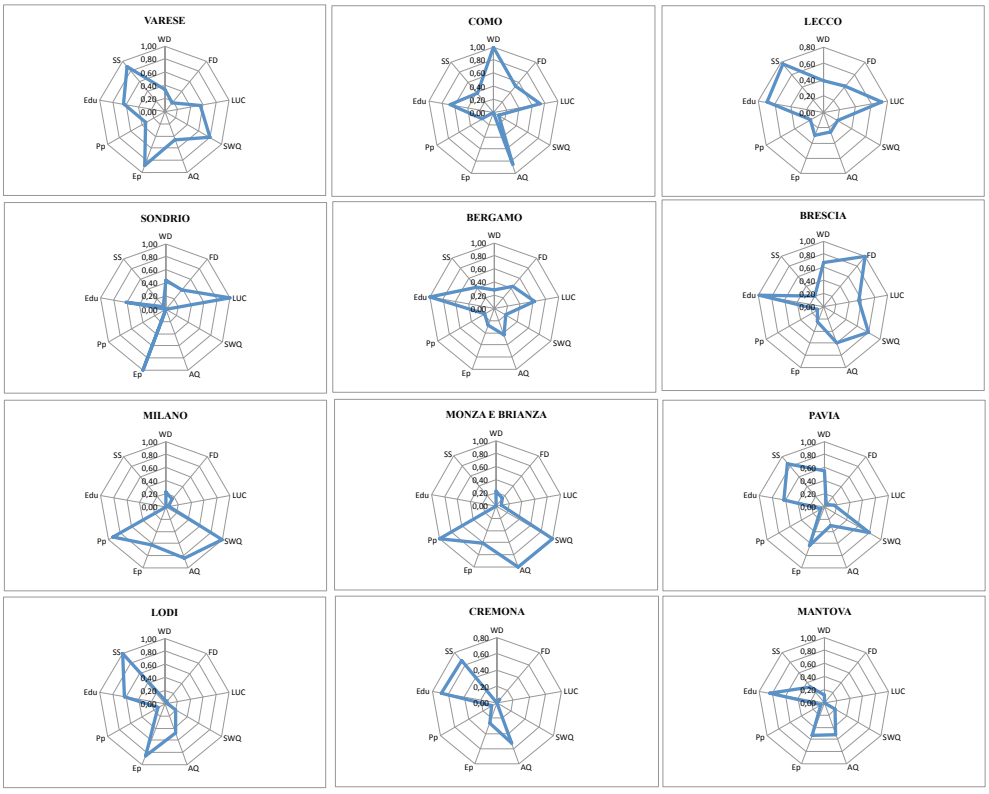
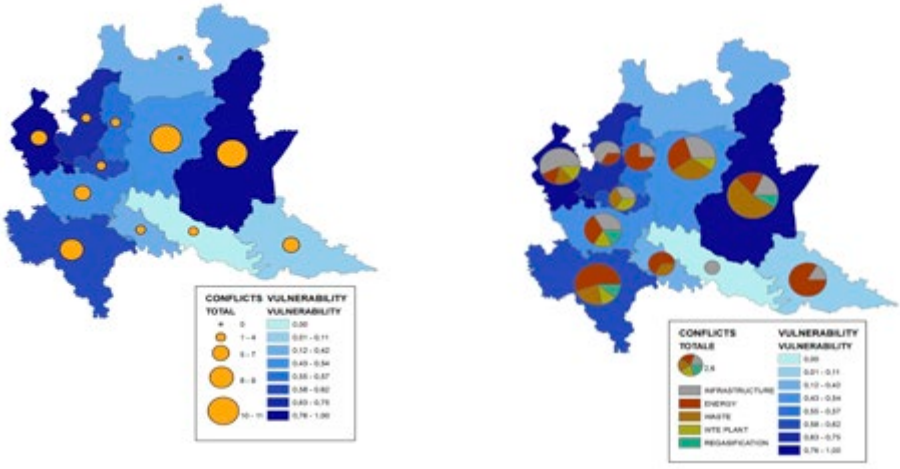


Figure 2. The level of vulnerability for each environmental and socio-economic factor at the province level.



ese, whose VI is respectively 1 and 0,96 with a prevalence of environmental vulnerability, reveal the higher number of oppositions (10-11), as the province of Bergamo, whose VI is 0,54. The lower number of conflicts is observed in the provinces of Sondrio (VI=0,42), Lodi (VI=0,39), Cremona (VI=0,11) and Mantova (VI=0).

Figures 3 and 4. Number of local conflicts and degree of vulnerability. Typologies of conflicts and degree of vulnerability. Source: Authors' rielaboration on ARIS' data.



Discussions

The VI is an instrument of great interest and effectiveness to the functional classification of the territories and planning of public or private interventions in the medium and long term. If the factors that constitute the index are widely shared and supported by the literature, weighting is a subject of more attention. The results presented in the paper, as already described, have not deliberately contemplated the weighting of the VI, but the allocation of the weights may change also impressively the analysis results.

The weighting should come from a consultation of the populations and thus from the assumption of the perception of vulnerability. Properly agricultural lands, as well as mountain areas of Valtellina, seem much less vulnerable than highly urbanized provinces.

Agricultural areas are not subject to special protection and therefore they do not affect VI, but this definition could lead the policymakers to identify them as potential areas of development and therefore as suitable location of plants and

infrastructures. Most of the scientific literature identifies them as green areas, though anthropized, in which the consumption of soil must be contained.

With regard to the location of the conflicts significant differences are not detectable, but the spread of local opposition corresponds to low willingness of the community to accept a change in the social welfare.

At first the bottom up approach for enhancing the involvement of local communities in decision making processes appears to be the solution for the conflicts and at the same time the instrument of spreading awareness about the vulnerability of the territories, but the scope and intensity of the opposition lead to think that the willingness to accept is very low because of the local populations are not often able to understand the benefits according to long time horizons and are wary of the good faith of the promoters.

The level of compensation and the recipients of compensation, which should be commensurate with the environmental and socio-economic vulnerability of the territories, is probably the key to the success of local initiatives and the tool to reduce conflicts.

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