

VULNERABILITY AND RESILIENCE OF THE ECONOMIC, SOCIAL AND ENVIRONMENTAL DIMENSIONS OF ITALIAN PROVINCES

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SUMMARY

This paper uses the theoretical framework proposed in *Rischio, vulnerabilità e resilienza territoriale* (Graziano, 2011) for a study of the Italian provinces. The representation of regional risk using a systemic approach (Holling, 2001; Walker, 2002; Resilience Alliance, 2007) led the author to the identification of two descriptive categories of this concept: vulnerability and resilience, where risk is positively and negatively correlated. The intent of representing the characteristics of local systems in the three dimensions of sustainability, Economy, Society, Environment, led to three versions of vulnerability and resilience concepts, and the identification of some macro-themes that describe them. In this paper, the author aims to verify, through a study of Italian local systems, the scheme defined. She makes up, through a multivariate technique of dimensional reduction, a system of indicators and composite indices, which can allow a synthetic and complete evaluation of the phenomena investigated, and a comparison among local systems under observation.

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1 Introduction²

The objective of this work is to verify, through a study of the Italian provinces, the theoretical framework describing the multidimensional concept "regional vulnerability", proposed in *Rischio, vulnerabilità e resilienza territoriale* (Graziano, 2011) presented at the XXXII Conferenza di Scienze Regionali. In the proposed scheme the author adopts a systemic approach to the study of the phenomenon (Holling, 2001; Walker, 2002; Resilience Alliance, 2007): risk is represented as a combination of vulnerability and resilience factors. The concept is described in an as complete as possible way, to give a representation in all three spheres of sustainability, the economic one, as well as the social and environmental ones. For a definition of the local system in three dimensions the author uses, as a starting point, the theoretical background and conceptual basis of ESA index, which was developed in 2006 by E. Ciciotti, A. Dallara and P. Rizzi, to describe the competitive positioning of the local systems and of the co-evolution, with a view to balance the three subsystems (Economy, Society, Environment) that comprise them.

For the application of the scheme concerning the study of Italian provinces, the author makes up a system of indicators and composite indices, according to the following steps: firstly a connection of some indicators with economic, social and environmental dimensions, then with the descriptive categories of vulnerability and resilience and finally, the macro-themes that define them; selection of elementary variables defined in the theoretical step; application of multivariate analysis, in particular principal components analysis, to get composite indices, at the level of macro-variables and, in a second moment, at the level of the *vulnerability* and *resilience* descriptors. The aim is to get a tool for regional analysis which can produce an assessment, as synthetic as comprehensive at the same time, of regional vulnerability in the three spheres of sustainability. It is intended to build a geographic information system, used to provide synthetic information or to focus on specific topics, in order to evaluate the positioning of a local system, according to a comparative approach.

2 From the theoretical framework to the case study

The topic of risk mitigation is now a crucial factor for achieving the conditions for sustainable development of local systems. A sustainable urban planning necessarily takes into account two important goals, in order to face the uncertainty that characterizes the evolution of regions that is: on one hand, the improvement of the ability to recover to adverse shocks and, on the other hand, the reduction of impact of action and interventions which, leading to strong anthropogenic pressures, may affect this ability. In the paper *Rischio, vulnerabilità e resilienza territoriale* (Graziano, 2011) the author proposes a theoretical framework useful for

investigating the phenomenon of risk for every level of analysis, extending the interpretation of the phenomenon to the three dimensions of sustainability that is: Economy, Society and Environment.

The concept of "regional risk" is complex and multidimensional. The design of the theoretical framework and its empirical translation followed a logical/operational sequence which is inspired by the one proposed by Lazarsfield (1953) for the quantitative determination of a concept designed for measuring. First, the theoretical framework has been *designed*, identifying the elements of the concept description, its dimensions: an analysis of the literature on the complex adaptive systems in the context of both the socio-ecological sciences (Carpenter, Walker, Anderies, Abel, 2001; Holling, 2001, Walker, 2002; Pickett, Cadenasso, Grove, 2003; Walker, Holling, Carpenter, Kinzig, 2004; Walker, 2006; Berkes, Folke, Olsson, 2004; Folke, 2006) and regional sciences (Rose and Liao, 2005, Vale and Campanella, 2005; Foster, 2007; Pendall, Foster and Cowell, 2010; Simmie and Martin, 2010, Martin, 2011) which has suggested the existence of two dimensions, vulnerability and resilience. The vulnerability is the ability of the system to undergo negative changes resulting from an adverse shock, as well as the inability to restore the structures that distinguish it. The vulnerability of a region depends on the fragility of its structure and increases the probability of the system to enter into functional crisis as a result of an exogenous shock. Resilience is the ability to cope with a negative event, tolerating the negative impact produced by the perturbing action. Resilience of region depends on the ability to adapt, recover and regenerate. According to the systemic representation of the regional risk this concept is positively related to the factors of regional vulnerability and negatively to the resilience factors.

Subsequently, the design was *filled*, describing it in such a way as comprehensive as possible, to give a representation in all three spheres of sustainability. We have therefore identified the economic, social and environmental dimension and sub-dimensions that are relevant from the view of the phenomenon being investigated. In this step, we have used the contributions on the theme of the economic systems fragility and resilience (Briguglio, 2008; Naude, 2008; Chapple and Lester, 2007; Sheffi, 2005; Foster, 2009; Sotarauta, 2005; Liou and Ding, 2004), social (and Zautra Bachrach, 1985; Sonn & Fisher, 1998; Breton, 2001; Woolcock, 2001; Sarig, 2001; Clauss-Ehlers and Lopez-Levy, 2002; Zimmermann, 2004; Cutter and Finch, 2008, 2010; Blaike, Cannon, Davis and Wisner, 2004; Walker, 2009) and environmental factors (IPCC, 2001; Hansen, Biringer, Hoffman, 2003; Jansen, Graumlich, Steffen, 2007). Finally, these components have been traced back to the descriptive categories (vulnerability and resilience) identified before, through some logical criteria suggested by the literature on the complex adaptive systems (Resilience Alliance, 2007). Regional components that feed systemic vulnerability are those which promote the homogeneity of its structure and reduce the redundancy and the functional modularity of the elements that compose it. The

components that feed the resilience are those that promote the availability of resources and facilitate the ability to the strategic adaptability.

At the design stage of the theoretical framework, described above, a collection of some indicators has been connected with the dimensions and with the individual themes that constitute the phenomenon investigated. A certain amount of discretion has characterized the assignment of indicators to the three dimensions, as well as to the categories and macro-themes that define them, because in some cases it was the result of interpretations inspired by the literature analyzed, and, in other cases, as the result of choices on the basis of assumption of work formulated.

In this paper we use the defined theoretical framework by applying it to a study on risk of Italian local systems and operating a complete reading of these features to represent the phenomenon within the anthropogenic and environmental sphere. Despite the contributions on this topic highlights the importance of regional risk definition regarding the elements of socio-economic and eco-systemic fragility as well as the political and institutional factors, the cases of empirical translation of this concept that can be found in the literature have never explored effectively its multidimensional nature. In the case of construction of composite indexes of risk and vulnerability, the three spheres Economy, Society and Environment are usually not very distinct and therefore characterized by a description not so deep.

3 The data and the method of synthesis

For the empirical application of the theoretical framework defined it was decided to consider the province as unit of analysis and was considered the period of time from 2007 to 2011, with average values (where possible) of the variables used. 146 variables were collected, using as sources the main Italian datasets, reports and studies conducted periodically in Italy on the social, environmental and economic systems. The variables were associated with the dimensions Economy, Society and Environment that define the theoretical framework, then the categories vulnerability and resilience, and finally the macro-themes in which they are articulated. The data matrices were built, however, to overcome the difficulties related to the way they are made available from sources: in order to overcome the difficulties of reading the local systems characteristics through a system of individual indicators, it was decided to adopt a statistical aggregation method of variables in subsequent steps (Dallara, 2006; Coppi, 2006; Annoni, Kozovska 2010). This method allows the generation of macro-variables and composite indices, thus making possible the function of the constructed model of analysis and understanding the characteristics of the local systems. The multivariate technique chosen for dimensions reduction of the partitions and sub-partitions identified in the theoretical step is principal components analysis.

Since the dataset has been built, a selection of variables has been made, based on a “factorizability” checking. The stage of analysis and variables selection is thus provided in the study of their structure, through descriptive statistics and graphical representations, to verify, by examining asymmetry and kurtosis, the normality of the distributions and the homogeneity of their variation range. Where deemed appropriate, some steps were taken to a transformation of the elementary variable and subsequent standardization.

The type of approach adopted for the selection of the individual variables and for the construction of the synthesis, is correlative, on one hand assumed to ensure the possibility to build synthesis, and on the other hand to avoid the duplication of information. Therefore we proceeded to exclude redundant variables or too little correlated, analyzing, for each sub-matrix extracted from the variables matrix inserted in theoretical step, the corresponding correlation matrix. Coefficients of Pearson correlation were thus considered for each pair of variables. Among the couples of variables that have not passed the requirements the “factorizability” check (the ones which showed correlation coefficients as an absolute value greater than 0.8 or less than 0.3) one of them has been eliminated (Jolliffe, 2002; Krzanowski, 1987). Subsequently it was used the technique of principal components analysis to get to the synthesis variables which could merge all the individual elementary variables selected either in statistically or significantly way (Dallara, 2006). By using the technique of principal components analysis and a subsequent steps approach it was tried to reproduce a pattern of studying of local systems that would allow, at the level of each individual partition and sub-partition, a reduction of the complexity of the problem evaluation, minimizing the loss of the available information. Therefore this technique has been initially used at the level of elementary variables to get to the macro-variables and, subsequently, at the level of macro-variables to reach the descriptive categories "*vulnerability*" and "*resilience*".

In order to facilitate the study of local systems features and the interpretation of the phenomenon we have chosen to extract, for each partition and sub-partition of data matrix, a single factor (Dallara, 2006; Annoni, Kozovska 2010). This means that we have constructed one statistically significant principal component, for each successive step, that is the first component, that capture the largest share of variability information.

To assess the potential of the information obtained through the synthesis procedure, the uniqueness of macro-variable was tested for statistical significance. For each partition and sub-partition of the data matrix it has been verified that the only factor extracted:

- explain a proportion of the total variance of at least 50%
- had eigenvalue greater than 1 (and one screeplot with a net cutting point between the components)
- had KMO test and a significant Bartlett's test of sphericity.

The loading factors resulting from principal components analysis are the measure of correlation that links the elementary variables to the synthesis macro-variable obtained. Through the loading factors it has been possible to identify elementary variables that could better describe the phenomenon investigated. The eigenvector associated to the first eigenvalue of each partition and sub-partition of the matrix represents the row vector of the coefficients, which multiply the original variables in the linear combination that generates the "new" variable, that is the synthesis variable. Thus it has been possible to assign, through this technique of analysis, a diverse importance to each elementary variable that composes the composite index generated.

4 The variables constituting the descriptive diagram of the territorial risk

We obtained a dataset of 68 variables, organized as follows: 28 for the economic dimension, 25 for the social dimension and 15 for the environmental one. For Economy vulnerability is defined by 9 elementary variables grouped into four macro-variables, resilience by 19 elementary variables grouped into five macro-variables; for Society vulnerability is represented by 13 elementary variables aggregated into three macro-variables, resilience by 12 elementary variables aggregated in 4 macro-variables; for Environment vulnerability is described by 7 elementary variables grouped into 3 macro-variables and resilience by 8 elementary variables grouped into 3 macro-variables.

The following figure shows the descriptive layout of the vulnerability and resilience of local systems in its dimension "Economy", "Society" and "Environment", which is a result of the analysis phases, selection and adequacy evaluation of the elementary variables and construction of composite indices and their validation.

Table 1 – Economic, social - environmental vulnerability of italian provinces

ECONOMY	SOCIETY	ENVIRONMENT
1. Financial stress of enterprises 1.1 Debt/Equity 1.2 net interest expenses/gross operating profits 1.3 Bad loans to enterprises/performing loans to enterprises	1. Demography and health 1.1 Death rate from infectious diseases 1.2 Death rate from respiratory diseases 1.3 Death rate from diseases of the circulatory system 1.4 Death rate from cancer 1.5 Dependency ratio	1. Air quality 1.1 Particulate matter (PM10) concentrations 1.2 Nitrogen dioxide (NO2) concentrations
2. Financial stress of households 2.1 Bad loans to households/performing loans to households 2.2 Protests / population	2. Social dissatisfaction 2.1 Suicide death rate 2.2 Accidents at work / employment 2.3 Traffic accidents / population	2. Anthropic pressure 2.1 Urban Waste / population 2.2 Circulating Vehicles / population 2.3 Inorganic fertilizers/Farming land area
3. Labour market 3.1 Unemployment Rate 3.2 Rate of female inactivity 3.3 Labour costs / Value Added	3. Crime 3.1 Sexual violences / population 3.2 Thefts / population 3.3 Damages / population 3.4 Receiving stolen goods / population 3.5 Robberies / population	3. Land state 3.1 Contraction of Utilised Agricultural Area 2000-2010 3.2 Areas at hydrogeological risk
4. specialization 4.1 Index of production specialization		

Table 2 Economic - social - environmental resilience of italian provinces

ECONOMY	SOCIETY	ENVIRONMENT
1. Size of the local economy 1.1 Population growth rate 1.2 Business Density 1.3 Value added per capita	1. Social infrastructure and leisure 1.1 Libraries / population 1.2 Gyms / population 1.3 Shows / population 1.4 Nurseries / population (0-3 years)	1. biodiversity 1.1 Urban green areas
2. Availability of resources for enterprises 2.1 Return on Equity 2.2 Liquidity Ratio 2.3 Loans to firms	2. health infrastructure 2.1 Rate of nursing staff 2.2 Rate of medical staff 2.3 Rate of hospital beds used	2. Sustainable production and consumption 2.1 Separate Waste collection (percentage waste) 2.2 Composite index of eco-management for public administration 2.3 International Organization for standardization (ISO) 14000 – certified industries
3. Availability of resources for households 3.1 Amount of pensions per capita 3.2 Families bank deposits per capita 3.3 non-food consumption / total consumption 3.4 Intensity of residential real estate market	3. Social capital 3.1 Newspapers sold / inhabitants 3.2 Voluntary service organizations / population 3.3 Foundations / inhabitants 3.4 Recreational, cultural art associations / inhabitants	3. Public policy for environment 3.1 Pedestrian areas 3.2 Restricted access areas 3.3 Cycle paths 3.4 Composite index of policies for renewable energy
4. Innovation 4.1 Italian patents submitted 4.2 Italian applications of designs 4.3 Italian applications of models 4.4 European applications of trademarks 4.5 European applications of designs	4. Human capital 4.1 Life long learning	
5. Economic infrastructure 5.1 Rail infrastructures 5.2 Broadband services 5.3 Electrical network 5.4 Energy networks		

5 The economic dimension

The economic dimension is described by 28 indicators, obtained by a selection performed on a dataset of 52 initial variables, which made it possible to eliminate the redundant ones and identify those most significant in statistical terms.

The multidimensional concept "economic vulnerability" is described by a factor which is divided into the macro-variables "production specialization", "financial stress of enterprises", "financial stress of households" and "labour market". The financial stress of enterprises is described by three variables that together determine the degree of solvency and financial risk of local business. The elementary variable Net interest expenses/Gross operating profits is the impact of the cost of debt on economic results of enterprises; debt / equity indicator represents the financial structure of the companies; bad loans to enterprises are defined on a customer basis and therefore include all the outstanding credit extended by a bank to a borrower considered insolvent. The indicators for business financing operations explain the impact of the financial risk more than the cost of debt. The concept of "financial stress of households" is described by two elementary variables representing the families' ability to pay its debts: bad loans ratio, where bad loans to households are defined on a customer basis and therefore include all the outstanding credit extended by a bank to a borrower considered insolvent and the amount of protests per capita. The macro-variable "labour market" is included in the synthesis with a logical sense (and sign) coherent with the concept of "regional risk": the variables related to labour market included in this scheme will therefore express negative aspects. The labour market is described by the unemployment rate, the inactivity rate of women aged between 15 and 64 years and the labour cost incidence on the value added business. Individual variables are brought together and they explain a total variance of 0.706. The unemployment rate and the female inactivity rate contribute more than labour cost to explain the meaning of macro-variable and enter in the corresponding linear combination with the greater weight.

The synthesis of macro-variables in the index "economic vulnerability" highlights a consistent relationship (with a total variance of 0.651 and KMO test of 0.74) and positive. The financial stress of enterprises and the labour market, which represents a logical negative sense in this context, contribute more than the others to explain regional economic vulnerability. The index of production specialization is the factor that contributes less to qualify the economic fragility of the Italian provinces. Although specialized local systems with economic basis structured on one or a few sectors are more vulnerable to the shocks than those with diversified economies (Sotarauta, 2005; Naude, 2008), this aspect affects less than the others in the definition of the concept of economic fragility, for the case study that is considered.

The scheme used to describe the multidimensional concept "economic resilience" partially follows the format used for vulnerability definition. The variables of description, unlike those

in the previous dimension, have all positive meaning, so they are characterized by a logical sense (and sign) discordant with respect to the phenomenon of "regional risk". The theme of resilience is divided into the macro-variables "size of the local economy", "availability of resources for business", "availability of resources for families", "innovation" and "economic infrastructures". The theme of the size of the local economy is defined by population growth rate, business density and value added per capita, expressions of the potential growth of the domestic market and the income produced by the economic system (Liou and Liou and Ding, 2004; Briguglio, 2008). Population growth rate and value added per capita enter into the construction of the composite index with a higher weight. The availability of resources for businesses and families promotes the responsiveness of an economic system to the negative consequences of an adverse event (Naudé, 2008). The concept of "availability of resources for enterprises" is described by some variables that are expression of local businesses accessibility to the financial system and the ability of this to self-finance production activities through management performance: the ratio between loans and active companies, the Return on Equity rate, that is the ratio between net income and equity, which expresses the company's profitability, the liquidity ratio, that is the ratio between assets and liabilities. As in the scheme of the vulnerability, the financial performances of the companies seem to identify, better than the income results, the companies' ability to respond to an adverse event. The theme of "availability of resources for families" is represented by some indicators of income, savings and the properties of households, who significantly join in the synthesis, explaining a total variance of 0.679. The incidence of non-food consumption on total consumption of goods and services, usually higher in wealthier households, and the average amount of pensions describes the income situation of the families on the 103 Italian provinces. The amount of deposits per capita and the intensity of the residential real estate market, calculated on the number of standardized transactions of property-residential, describe the financial situation. In the case of households, in contrast to businesses, the reading of the correlations between variables and first component extracted, reveals a higher incidence for income indicator in the construction of resources availability index. The ability to innovate is an important factor of regional resilience, as it promotes the ability to cope for a local economy (Sotarauta, 2005). It is described by a group of elementary variables that represents the potential of creative response to the effects coming from an adverse unexpected event: Italian patents submitted, applications of designs, models, European applications of trademarks and designs. The first component that is extracted is significant (with a total variance explained of 0.816 and KMO test of 0.737) and individual indicators come into the synthesis with similar weight. The macro-variable "economic infrastructures" is obtained from the synthesis of indicators related to transport and communication (railway network and broadband services) and refers to the electric energy supplies and energetic/environmental networks. Economic infrastructures are essential elements for the integration among areas as well as enterprises

and people settlement. In the case of the 103 Italian provinces indicators which best describes the quality of the infrastructure are the provision of broadband services and the energetic/environmental networks.

The synthesis of macro-variables in the index of "economic resilience" highlights a consistent relationship (with a total variance explained of 0.676 and KMO test of 0.814) and positive. With higher loading factors, the availability of resources for businesses and families are the dimensions that define better this concept.

The following table shows the elementary variables that constitute economic dimension for the 103 Italian provinces and the results from principal components analysis.

Table 3 – The variables that constitute the economic dimension

Variabili	Final Communalities	Loading Factors	Coefficient score	Variance explained	KMO test	Source
<i>Financial stress of enterprises</i>				0,629	0,626	
Debt/Equity	0,698	0,836	0,443			Unioncamere
Net interest expenses/gross operating profits	0,465	0,682	0,361			Unioncamere
Bad loans to enterprises/performing loans to enterprises	0,724	0,851	0,451			Banca d'Italia
<i>Financial stress of households</i>				0,767	0,5	
Bad loans to households/performing loans to households	0,767	0,876	0,571			Banca d'Italia
Protests / population	0,767	0,876	0,571			Istat
<i>Labour market</i>				0,706	0,578	
Unemployment Rate	0,876	0,936	0,442			Istat
Labour costs / Value added	0,378	0,615	0,29			Unioncamere
Rate of female inactivity	0,864	0,93	0,439			Istat
<i>Economic vulnerability</i>				0,651	0,74	
Index of production specialization	0,200	0,521	0,2			Movimprese
Financial stress of enterprises	0,345	0,898	0,345			
Financial stress of households	0,316	0,823	0,316			
Labour market	0,354	0,922	0,354			
<i>Size of local economy</i>				0,565	0,54	
Population growth rate	0,756	0,87	0,512			Istat
Business density	0,259	0,509	0,3			Movimprese
Value added per capita	0,683	0,827	0,487			Ist. Tagliacarne
<i>Availability of resources for enterprises</i>				0,603	0,586	
Return on equity	0,440	0,663	0,366			Unioncamere

Liquidity ratio	0,623	0,789	0,436			Unioncamere
Loans to firms	0,747	0,864	0,478			Banca d'Italia
<i>Availability of resources for households</i>				0,679	0,794	
Amount pensions per capita	0,674	0,821	0,302			INPS
Family banks deposits per capita	0,637	0,798	0,294			Banca d'Italia
Non-food consumption / total consumption	0,793	0,89	0,328			Ist. Tagliacarne
Intensity of the residential real estate market	0,613	0,783	0,288			Min. Econ. e delle finanze
<i>Innovation</i>				0,737	0,816	
Italian patents submitted	0,804	0,896	0,243			Istat
Italian applications of designs	0,720	0,848	0,230			Istat
Italian applications of models	0,780	0,883	0,239			Istat
European applications of trademarks	0,704	0,839	0,227			Istat
European applications of designs	0,681	0,825	0,224			Istat
<i>Economic infrastructure</i>				0,606	0,754	
Rail infrastructures	0,307	0,554	0,228			Ist. Tagliacarne
Broadband services	0,738	0,859	0,354			Ist. Tagliacarne
Electrical network	0,634	0,796	0,328			Ist. Tagliacarne
Energy networks	0,746	0,864	0,356			Ist. Tagliacarne
<i>Economic resilience</i>				0,676	0,814	
Size of the economy	0,706	0,840	0,248			
Availability of resources for enterprises	0,832	0,912	0,270			
Availability of resources for households	0,835	0,914	0,270			
Innovation	0,694	0,833	0,246			
Economic infrastructure	0,314	0,56	0,166			

The map of the economic vulnerability of the Italian local systems highlights the structural fragility of many provinces in southern Italy, with a strong financial stress, both at company level and at families level. The provinces of Enna, Isernia, Vibo Valentia, are the most disadvantaged in terms of corporate debt exposure. Potenza, Ragusa and Caltanissetta have the highest incidence of bad loans to households on performing loans to households. The phenomenon of economic vulnerability is also represented by the theme of the labour market, which highlights again the fragility of the southern provinces of Italy. Emerges the strong economic structure of some areas of the Northeast (Trento, Belluno, Trieste, Udine) with firms characterized by a higher level of capitalization rates and lower unemployment.

The geography of economic resilience highlights the good performance of areas with significant economies of urbanization (Milan, Bologna, Parma, Rome). The most

disadvantaged provinces in terms of capacity to respond are those of the south of Italy and, in particular, the provinces of Sicilia and Calabria. The largest economic systems are located in Emilia Romagna and Lombardia, in terms of income produced as well as in terms of population growth. This scheme also highlights the good performance of provinces of Lazio (Viterbo, Rome, Latina). The availability of resources for enterprises, both as equity and as loans to firm, awards several areas of northern and central Italy. In particular, enterprises from some northern small provinces (Parma, Siena, Biella, Savona) and some central provinces (Latina, Prato, Pescara) record the best profit results, showing the strongest self-financing capacity of production. On the other hand in the provinces of Sicilia, Calabria and Campania where the financial stress of companies is higher, the access to financial markets seems to be more difficult. Also the availability of families resources reveals a rift between the North and South of the country. The ranking according to the variable "incidence of non-food consumption on total consumption" rewards the North East and Emilia Romagna and penalizes especially the provinces of Campania. According to the scheme defined, the business systems which can better respond to change through creative responses are concentrated in a few metropolitan areas (Milano, Bologna) and in some areas considered marginal in the past (Macerata, Pordenone). It also highlights the good performance of some provinces of Adriatic coast (in particular, Ancona and Rimini) and Tuscany. The provinces that show the smallest allocation of economic resilience factors are in south of Italy. The provinces of the islands are those with the least significant patent capacity of firms. These provinces, with other of the South Central area (Isernia, Rieti, Campobasso, Potenza) are also disadvantaged in regional infrastructure. The province of Northern Italy with the most meager economic infrastructure is Aosta, which occupies the 94th position in the ranking according to this indicator. The ranking rewards the North East (Trieste, Gorizia, Venezia) and the provinces of Milano and Napoli (first in the ranking according to supply of broadband services).

Figure 1 – Index of economic vulnerability

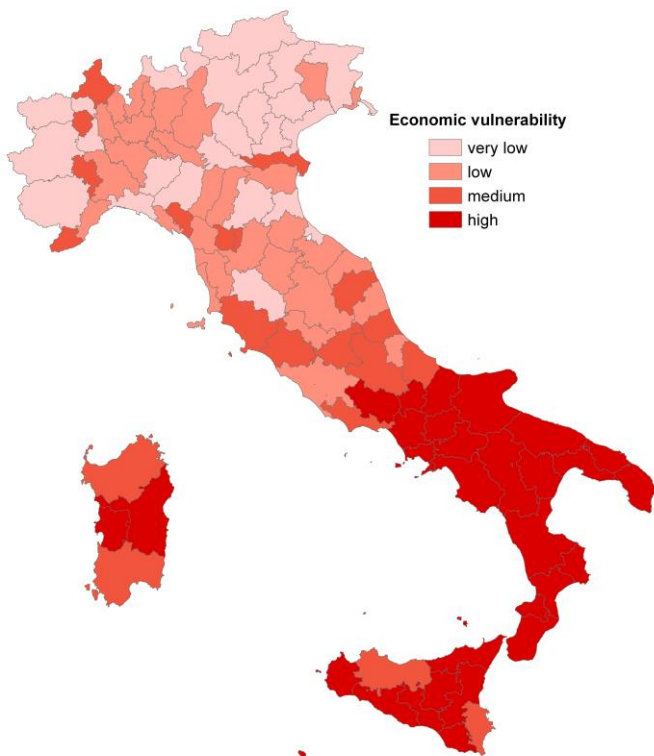
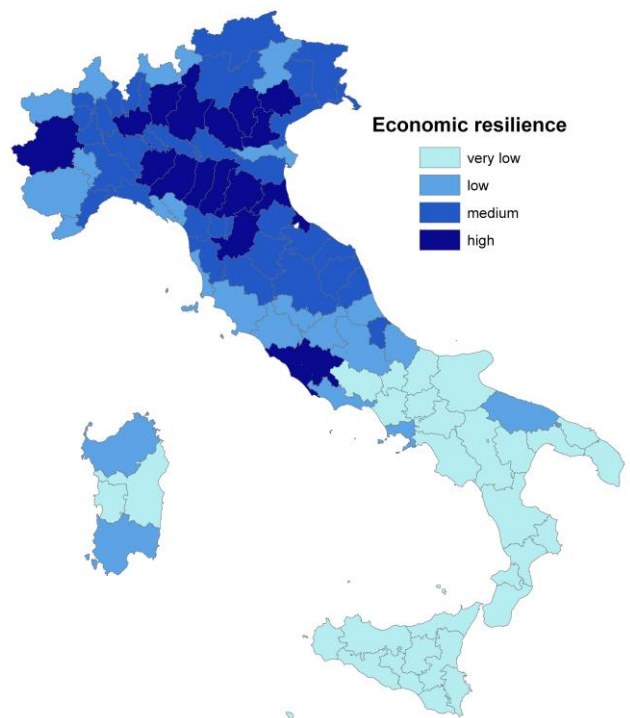


Figure 2 – Index of economic resilience



5 The social dimension

The social dimension is described by 25 indicators, obtained by a selection performed on a dataset of 57 initial variables.

Social vulnerability is represented by three macro-variables, obtained from principal components analysis, "Demography and health", "dissatisfaction" and "crime." All the variables used to describe the basic concept have a logical negative sense, so they are concordant to the significance of the multidimensional phenomenon "regional risk." The theme "Demography and health" is represented by a group of elementary variables that describe the negative aspects of the social structure. First of all we have in this scheme the mortality rates of the population for the main causes of death in Italy: cancer, diseases of the cardiovascular system, infectious and respiratory system diseases. The mortality rate for cancer contributes more than any other to explain the state of the population health of Italian local systems. The composite index constructed describes the structural aspects of demography, also through the elementary variable "dependency ratio", calculated as the ratio of the population over 65 years and the population of 15-64 years. The individual indicators aggregate together in the synthesis significantly, explaining a total variance of 0.708, and express a positive relationship. Areas characterized by a strong demographic dependency and a bad state of health are more vulnerable versus the negative effects coming from an exogenous event. "Dissatisfaction" is described by indicators relating to the malaise of individuals: the death rate from suicide, accidents at work and the number of traffic accidents per capita. The last two come into the synthesis with heavier weights. "Crime" is an element of social vulnerability which tends to worsen as a result of complications arising from an unexpected event (Blaike, Cannon, Davis and Wisner, 2004). This theme is represented by elementary variables related to the offenses against the person and against property, calculated as the ratio between reported crimes and population. The ratio between reported thefts and people contribute to explain the phenomenon of crime in Italian local systems with a loading factor of 0.905. The combination of the macro-variables in the composite index of vulnerability reveals a consistent and positive relationship (with a total variance explained of 0.615). The reading of the correlation between the macro-variables and the first component extracted highlights the importance of individual dissatisfaction sphere as well as the aspects related to health and population aging, within the definition of the social vulnerability concept.

Resilience is represented by two macro-variables related to the sphere "Social infrastructure", that is the provision of services for culture, leisure and health, the one that describes "social capital" and the other one that is the indicator for the representation of "human capital". All the elementary variables used to define this dimension have a positive logical sense, so they have a discordant sign with the phenomenon of regional risk. Accessibility to health services,

services for communication, education and primary care has positive effects on resilience of social systems (Cutter, Finch, 2008, 2010). The composite index "infrastructure for culture and leisure" aggregate indicators of cultural and recreational resources of the area, i.e. the number of libraries, gyms and shows per capita (the latter calculated as the sum of the shows and events on inhabitants in the province within the cinema, theater, concerts, sporting activities and within artistic exhibitions and attractions of traveling shows) and an indicator of social welfare sphere, that is the number of childcare per inhabitant aged between zero and three years. The four variables enter with similar weights in the linear combination to generate the composite index of social infrastructure and leisure. The sphere of provision of health services is described by three indicators, the rate of nursing staff, medical staff and the rate of hospital beds, all calculated as a percentage of the service on the resident population. With a total variance explained of 0.813 and values of final communalities above 0.7, the first component extracted seems to be significant. To define aspects of community resilience and coping ability of the social systems some of indicators suggested by the contributions about social capital are used (Putnam, 1993; Triglia, 1999; Breton, 2001; Zimmerman, 2004; Rizzi, 2003; Rizzi, Popara 2006; Cartocci, 2007). Social capital, the main *driver* of a social system responsiveness, is made of networks, formal and informal groups of individuals who favor collective action in a territorial system. The theme is represented by four indicators relating to the sphere of civicness and cultural community, the elements that characterize social systems capacity of adapting to changes due to the unexpected events. The variables "voluntary organizations" and "foundations", calculated on the inhabitants represent the geographical spread of groups that provide social and economic support to the local community. They describe the altruistic dimension of social capital, the availability of individuals to support local communities (in terms of time or money). The "number of newspapers sold per capita" represent the relationship between individuals and the political community and expresses interest in collective themes. Finally, local distribution of artistic and cultural associations defines the individual's belonging to networks that makes available cognitive resources (information) and regulations (trust). The first component extracted is significant (with a total variance explained of 0.674 and 0.797 KMO test) and it's explained by the community culture (newspapers sold per capita) and social relations (voluntary organizations per capita). The three macro-variables "social infrastructure and leisure", "health infrastructure" and "social capital" together with the elementary variable "Life long learning" are synthesized in the composite index of social resilience. Life long learning indicator as the share of individuals aged between 25 and 64 years who have received education or training in the last four weeks prior to the data collection, represents the dimension of "human capital". A good and constant instruction of the population contributes to promote the development of a social resilient structure. Among the dimensions of social resilience, social capital, with a loading factor of

0.770, is the most significant, as shown by studies on the adaptive capacity of communities affected by adverse events (Sonne Fisher, 1998; Sarig, 2001; Woolcock, 2001).

Table 4 - Constitutive variables of the dimension Society

Variabili	Final Communalities	Loading Factor	Coefficient scores	Variance explained	KMO test	Source
<i>Demography and health</i>				0,708	0,808	
Death rate from infectious diseases	0,548	0,741	0,209			Istat
Death rate from respiratory diseases	0,710	0,843	0,238			Istat
Death rate from diseases of the circulatory system	0,651	0,807	0,228			Istat
Death rate from cancer	0,778	0,882	0,249			Istat
Dependency ratio	0,853	0,924	0,261			Istat
<i>Individual dissatisfaction</i>				0,624	0,573	
Suicide death rate	0,381	0,617	0,329			Istat
Accidents at work / employment	0,788	0,888	0,474			Italia Oggi
Traffic accidents / population	0,705	0,840	0,448			Istat
<i>Crime</i>						
Sexual violence / population	0,408	0,639	0,226			Istat
Thefts / population	0,819	0,905	0,321			Istat
Damages / population	0,525	0,725	0,257			Istat
Receiving stolen goods/population	0,461	0,679	0,241			Istat
Robberies /population	0,607	0,779	0,276			Istat
<i>Social vulnerability</i>				0,615	0,534	
Demography and health	0,669	0,818	0,443			
Dissatisfaction	0,810	0,9	0,487			
Crime	0,368	0,607	0,329			
<i>Social infrastructure and leisure</i>				0,573	0,739	
Libraries / population	0,591	0,769	0,335			Il sole 24 ore
Gyms / population	0,639	0,799	0,349			Il sole 24 ore
Shows/population	0,476	0,69	0,301			SIAE
Nurseries / population (0-3 years)	0,587	0,766	0,334			
<i>Health infrastructure</i>				0,813	0,744	
Rate of nursing staff	0,832	0,912	0,374			Istat
Rate of hospital beds used	0,795	0,902	0,37			Istat
Rate of medical staff	0,814	0,892	0,365			Istat
<i>Social capital</i>				0,674	0,797	
Newspapers sold / inhabitants	0,721	0,849	0,315			Acc. diff.

						Stam pa
Voluntary service organizations / inhabitants	0,707	0,841	0,312			Isfol
Foundations / inhabitants	0,595	0,771	0,286			Isfol
recreational, artistic and cultural association / inhabitants	0,675	0,822	0,305			Il sole 24 ore
<i>Social resilience</i>				0,561	0,629	
Social infrastructure and leisure	0,721	0,849	0,378			
Health infrastructure	0,445	0,667	0,297			
Social capital	0,770	0,878	0,391			
Life long learning	0,312	0,558	0,248			Istat

The graph below shows the maps of vulnerability and social resilience of the Italian provinces. With regard to the vulnerability a clear split emerges between the North and South of the country: the central and northern provinces mark the worst performer, the provinces of Calabria and Campania are those that are less at risk. The ranking referred to crime rate is headed by Rimini but emerges a high incidence of crime events in the highly urbanized contexts (Bologna, Milano, Genova, Torino, Firenze), in particular where there is a higher frequency of thefts per capita. It should be noted however a low level of crime in different areas of the North East (Belluno, Bolzano, Udine) and in many provinces of central and southern (Campobasso, Matera, Potenza, Isernia). Even the ranking referred to demography and health sphere rewards the southern provinces. The northern province which records the best performance is Bolzano, at 97th place in demography and health ranking and at 94th in the dependency ratio. The provinces with the lowest incidence of cancer mortality are those of Calabria.

The map highlights the resilience of some provinces of Tuscan-Emilian area (Parma, Pisa, Bologna, Florence, Ferrara, Siena) and some of the Adriatic area (Trieste, first of all, Ancona, Rimini and Ravenna). It's possible to find an explanation mainly in the local concentration of social infrastructure and leisure as well as social capital. For the latter we also show the good performance of some provinces in Liguria, Sardegna and Friuli Venezia Giulia. In particular, in these provinces there is an intensive relationship between individuals and institutions (represented by press) and a strong presence of the Third Sector. The provinces of Sicilia, Puglia, Campania and Calabria, despite seem to be less vulnerable according to this scheme, show the most meager provision of social resilience factors. The ranking according to the provision of health infrastructure awards Pavia, Pisa and some provinces in central Italy (Isernia, Rome, L'Aquila and Chieti).

Figure 3 – Index of social vulnerability

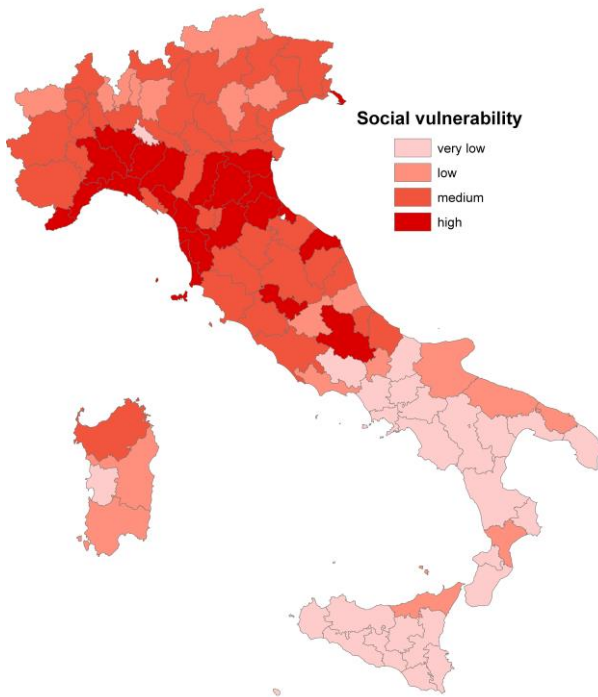
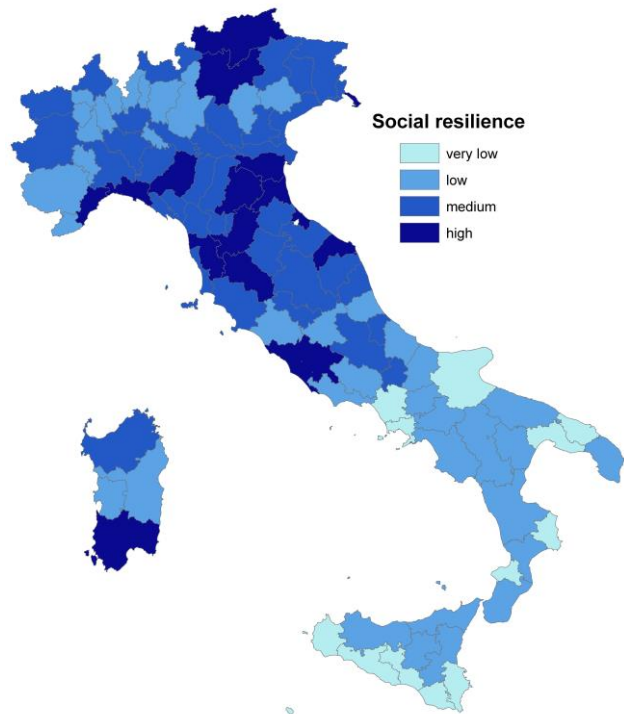


Figure 4 – Index of social resilience



6 The environmental dimension

The environmental dimension is described by 15 indicators, obtained by a selection performed on a dataset of 37 initial variables.

The theme of "environmental vulnerability" is described by the macro-variables "air quality", "land use" and "anthropic pressure." All the variables have a negative meaning, they are characterized by logical sense (and sign) concordant with the phenomenon "regional risk." Air quality is defined by two indicators: air concentrations of nitrogen dioxide (NO₂) and particulate matter (PM₁₀), which are among the most important events of air pollution in Italian urban centers. The concentration of the two elements ($\mu\text{g}/\text{cm}^3$) is measured as the average of annual values recorded by all the urban control units and data refer to provincial capitals. The human pressure index summarizes three variables related to the pressures on environment generated by population density and companies' activities of the region: the annual production of municipal waste per capita (kg per capita) and the vehicles rate (cars on the road per capita) for the first aspect, the use of inorganic fertilizers (corrective and organic-mineral fertilizers per square meter of farming land area) for the second aspect. The macro-variable built is explained by the production of MSW (with a loading factor of 0.815),

which enters into the corresponding linear combination with a higher factor score coefficient. The theme of "land state" is defined by two indicators, one referred to the land protection function made by agriculture, the other referred to the hydrogeological risk. The indicator Contraction of Utilised Agricultural Area considers the time interval 2000-2010 and uses data from the two censuses of agriculture. The variable was constructed by a concordant orientation with respect to the logical sense of the theme "regional vulnerability." Hydrogeological risk indicator is the relationship between flooding and landslide areas and total provincial areas.

The macro-variables so constructed aggregate into the index of environmental vulnerability showing a positive relationship among themselves. The composite indices of "air quality" and "land state" take a negative meaning in this scheme, as well as the index of human pressure. Local systems characterized by a vulnerable and degraded ecological dimension, have less ability to react to adverse phenomena: for these the occurrence of a small perturbation can lead to a state qualitatively lower (IPCC, 2001). Human pressure (with a loading factor of 0.831 and factor score coefficient of 0.529) boosts the environmental fragility of Italian local systems.

The theme of "environmental resilience" is described by three macro-variables: "models of production and consumption", "public policy" and "biodiversity". Indicators that describe this concept have a logical sense (and sign) discordant with respect to the phenomenon of "regional risk." The dimension "models of production and consumption", which assumes positive meaning, describing the best practices of individuals and enterprises, is defined by the following elementary variables: incidence of separate waste collection systems (recyclable fractions) on total waste produced, the number of ISO 14001 certifications and finally the composite index "eco-management" developed by Legambiente and used in the report Ecosistema Urbano (years 2008, 2009 and 2011) with the aim to represent the carefulness of public administration to the environment protection. The indicator of recycling and the eco-management one display the highest correlation with the first component extracted (0.814 and 0.809) and therefore contribute mostly to explain its meaning. Public policy dimension describes the actions of public authorities relating to the protection and improvement of the environment as well as the contrast of the pressures on the environment from anthropogenic component. The first component extracted summarizes the variables: pedestrian areas, cycle paths and restricted access areas, and the composite index "policies for renewable energy" developed by Legambiente and used in the report Ecosistema Urbano (years 2008, 2009 and 2010) to represent the actions of public authorities to promote energy efficiency. The dimension of biodiversity is represented by "total green areas" indicator, which takes into account different types of green spaces (neighborhood green spaces, urban parks, historical gardens, urban areas, green and functional areas, urban forestry, protected areas and nature reserves) respect to land. The availability of green areas and in particular the provision of

protected areas and nature reserves helps to maintain the functional redundancy in ecosystems. The aggregation in the environmental resilience composite index of the two macro-variables "production and consumption models" and "public policy strategies" and the variable "total green areas", highlights a consistent and positive relationship (total variance explained of 0.629). The two macro-variables concerning public and private action have the highest correlation with the first component extracted. According to the scheme defined, local systems where public and private actions protect the environment are the ones able to cope with the negative effects which come from unexpected events.

Table 5 – The variables of the constitutive dimension Environment

Variabili	Final Communalities	Loading Factor	Coefficient scores	Variance explained	KMO test	Source
<i>Air quality</i>				0,721	0,5	
Particulate matter (PM10) concentrations	0,721	0,849	0,589			Ecos. Urbano
Nitrogen dioxide (NO2) concentrations	0,721	0,849	0,589			Ecos. Urbano
<i>Anthropic pressure</i>				0,48	0,516	
Urban Waste / population	0,664	0,815	0,566			Ecos. Urbano
Inorganic fertilizers/Farming land area	0,332	0,576	0,4			Istat
Circulating vehicles / population	0,445	0,667	0,463			ACI
<i>Land state</i>				0,685	0,5	
Contraction of Utilised Agricultural Area 2000-2010	0,685	0,828	0,604			Istat
Areas at hydrogeological risk	0,685	0,828	0,604			Min. tutela dell'amb. e territorio
<i>Environmental vulnerability</i>				0,524	0,542	
Air quality	0,436	0,660	0,420			
Anthropic pressure	0,691	0,831	0,529			
Land use	0,446	0,668	0,425			
<i>Sustainable production and consumption</i>				0,593	0,629	
Separate waste collection (percentage waste)	0,662	0,814	0,457			Ecos. Urbano
Composite index of eco-management for public administration	0,655	0,809	0,454			Ecos. Urbano
International Organization for standardization (ISO) 14000 – certified industries	0,464	0,681	0,382			Ecos. Urbano
<i>Public policy for environment</i>				0,544	0,703	
Pedestrian areas	0,504	0,71	0,326			Ecos. Urbano
Restricted access areas	0,573	0,757	0,348			Ecos. Urbano
Cycle paths	0,663	0,814	0,374			Ecos. Urbano
Composite index of policies for renewable energy	0,437	0,661	0,304			Ecos. Urbano

<i>Environmental resilience</i>				0,629	0,585	
Sustainable production and consumption	0,735	0,857	0,454			
Public policy for environment	0,779	0,883	0,468			
Urban green areas	0,373	0,611	0,324			

The map of environmental vulnerability index highlights an articulated geography. The provinces most vulnerable are those characterized by major hydro-geological risks and abandonment of agricultural land (especially the provinces of Lucca, Parma and Piacenza). It also shows the fragility of territorial systems urbanized (Naples, Turin, Florence, Milan) and other traditionally industrialized (Modena, Reggio Emilia, Italy), especially for a worse air quality. The ranking on the pollutants concentration in the air penalizes provinces in Southern Italy (Messina, Catania, Syracuse) and Central (Frosinone). With regard to intensive farming practices, in the province of Savona, Varese and Milan there is widespread use of inorganic fertilizers. They also highlight the anthropogenic pressures in some areas with heavy tourist presence (especially the provinces of Romagna and some areas of Tuscany), measured by the production of Waste per capita. The provinces characterized by less fragile ecosystem are those of Southern Italy and the Islands (in particular, Nuoro, Potenza, Matera and Foggia). Good performances are recorded also by some mountain areas, as Belluno, Bolzano and Verbania that are positioned respectively 98th, 90th and 85th position.

The map of environmental resilience rewards some provinces of small to medium size.

These are systems where local businesses and local communities adopt sustainable patterns of production and consumption (Verbania, Pordenone, Ravenna and Belluno), or where the government put in place strategies to mitigate pressures on the environment (Verbania, Mantova, Cremona, Reggio Emilia). Good performance are still showed by the province of Verbania, in terms of responses either private or public. The first two positions in the ranking of environmental resilience are still occupied by Mantova and Pisa, where there is also a strong incidence on the municipal area of green areas. The most disadvantaged provinces are in the Center South, in particular Enna, Viterbo and Crotone, which occupy the last positions in the ranking accordingly. In these areas, characterized by a lower rate of anthropogenic and by better quality of ecosystem state, there is less attention by public authorities in the mitigation of environmental and anthropogenic risks.

Figure 5 – Environmental vulnerability index

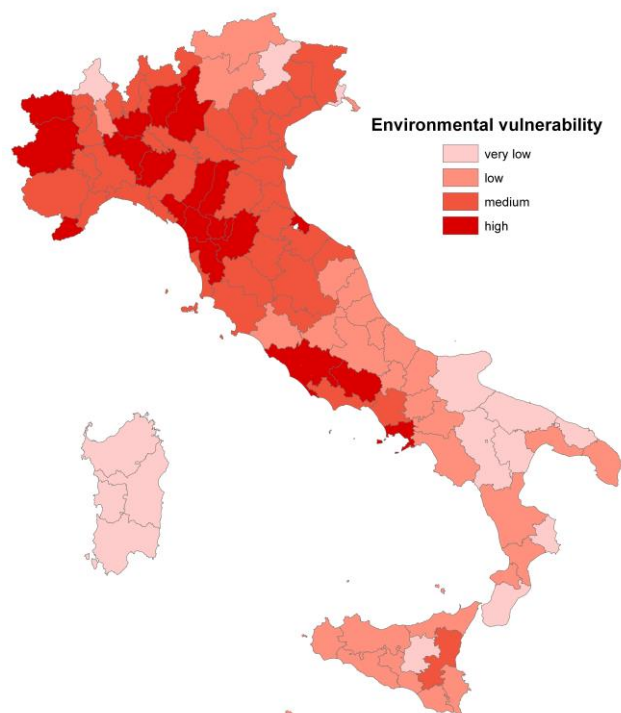
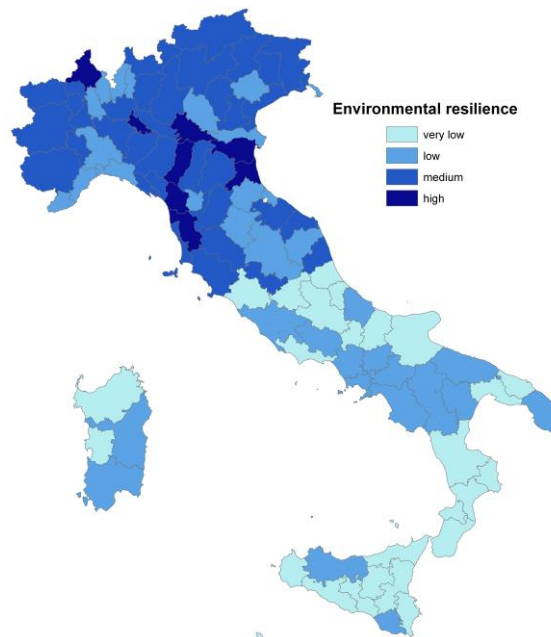


Figure 6 – Resilience environmental Index



7 Conclusions

In this paper we use the theoretical framework for defining the concept of regional risk presented in the paper *Rischio, vulnerabilità e resilienza territoriale* (Graziano, 2011), applying it to a study of the Italian provinces. Adopting a systemic approach we considered the regional risk positively correlated to resilience and negatively to vulnerability. Trying a reading as complete as possible, we describe region describing a multidimensional concept of risk within its economic, social and environmental sphere.

A system of indicators and composite indices was built, following the steps hereafter specified. Some indicators have been associated firstly with the three dimensions Economy, Society and Environment, then with the categories vulnerability and resilience, and finally with the macro-themes into which the individual categories are divided. Once the corresponding variables have been gathered, referring to the time interval 2007-2011, then they are selected on the basis of statistical adequacy requirements and factorizing. Subsequently a multivariate technique was applied, the principal components analysis, to get a dimensional reduction of the phenomenon and construction of a composite index for each theme and dimension that describes it. In this case study economic vulnerability is made up of these macro-themes: production specialization, financial stress of households, financial stress of enterprises, labour market; social vulnerability coming from these macro-themes: demography and health, individual dissatisfaction and crime; environmental vulnerability as: quality of air, land state, human pressure. Economic resilience consists of these macro-variables: the size of the local economy, availability of resources for businesses, availability of resources for families, innovation and economic infrastructure. Social resilience consists of: social capital, human capital, social and leisure infrastructure, health infrastructure. Finally environmental resilience consists of: biodiversity, sustainable production and consumption as well as public policy for the environment.

From the map of vulnerability and resilience emerges a split between north and south of Italy in the economic sphere: on the one hand the best structure and the best potential response in the northern provinces, particularly in the North-East and in the more urbanized areas, on the other hand the fragility and lack of factors of economic resilience in the southern provinces. If in the economic sphere there is some coherence between vulnerability and resilience of the local systems, in the social one the best response strategies either in public or private terms are found in the most vulnerable areas, that is in the North of Italy. The map of social resilience highlights, in particular, a good deal of response factors in the provinces of the Tuscany and Emilia and some of the Adriatic coast. The geography of environmental vulnerability is articulated in this way: the fragility of urbanized and industrialized local systems and of areas with high tourist vocation, which have often not adequate answers. The map of the resilience, instead, rewards some northern provinces of small to medium sized.

In the next work we will attempt further to improve the description of the three spheres of sustainability, either through the inclusion of new elementary variables or through the construction of new macro-themes. For example, with regard to Economy, we intend to build and incorporate in the synthesis an indicator of business development rate for emerging economic sectors and a macro-variable regarding the default risk of public administration. With regard to Society, we will attempt to further complete description of the subject "social capital", by inserting in the synthesis two other indicators related to the altruistic dimension and the relationship between individuals and the political community: the number of blood donors per capita and the electoral participation rate in the Italian provinces (Cartocci, 2007). We will try to complete the description of the dimension Environment, exploring in particular the area of biodiversity, which seems to be poorly represented in the proposed scheme. The functional redundancy in ecosystems (biodiversity) is indeed something of paramount importance, not only to maintain the evolutionary options of natural systems, but also to ensure the functions and services provided by these with human societies (IPCC, 2001). After merging the dataset with these new variables and calculating the macro-variables to which they refer, then the author will try to reach composite indexes of vulnerability and resilience, which are able to aggregate together economic, social and environmental dimensions of local systems analyzed. In order to do this she will compare the synthesis obtained from different aggregation methods (OECD, 2008) and adopt the technique that describe the complex concepts "vulnerability" and "resilience" in the best way. This will make it possible to define the positioning of Italian provinces according to the multidimensional concept "regional risk" as a combination of the characters low / high vulnerability and low / high resilience.

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ABSTRACT

The aim of this work is to verify, through a study of Italian provinces, a theoretical representation of the multidimensional concept which is referred to as "exposure of the territorial system to the risk of a exogenous event " as a combination of factors of fragility and resilience. This scheme has been proposed in the article Risk, vulnerability and resilience of local systems (Graziano, 2011) presented at the XXXII Conferenza di Scienze Regionali. In the previous work elements of the organization of a territorial system had been identified, in its economic, social and environmental dimensions, mostly affecting his exposure to the adverse impact generated by a disturbing event and the ability to answer and to regenerate. According to this scheme of representation, the territorial risk is the result of the combination of these factors that influence the probability of a local system to undergo negative changes as a result of the occurrence of the event. Assess vulnerability and resilience of a system, by adopting a holistic reading of the phenomenon, involves the identification, in all the systemic components of attributes such as: openness to the external environment, structural diversification, availability of resources, structural dependence/independence, modularity, functional redundancy, adaptability strategy. These attributes, identified from the analysis of the literature on the complex adaptive systems (Resilience Alliance, 2007) were used in the previous work as logical criteria for the reconciliation of the territorial components to the descriptive categories defined. In this article the author proposes the construction of a indicators system and composite indices for monitoring, through multivariate statistical techniques, the factors of fragility and ability to recovery. The proposed system is applied to a study of the economic, social and environmental vulnerability and resilience of the Italian provinces. This study provides a preliminary assessment of exposure to the risk of territorial disturbing events: lets you define the positioning of the territories as a combination between low/high vulnerability and low/high resilience factors.