Roberto Gerundo

Alessandra Marra

LANDSCAPES AT RISK OF PERIPHERALIZATION

A methodological framework for risk assessment to support regional planning strategies

Abstract

In Italy, Legislative Decree 42/2004 requires the identification of degraded areas within Regional Landscape Plans, also with reference to urban landscapes, transposing the new concept of landscape introduced by the European Convention. Urban landscapes are the most frequently perceived by the population but least investigated in such planning instruments. However, the new urban and socio-economic geography poses the challenge of identifying not only existing degraded areas, but also areas at greatest risk of degradation or peripheralization, in a dynamic sense. The objective of this paper is to define a methodological framework for the identification of potential degraded areas, based on the theory of territorial risk. Such an approach constitutes the novelty of the work. So, on the basis of the reviewed literature, the main vulnerability factors are defined, with reference to the elements at risk, in the four social, building, urban and environmental domains. Then a methodological framework for vulnerability assessment and final risk mapping is outlined, in order to support the definition of contrast actions driven by the Regional Landscape Plan. The proposed methodology is applied to a study area in Campania Region (Italy).

Keywords: Peripheralization risk, Landscape vulnerability, Urban landscapes, Regional planning, Landscape planning

Introduction[1]

The European Landscape Convention, signed in 2000 in Florence, has radically changed the concept of landscape, which concerns not only remarkable areas but the whole territory. Furthermore, it intends landscape as a significant resource for the population's quality of life and a key issue for social, economic and environmental sustainable development [1].

According to the new conceptualization, it is essential to protect not only the landscape excellences, but the entire territory. So, in order to preserve its quality, it is crucial to identify elements of degradation and potential threats of landscape values, against which to address prevention or mitigation actions.

In Italy, the new orientation was implemented by the Code of Cultural Heritage and Landscape, came into force with the Legislative Decree 42/2004. The above mentioned decree requires the identification of risk and vulnerability factors of landscape for the drafting of the Regional Landscape Plan (PPR). In addition, the Code states that such a plan has to define recovery and rehabilitation interventions for the severely damaged and degraded areas.

In line with the European Landscape Convention, two are the main recognizable landscapes on the territory: the natural landscape and the anthropic one. The latter, which substantially corresponds to the urban landscape, is also the most frequently perceived, considering that the majority of the population spends their everyday lives in urban areas. The identification of degraded areas, in which landscape values are debased, therefore, applies both to natural and urban landscapes, less investigated in landscape planning. The reason is certainly connected with the deepening scale of landscape planning, generally the regional one, which allows a limited level of detail.

Recent landscape plans, developed in application of the Code[2] [2], consider the entire regional territory as an object of investigation, identifying in the urban peripheries and in contemporary urbanizations an important area of application for the redevelopment and reconstruction interventions of degraded urban landscapes. For the latter, some plans propose specific guidelines, as in the cases of the Tuscany and Apulia Regions. In fact, peripheries, understood in their etymological meaning of geographic-spatial distance from an urban centre, in Italy, as in Europe, are traditionally associated with conditions of degradation or, in other words, with degraded urban landscapes [3-5].

Today, degradation conditions do not always correspond to spatially intended peripheries, located at the physical margins of historical cities or near the urban-rural interface. Rather, the territory is entirely susceptible to peripheralization, which can be considered as a dynamic process [6] that identifies spaces affected by degradation conditions, regardless of their spatial dislocation. In fact, as urban areas continue to expand globally [7], the consumption of soil and environmental resources, which could be matched by the term 'spatial peripheralization', is accompanied by the growing development of social and economic inequalities, combined with the accentuation of physical and environmental degradation even within urban areas, a process that can be more properly defined as 'a-spatial peripheralization' [8].

In Italy, these processes permeate the whole territory, in particular in the Southern Regions, where they are accentuated by a *southern question* that is still unresolved and exacerbated by the economic crisis, posing a significant risk to the loss of quality of urban landscapes and, therefore, to the competitiveness of territories.

In this context, a crucial challenge is to identify not only existing degraded areas but, in a dynamic-evolutionary sense, the areas at a greatest risk of degradation, susceptible to attention already to the deepening scale of Regional Landscape Planning. This is particularly relevant in consideration of the superordinate role of the PPR in relation to large and local area planning tools, for which it specifies guidelines and prescriptions.

The present work is part of a wider research project aimed at countering this type of risk through the multiscale planning system[3] [9]. On the basis of the results obtained from the analyses already carried out by the authors, referred to in the text, the objective of this contribution is to define a final methodological framework for the identification of urban areas at greater risk of peripheralization, in order to support the definition of contrast actions through the PPR. So, the proposal for risk assessment, based on the risk general theory, is presented. After the study area is described, the final results are presented and briefly discussed. Finally, the main conclusions and future developments of the work are described.

Assessment of urban landscapes at risk of peripheralization: a proposal for a methodological framework

The method for assessing urban landscapes at greater risk of peripheralization is based on the general theory of territorial risk. According to this approach, which is the basis of the research project to which the contribution belongs, peripheralization risk is the product of the Overall Vulnerability and Exposure. Specifically, the Overall Vulnerability is defined as an expression of the propensity to degradation of the exposed goods, with reference to four dimensions: social, building, urban and environmental domains. Elements at risk are represented by the following: population, in the case of social dimension; buildings, for building domain; urban fabric, in the case of urban dimension; urban environment, in the case of the environmental domain.

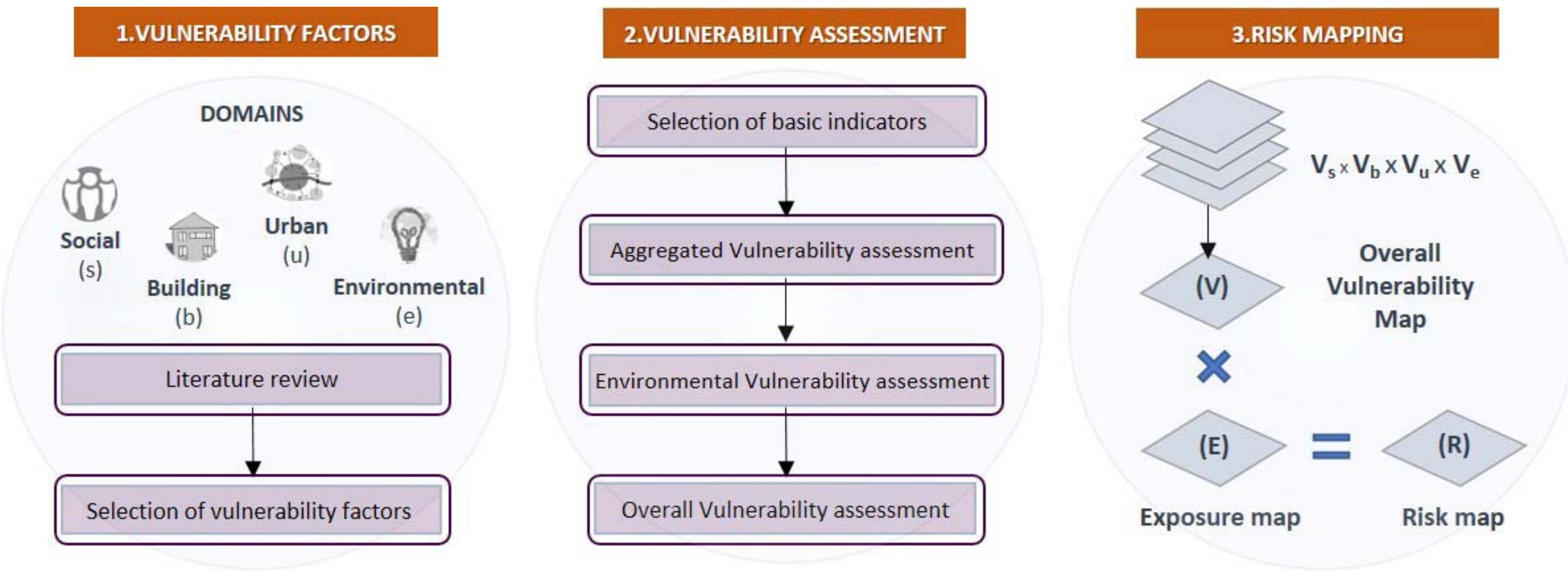

Fig. 1. Methodological framework for the identification of urban landscapes at risk.

Therefore, in order to identify urban landscapes most at risk, a methodological procedure is proposed (Fig. 1), consisting of three main phases:

- identification of vulnerability factors;
- vulnerability assessment and mapping;
- risk mapping.

Identification of vulnerability factors

Vulnerability factors express potential degradation conditions in the different Social, Building, Urban and Environmental Domains under consideration and they are defined on the basis of the examined scientific literature, as well as national and international guidelines. Their selection is carried out in relation to the impact on the degradation of urban areas and the possibility of response within the multiscale planning system, starting with the regional scale. In particular, the selected social vulnerability factors relate to the following themes: employment; education and culture; demographic structure. The latter issues have traditionally been investigated in order to measure urban poverty or social deprivation [10-12]. Unemployment or the presence of unemployed people who do not seek work, the lack of minimum levels of education, the widespread presence of elderly people or families living in overcrowding, are considered here as potential factors of degradation for urban landscapes, as they determine their possible abandonment by the population, which is most likely to be reduced to absolute poverty.
The factors of potential degradation for the building-housing domain relate to the state of conservation and technological obsolescence of buildings, as well as time of permanence in them and property deed. The presence of buildings in a poor state of conservation is one of the most visible elements that characterize degraded urban landscapes. On the other hand, empty or sporadically occupied dwellings lead to the possible deterioration of the building stock due to a lack of maintenance.
With regard to urban dimension, the factors of potential degradation concern the fragmentation of the landscape in terms of configuration and composition of the urban fabric, with reference to the jagging of the edges of the latter and the presence of sealed areas. Other factors of urban vulnerability are the lack of facilities for the population, a low accessibility to the main road or rail stations, as well as the presence of critical urban areas, in particular the following: derelict or abandoned areas; landfills and waste storage areas. In this case, many of these factors have been identified in technical literature related to spatial peripherality, with reference to urban-rural interface areas, on an urban-scale, while to the so-called *inner peripheries*, away from the main essential services poles, on a territorial scale [13].
With reference to the assessment of environmental vulnerability, the topics under consideration are the following: energy performance of the building stock, in terms of building heating and domestic hot water production; polluting emissions, and inefficient waste management. In fact, such factors can have a negative impact on the urban environment and on living conditions of the population, exacerbating existing inequalities [14-16]. All the factors mentioned above, put to system, determine an overall vulnerability responsible for the potential loss of quality of urban landscapes and competitiveness of territories or, in other words, of their abandonment.

Vulnerability assessment and mapping

The assessment of vulnerability is conducted by reference to quantitative indicators, in order to estimate the above mentioned factors, evaluating composite indices of social, building, urban and environmental vulnerability and, finally, the overall vulnerability index.
The selection of elementary indicators (Tab. 1) is made taking into account the quality and availability of data at census section level, which is the minimum space unit at which the mapping can be carried out.
In order to define suitable indicators for the Italian context, many of them derive from census data, provided by the National Statistical Institute, or from ordinary territorial planning tools, such as the Provincial Coordination Plan.
However, as regards environmental vulnerability indicators, the lack of datasets related to the examined spatial level requires the definition of a methodology for the estimation of indicators by census section. Moreover, while the evaluation of the Environmental Vulnerability composite index is well suited to be modeled with traditional mathematical-statistical techniques, recalled by the specific literature, the estimation of the composite indices of Social (V_s), Building (V_b) and Urban Vulnerability (V_u) is more subjective and needs a different modelling. In fact, the lack of aggregation techniques and well-established threshold values in the relevant literature, makes the process affected by greater uncertainty. For these reasons, the methodology proposed for the assessment of Aggregated Vulnerability (V_a), given by the product of Social, Building and Urban Vulnerability, is different from that outlined for the evaluation of Environmental Vulnerability (V_e).

Aggregated Vulnerability assessment

For the evaluation of the composite index of Aggregated Vulnerability, we propose a method based on fuzzy logic, described by the authors in a previous contribution, to which reference should be made for further details [17]. This method makes it possible to manage the uncertainty related to the aggregation and classification of basic indicators. The quantitative values of the latter, referring to the selected mapping territorial units, are first organized within a geodatabase and then normalized with the Min-Max interpolation method, constituting the input data for the subsequent fuzzy analysis. The latter is composed of some main phases, in particular the following ones: fuzzification, through membership functions; inference; aggregation; defuzzification.
In order to reduce the subjectivity of the choices made in each of the four phases, a sensitivity analysis is proposed, simulating different fuzzy schemes, obtained by varying membership functions, inference, aggregation and defuzzification methods, among those most used in the technical literature.

Tab. 1. Set of indicators for mapping vulnerability (Re-elaboration on data from [17], [18]).

Sub-domain	Indicator	Definition and unit of measurement	Source and Spatial Detail of input data
		SOCIAL DOMAIN	
Employment	I_1 - Unemployment rate	Ratio between the unemployed in a given age group and the set of employed and unemployed people of the same age group (%)	Istat—Census of population and housing; Census section
	I_2 - Inactivity rate	Ratio between people not belonging to the labor force, i.e. those not classified as employed or looking for employment, and the corresponding reference population (%)	Istat—Census of population and housing; Census section
Education and culture	I_3 - Index of non-completion of the secondary school cycle (middle school)	Percentage of population in the 15-52 age group who did not obtain a middle school diploma out of the total population of the same age class (%)	Istat—Census of population and housing; Census section
	I_4 - Incidence of illiterate	Number of illiterates aged 6 and over the total resident population aged 6 and over (%)	Istat—Census of population and housing; Census section
Demographic structure	I_5 - Old age index	Ratio between the population aged 65 and over and the population aged 0-14 (%)	Istat—Census of population and housing; Census section
	I_6 - Incidence of large families	Ratio between the number of families of 6 or more people and the total number of families (%)	Istat—Census of population and housing; Census section
		BUILDING DOMAIN	
Building construction quality	I_7 - Disused buildings with historical, architectural or artistic value	Number of abandoned buildings with historical, architectural or artistic value out of total buildings with historical, architectural or artistic value (%)	Territorial plans of provincial coordination; 1:25,000
	I_8 - Buildings in bad and mediocre conservation state	Ratio between residential buildings in bad and mediocre conservation state and the total of residential buildings (%)	Istat—Census of population and housing; Census section
	I_9 - Index of improper housing	Ratio between the number of accommodations of other type[1] and the total of the housing units (%)	Istat—Census of population and housing; Census section
Dwellings use	I_{10} - Empty dwellings	Number of empty dwellings out of the total of the housing units (%)	Istat—Census of population and housing; Census section
	I_{11} - Property deed	Number of rental dwellings out of the total of occupied housing units (%)	Istat—Census of population and housing; Census section

The final scheme to be selected shall ensure distributions of inputs and outputs with similar dispersion values.
In this way, secondary composite indices, representative of the subdomains, are obtained, then the primary composite indices, relative to the domains, and, finally, the Aggregated Vulnerability index, classified according to five intensity levels: Very Low, Low, Medium, High, Very High. The output data of the analysis are incorporated into the original geodatabase, and associated with census sections, in order to spatially map the aggregated vulnerability levels.

Environmental Vulnerability assessment

The methodology for the evaluation of the Environmental Vulnerability index has been treated by the authors in the contribution Gerundo, Marra and Giacomaniello, 2020, to which reference can be made for further details [18].
In particular, the energy performance of residential buildings, in terms of heating and domestic hot water production, can be estimated by referring to buildings-type of which are known energy consumption, based on some features: the prevailing building form and the average age class.
Vulnerability to pollutant emissions can be obtained from the municipal values and operating two spatial breakdowns: the first based on the prevailing land use, knowing the emissive incidence of industrial and non-industrial macro-classes; the second, on the basis of resident population and building volumes, for the non-industrial class, and industrial surface, for the industrial class.
Finally, the synthesis map is obtained by adding up the values of emissions for the individual pollutants.
The vulnerability from an ineffective waste management can be estimated by knowing the municipal values of total and differentiated waste per capita. By making a spatial breakdown based on the number of inhabitants per section, the value of the non-differentiated waste is derived by operating a simple algebraic difference between the disaggregated value of the total waste and that of the differentiated waste.
Secondary composite index maps are reclassified according to the five intensity levels already defined for the Aggregated Vulnerability.

Tab. 1. (Cont.)

Sub-domain	Indicator	Definition and unit of measurement	Source and Spatial Detail of input data
		URBAN DOMAIN	
Configuration and composition	I_{12} - Edge Density	Ratio between the total sum of the perimeters of the polygons of the built areas and their surface (m / ha)	Elaboration on Imperviousness Cartography; 20 × 20 m
	I_{13} - Housing density	Ratio between the number of resident inhabitants and the surface of the urban fabric (ab / ha)	Istat—Census of population and housing; Census section
	I_{14} - Incidence of impermeable areas	Ratio between the surface of the urban fabric minus the urban green areas and the surface of the urban fabric (%)	Elaboration on Imperviousness Cartography; 20 × 20 m
Services and accessibility	I_{15} - Lack of public interest facilities and services	Ratio between the number of facilities of supra-municipal interest and the total of resident inhabitants (N°/Ab)	Territorial plans of provincial coordination; 1:25,000
	I_{16} - Distance from the main railway station	Time needed to reach the nearest railway station measured on basis of the travel isochrones (class)	Regional topographic database; 1:5,000
	I_{17} - Index of centrality	Ratio between the number of commuter flows leaving the area (net of commuters residing and working in the area itself) and the number of commuter flows entering the area, (net of the same amount) (%)	Istat—Commuting; Census section
Urban criticalities	I_{18} – Incidence of abandoned or underused areas	Ratio between the surface of urban wasteland[2] in the urban fabric and the total surface of the urban fabric (%)	Territorial plans of provincial coordination; 1:25,000
	I_{19} - Index of unauthorized buildings	Ratio between the areas built-up in a given period not foreseen by the urban planning tool and the total area of the built-up areas (%)	Territorial plans of provincial coordination; 1:25,000
		ENVIRONMENTAL DOMAIN	
Energy Performance	I_{20} – Building form	Prevailing Building form in the urban fabric among the following: single-family house, terraced house, multi-family house, apartment block (class)	Elaboration on Istat—Census of population and housing—and Regional topographic database; Census section
	I_{21} – Age Class	Prevailing Age class of the buildings, in the urban fabric, between the following time intervals: 1901-1920; 1921-1945; 1946-1960; 1961-1975; 1976-1990; 1991-2005 (class)	Elaboration on Istat—Census of population and housing; Census section
Air Pollutants	I_{22} - Particulate Matter	Diffuse emissions of PM_{10} (t/km^2)	Regional Emission inventories; Municipality
	I_{23} – Sulfur Oxides	Diffuse emissions of SO_X (t/km^2)	Regional emission inventories; Municipality
	I_{24} – Nitrogen Oxides	Diffuse emissions of NO_X (t/km^2)	Regional emission inventories; Municipality
	I_{25} – Volatile Organic Compounds	Diffuse emissions of VOC (t/km^2)	Regional emission inventories; Municipality
Urban Waste	I_{26} - Total urban waste	Production of total urban waste per capita (t/inhab)	Ispra—National Waste Cadastre; Municipality
	I_{27} - Differentiated urban waste	Production of differentiated urban waste per capita (t/inhab)	Ispra—National Waste Cadastre; Municipality

The final map of Environmental Vulnerability is obtained through a weighted overlay of the input maps, attributing proportional values to the previously mentioned vulnerability classes.

Overall Vulnerability assessment

In order to obtain the Overall Vulnerability map (V), it is necessary to intersect the thematic map of the Aggregated Vulnerability (V_a) with that of the Environmental Vulnerability (V_e). So, a vulnerability matrix is proposed, constructed in such a way that the areas corresponding to. the 'Hgh' and 'Very High' vulnerability levels are those where this condition occurs: V_a is High and Very-High and simultaneously V_e is Very-High, High or Medium (Tab. 2).

Tab. 2. Vulnerability matrix.

Overall Vulnerability (V)		Aggregated Vulnerability (V_a)				
		Very High	High	Medium	Low	Very Low
Environmental Vulnerability (V_e)	Very High	Very High	High	Medium	Low	Very Low
	High	Very High	High	Medium	Low	Very Low
	Medium	High	High	Medium	Low	Very Low
	Low	Medium	Medium	Low	Low	Very Low
	Very Low	Low	Low	Very Low	Very Low	Very Low

It takes into account the greater weight that the V_a index, built from 19 indicators of origin, covers on V_e, resulting from 8 input indicators.

Risk mapping

For the construction of the final risk map, given by the product of Overall Vulnerability and Exposure, it is necessary to map assets exposed, represented, as a whole, by the urban fabric. Since the latter[4] also includes the individual elements at risk, the highest level of exposure is associated with it. In quantitative terms this is equivalent to placing the exposed value, in correspondence with the urban fabric, equal to the unit. For this purpose, a spatial definition of the built-up areas constituting the urban fabric is necessary: reference is made to the method adopted by ISPRA, according to which these areas correspond to those with a degree of waterproofing greater than or equal to 30%, with reference to the basic cartography Copernicus Imperviousness [19].
Therefore, performing an overlay between the vulnerability map and the exposure one, it is possible to derive the final risk map.

Study Area

The area selected for the application of the methodology includes the municipalities falling within one of the Complex territorial fields (Ctc) identified by the Regional Territorial Plan of Campania Region and, specifically, that relating to the Caserta conurbation. The latter covers a total of sixteen municipalities, with which the main City of Caserta has been merging since the post-war period (Fig. 2).
The territory in question, highly urbanized, today has a total of about 320000 inhabitants; it is divided into 1021 census sections and it is characterized by a high density of settlements, with an average of 2128 ab/km^2.

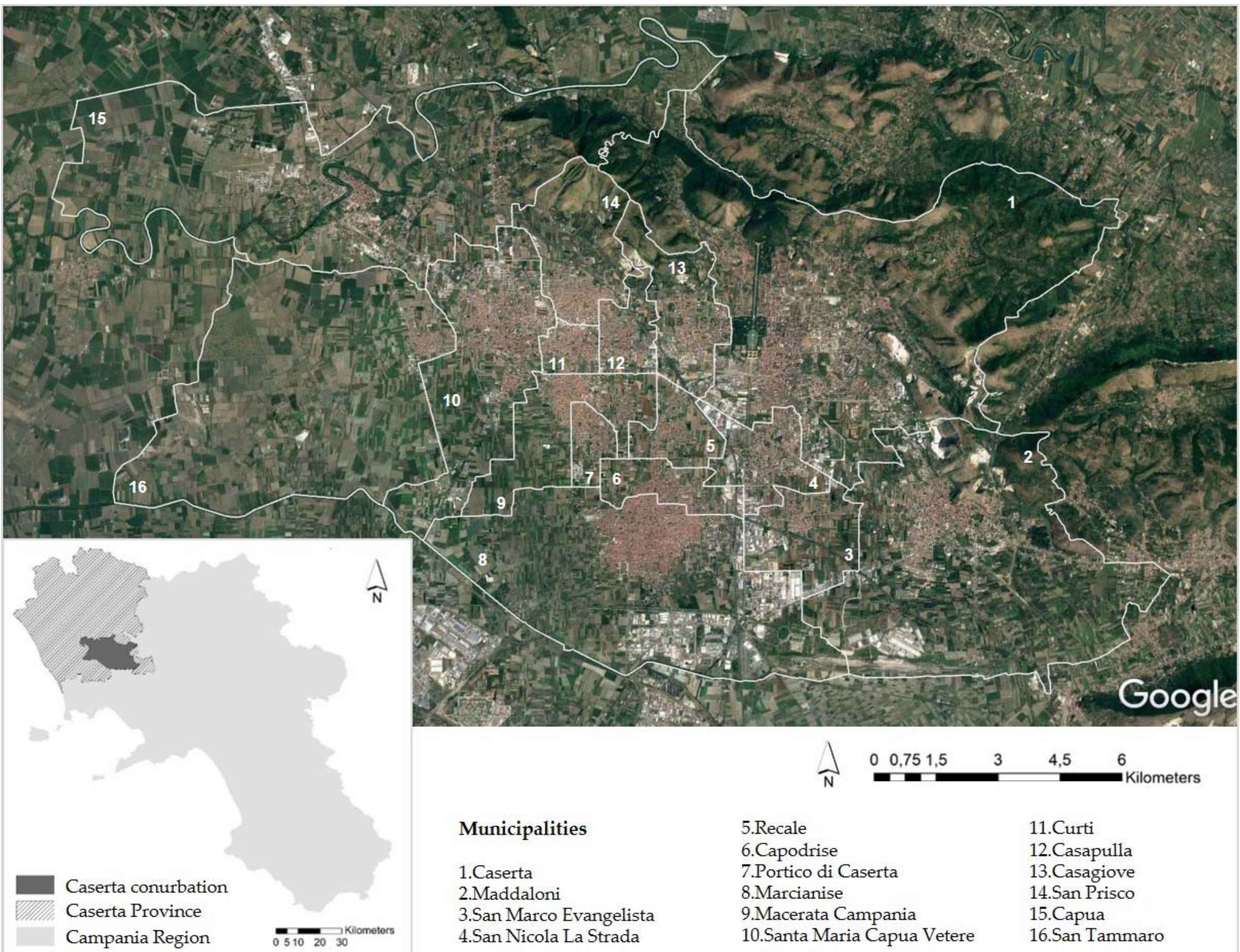

Fig. 1. Study Area.

Environmental pollution, urban disorder, the deterioration of the artistic heritage and unemployment make the Caserta conurbation one of the most complex territories in Italy. In fact, the Ctcs are identified as areas of intense concentration of risk factors, where the Campania Region should promote priority interventions.

Results and Discussion

The study area is the same examined for the application of the methods to map Aggregated and Environmental Vulnerability, carried out within the research project in which the work is framed.

Starting from the V_a and V_e maps resulting from these studies, we implemented the vulnerability matrix defined in this paper. So we obtained the Overall Vulnerability map (Fig. 3) and then, from the intersection of the latter with the exposure map, the Risk map (Fig. 4). Compared to the results achieved by the authors in Gerundo, Marra and De Salvatore, 2020, where the risk map does not consider the environmental domain, but only the social, building and urban dimensions, there is a decrease in the areas at greatest risk. This is due to the criterion used for defining the vulnerability matrix, so it is likely to have a critical condition in all four domains examined in fewer areas.

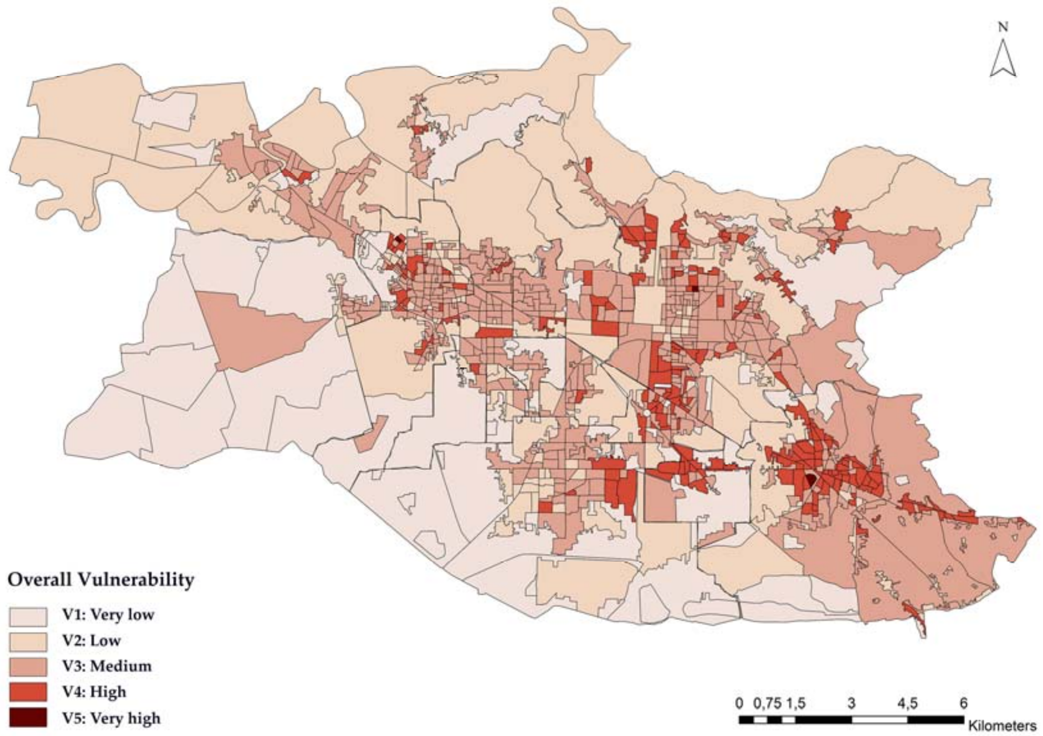

Fig. 3. Overall Vulnerability map.

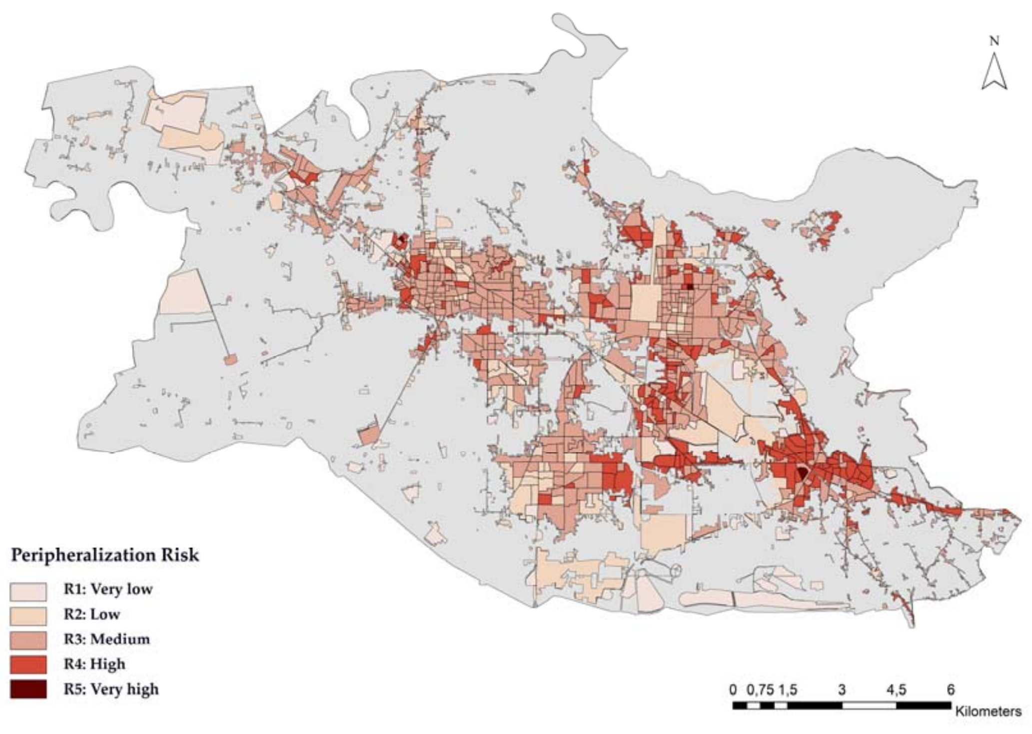

Fig. 4. Peripheralization risk map.

The risk scenario outlined in this contribution, including the assessment of environmental vulnerability, allows to restrict priority areas of intervention, where the risk is High or Very High. Such a result means a further optimization of the economic resources needed to implement the interventions. It is interesting to note that, even considering all social, building, urban and environmental domains, the areas most at risk may be both neighbourhoods traditionally considered peripheral, located at the urban-rural interface, both typically central neighbourhoods, or whole municipalities (Fig. 5). This confirms the need for multi-scale mitigation actions, starting with coordination planning and, for particularly critical large areas such as the study one, effective actions must involve regional landscape planning. In a territorial and landscape context characterized by widespread degradation, the knowledge of urban landscapes most at risk can address priority actions, in the definition of protection guidelines or in general of the PPR strategies.

Conclusion

The proposed study focuses on urban landscapes susceptible to degradation, proposing an integration of the peripheralization risk among the canonically considered risks in Regional Landscape Planning, in accordance with Legislative Decree no. 42/2004. To this end, a methodological framework has been proposed for the identification of urban areas at greater risk of peripheralization, on the basis of the general theory of territorial risk, which is an innovative element of the work. The application of the proposed method to the case study has suffered from intra-urban scale data not always up to date. An analysis using the same techniques should be carried out in the future with more recent data. This is possible because the input data are provided by official authorities and periodically updated, which makes the proposed method transferable to not a few geographical contexts. In this context, the methodological framework here described can be implemented both for the urban landscapes of metropolitan contexts, both for those of territories characterized by a minor anthropogenic impact, as the so-called inner areas. In fact, this work considers potential factors of degradation both related to a traditional condition of spatial peripherality, both attributable to a-spatial peripheralization, not necessarily dependent on the greater or lesser proximity to urban centers. Peripheralization risk will be determined by factors which differ according to the territorial context in which the examined urban areas are situated. Moreover, following the same approach, this study can be further developed for the non-urban landscape, exploring the potential vulnerability factors for the open territory, with reference, for example, to the following: fire-covered areas; areas affected by intensive agriculture; sites with waste storage; quarries in degraded conditions; degraded or abandoned agricultural areas.

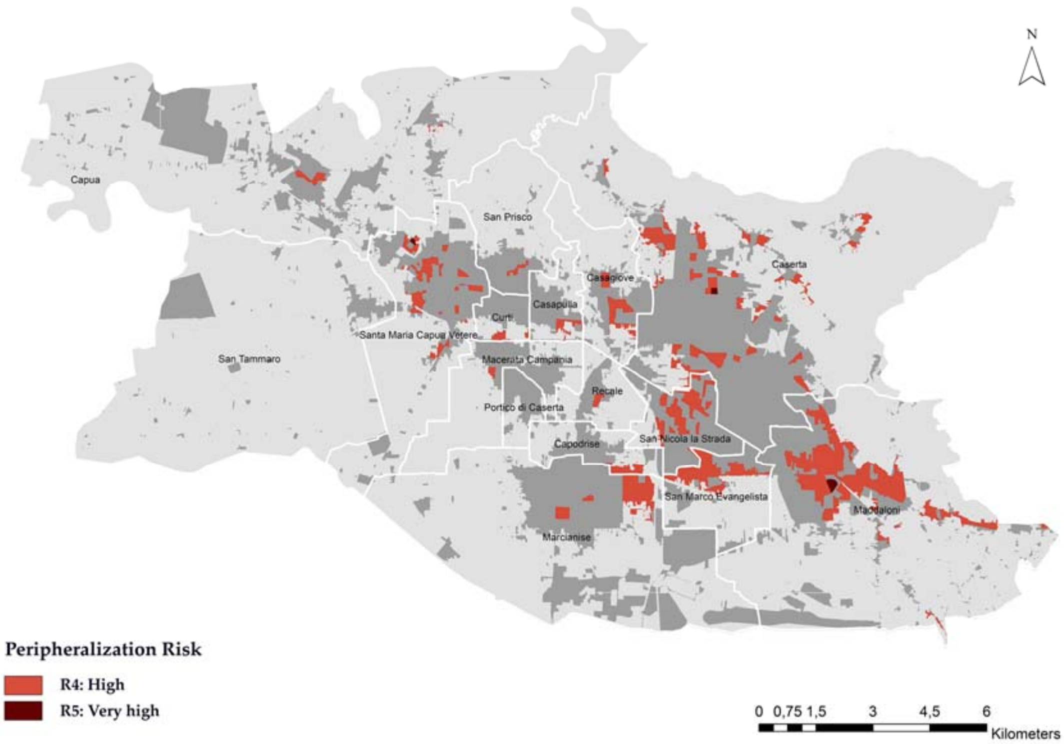

Fig. 5. Map of High and Very High risk areas (Elaboration on Fig. 4).

NOTES

1. Author Contributions: Conceptualization, Roberto Gerundo and Alessandra Marra (A.M.); Data curation, A.M.; Formal analysis, A.M.; Investigation, A.M.; Methodology, R.G. and A.M.; Software, A.M.; Supervision, R.G.; Visualization, A.M.; Validation, R.G.; Writing – original draft, A.M.; Writing – review & editing, R.G. and A.M.
2. Regional Landscape Plans approved under the Cultural Heritage and Landscape Code concern the following Italian Regions: Puglia, Tuscany, Piedmont, Sardinia and Friuli Venezia Giulia.
3. The research is part of Alessandra Marra's PhD thesis, developed at the University of Salerno and coordinated by Prof. Roberto Gerundo.
4. The urban fabric is intended as deriving from the envelope of all transformed areas occupied by residential and productive settlements, including public spaces and/or reserved for collective activities, in addition to widespread and scattered buildings.

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