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Article

Seysmic Vulnerability and the Old Towns: A Cost-Based Programming Model

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Abstract: Vulnerability is the big issue of the small inland urban centers exposed to the risk of depopulation. In the climate and in the context of an increasing seismic risk in the center-northern part of Italy, seismic vulnerability can become the determinant cause of the final abandonment of a small town. In some Italian regions, as well as Emilia Romagna, municipalities are implementing seismic vulnerability reduction policies based on the Emergency Limit Condition that has become a basic reference for ordinary land planning. This study proposes a valuation planning approach to the seismic vulnerability reduction carried out within the general planning framework concerning the Faentina Union, a group of five small towns located in the south-western part of the Province of Ravenna, Italy. The approach consists of three main stages: *knowledge* – the typological, constructive and technological description of the buildings specifically concerning their vulnerability degree; *interpretation* – the analyses aimed to outline a range of hypotheses about the damages in case of seism; *planning* – identifying the works intended to definitely reduce the vulnerability of the buildings. This stage includes a cost modelling tools aimed at outlining the trade-off between the extension and the intensity of the vulnerability reduction works, given the budget.

Keywords: Urban fabrics; Seismic vulnerability; Critic analysis; Cost modelling; Urban preservation programming; building works programming.

1. Introduction

The proposed contribution addresses the issue of reducing the seismic vulnerability of historic urban fabrics with reference to the case of the city of Brisighella, Italy.

The research was conducted within an Agreement stipulated by the Union of Municipalities of the Faentina Romagna and the Department of Civil Engineering and Architecture of the University of Catania, Italy, whose object is a joint study on the seismic vulnerability of building aggregates in the historic centers of Brisighella, Casola Valsenio, Castel Bolognese, Riolo Terme and Solarolo.

It was a multidisciplinary work that involved the disciplines of Restoration, Urban Planning and Economic-valuation Assessment.

The economic-estimative evaluation deals with the issue of seismic vulnerability of historical cities [1] on the basis of its own fundamental interest in the economic category of territorial capital and in its two forms, urban capital [2] and human capital; the perspective of this scientific and methodological interest is the original civil commitment of the economic-estimative evaluation regarding distributive justice.

In the case of the redevelopment of minor historical centers, the references to the notion of capital and distributive justice aims to answer a preliminary question: *is it worth it*?

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The answer to this dilemma involves questions concerning the way in which urban policies combine the need for capital in its urban form and the needs of capital in its economic essence.

With reference to these two needs, capital becomes an important interpretative filter in terms of vulnerability of small urban centers [3]; the consistency in volume and value of urban capital is the main reason for their resilience: in fact, marginal historical centers, generally those located in the mountain hinterland and characterized by poor accessibility, are condemned to the vulnerability trap: the seismic vulnerability, in particular, it is not added to the others (social, economic etc.) but constitutes a determining cause.

In the field of vulnerability of small urban centers, restoration and evaluation sciences, have common interests regarding some characteristics of architectural and urban heritage:

- the ability to endure, ascribable to the resilience of the social-urban system; it is necessary to preserve its ability to continue to perform its essential functions, or to survive during and after the catastrophic event [4];
- self-referentiality, or iconicity [5, 6], ascribable to the material aspects (masonry and construction systems) that must be conserved as such, not according to their functions or their appearance; self-referentiality does not concern the present value of an artifact, but the maintenance of its testimonial value, starting from its primary essence. Self-reference is a typical feature of the capital category in conditions of high tension in prices.

The resistance of the social-urban system to a catastrophic event, that is its resilience, depends on how much of the surplus of social product is set aside for its security, that is on the part of the production cost "or renovation", destined to its structural consolidation [7, 8, 9, 10].

This study exposes the methodology and the findings of the vulnerability assessment of the building heritage in the old town of Brisighella, referring both to the building aggregates and to the architectural units; starting from these results, it proposes an integrated model of analysis [11], evaluation and project [12] aimed at outlining a variety of strategies for programming interventions to reduce vulnerability, and therefore to optimize the urban policy choices.

2. Materials

2.1. Mitigation of urban vulnerability

The issue of urban vulnerability is studied in the specific context of the Emilia-Romagna Region with a wide range of approaches and tools only recently introduced in the regional planning aimed at reducing urban seismic risk. The vulnerability is analysed according to two scales: that of the entire urban centre, and that of the historic centre.

The aim is to ensure that during a seismic event an urban centre can persist, both regarding the efficiency of the main strategic activities for the recovery and the identity characteristics that distinguish it.

For the five municipalities of the Faentina Union, two studies were carried out: the evaluation of the seismic vulnerability of historical centres - agreement between the Union of Municipalities of Romagna Faentina and the University of Catania [1] - and specific urban studies to define the Emergency Limit Condition (ELC) - an urban scale analysis aimed at managing the behaviour of the settlement in the post-earthquake phase - carried out by the Technical Office of the Union of Municipalities [13].

The overlaying of the studies allows to develop an integrated project of intervention on which the economic evaluation illustrated in this paper was tested.

[1] Union of Municipalities of Romagna Faentina and the University of Catania (DICAR) agreement for the realization of the seismic vulnerability analysis in the historical centres of Brisighella, Casola Valsenio, Castel Bolognese, Riolo Terme, Solarolo (apporved with official act N.132/2016); scientific directors DICAR: Caterina F. Carocci, Salvatore Giuffrida; research team: Chiara Circo, Margherita Giuffrè, Luciano A. Scuderi, Vittoria Ventura.

The study on the 5 historical centres of the Faentina Union Faentina (Brisighella, Casola Valsenio, Castel Bolognese, Riolo Terme, Solarolo) was carried out in two phases.

In the first phase, the homogeneous areas of the entire municipal territory with regard seismic vulnerability were identified, following a method established by the Department of Civil Protection and tested on Faenza and Solarolo in 2011 [14]. The second phase included the qualitative assessment of the seismic vulnerability of historical centres – identified as the most vulnerable areas of the urban fabric – following a procedure already tested on the historic centre of Faenza between 2011 and 2013. The aim was defining criteria for the mitigation of building's aggregates seismic vulnerability, with regard to the specific characteristics of each fabric built [15].

At the same time, the Technical Office carried out the analysis of the Emergency Limit Condition (ELC), introduced by the Italian Government Ordinance (OPCM n. 4007/2012), in application of Law n. 77/2009 art.11 "National plan for the prevention of seismic risk" for each of the 5 municipalities. The ELC is an analysis at a municipal scale, set up on the Civil Protection Plans and aimed at guaranteeing the functioning of the emergency management system in the post-earthquake phase. By definition, the ELC represents that limit condition for which, after the seismic event, the urban settlement loses all its functions (including residence) and preserves only the operation of most of the strategic functions for emergency management, their accessibility and connection with the territorial context. ELC is in fact made up of strategic buildings, emergency areas and main links between the elements and the territorial context, as well as their interaction with the interfering elements [16].

The analysed emergency management systems, like the settlements they belong, have a rather simple configuration. The connection infrastructures cross the urban centre, reaching strategic buildings inside the historic centre, or to its border. The small size of the centres and the choice to place the strategic buildings in newly built areas outside the historical centres, imply a low presence of interfering structural aggregates.

2.2. The historic centre of Brisighella

The settlement of Brisighella rises on the slopes of the Tuscan-Romagna Apennines in the lower valley of the Lamone river. The first plant, dating back to the end of the XIII century, was constituted by a fortified nucleus, the current Rocca. In the 14th century the fortification works were extended to the settlement of the "Borgo", creating an elevated porticoed path for defensive purposes, integrated into the houses (now Via degli Asini). During the 1400s the nucleus expanded towards the valley creating a new fortification wall that was overcome in 1500 when the city developed beyond the walls.

The historical and evolutionary process of an urban centre and the orographic peculiarities of its territory have greatly influenced the definition of the urban form, characterized by aggregates of townhouses built against the slope. The residential buildings have incorporated the ancient walls, defining the peculiar configuration of the urban fabric

3. Methods

3.1. The analysis of the seismic vulnerability of the historic centre

The methodology used for the analysis of the vulnerability of the historical centres is based on the direct knowledge of the building aggregates and has been used often in contexts damaged by the earthquake [17] and in ordinary conditions [18]. The activities to be carried out are organized in three strictly connected phases: knowledge, interpretation and project.

The knowledge phase includes a preliminary bibliographical research and the studies already carried out by the UTC, which outlined the main evolutionary phases of the historic centre, and a on field survey aimed at detecting all the (constructional, typological, evolutionary) factors able to significantly affect, positively or negatively, the seismic behaviour of the urban fabric in its current configuration. The elements that positively influence the seismic response (resistance factors) and those that play a negative role (vulnerability factors) are identified, with particular reference to the development of important damage mechanisms, such as the overturning of the façade. It should be noted that all the information are collected through the observation from the outside of the whole urban fabric.

Moreover, the survey highlighted the specificities of the aggregates in terms of use and construction technique, distinguishing from masonry residential buildings, those in reinforced concrete or another construction technique and the buildings with specialized function, such as churches and historical palaces. The aim is to identify possible points of constructive discontinuity and the relationships of contiguity between buildings with different geometrical-structural characteristics.

This type of analysis conducted in the whole historic centre allows to obtain a map of the recurrent vulnerability and strength factors of the urban fabric, constituting an indispensable background knowledge for the definition of intervention criteria aimed at reducing vulnerabilities.

In the interpretative phase, the data collected on vulnerability and strength factors are critically selected with the aim of formulating a judgment on the mechanical quality of the urban fabric and therefore prefiguring the expected damage related to the precariousness observed.

In the project phase, the intervention criteria for the mitigation of vulnerabilities are established and - in the case of Brisighella - also the economic evaluation of interventions with the aim of managing the public financial resources

3.2. Vulnerability Reduction Assessment and Programming Model

The coherence between observations, assessments and decisions in the planning of interventions for the reduction of vulnerability consists in the correspondence between (even quantitative) heterogeneous aspects, and therefore difficult to compare: on the one hand the public expenditure for improving the resilience of the urban center; on the other the benefits in terms of increase in value (private and public) of buildings and urban fabric as supposed by the program.

It is possible to distinguish: direct benefits, such as the seismic improvement of buildings and the increase in the overall resilience of the entire city; externalities [19, 20, 21], such as the increase in real estate market value, the perception of a greater sense of individual security and so on.

From an economic point of view, the coherence between the value of investments and the value of security concerns two components of the calculation of seismic risk, *hazard* and *exposure*.

The measure of the *hazard* is affected by the randomness of the seismic event and by how this possibility is perceived by the public. This measure depends on two elements: the first, probabilistic, referable to the natural and geotechnical sphere (the probability of the seismic event); the second, instead, has a psycho-sociological and political nature; the political component of the dangerousness measure concerns the way in which the political-administrative system incorporates the geological evidence with the Urban Plan: in this case, the Urban-Building Regulation of the Union of Municipalities of Romagna Faentina takes into account the Emergency Limit Condition (ELC) as a reference for ordinary planning.

The extent of the *exposure* varies according to the different "qualities of value" associated with the vulnerable buildings, and their monetary measure, which allow planners and decision makers to compare the value of the increase in security with the value of the investment. This difficulty calls into question the effectiveness and completeness of the monetary measure, suggesting additional and alternative measures.

The economic-monetary measure of vulnerability can be carried out indirectly, starting from the critical observations and from the evaluations of the Restoration [22, 23, 24]; in such an inter-disciplinary context, and with reference to the urban center as a whole, the works necessary to increase its resilience are selected, not to guarantee the perfect integrity of the individual buildings, but also aiming at preventing the urban center from interrupting its basic functions. The convergence of two disciplines, restoration and urban planning, changes the objectives of both, which become more specific and less ambitious.

The economic evaluation expands the possibilities of the plan: once the cost of the works has been calculated, it is possible to provide a coherent multiplicity of budget allocation hypotheses. In this case, given some conflicting variables, such as the completeness of the interventions and the

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extension of the area involved, it is possible to define the trade-off relationship to maximize the cost-effectiveness function.

Such greater integration between observation, evaluation and decision-making [25, 26], and the expansion of the contents taken into consideration, consolidate the consensus and the success of the project.

The evaluation model, as mentioned, consists of a database that carries out all the calculation and logical operations necessary to transform the data set into information basing on which the assessments select the best project options. Such integration of cognitive functions allows to carry out scenario analysis at the building and urban scale.

The model coordinates the structural, material, geometric, technological, typological, maintenance characteristics of the units of study [27, 28], relevant for: a) characterizing their static attributes (seismic vulnerability); b) hypothesize the design aspects selecting the interventions corresponding to each degree of vulnerability; c) calculate the costs based on the definition of typical bundles of works for each of the façade units facing the public areas [29]; d) adjust the intensity and extent of the interventions; e) map the interventions corresponding to each combination of intensity and extension of the interventions; f) calculate the total cost for each hypothesis defining the trade-off functions between intensity and extension of the interventions [30].

The proposed model aims to integrate the way in which ELC is formed, and proposes its possible extension, according to the advantages resulting for the urban center as a whole.

Calculation vulnerability. The calculation of the vulnerability consists in a measure of the risk that the facades of the buildings interfering with the evacuation and rescue routes may overturn obstructing them and/or affecting the safety of the fleeing people and rescuers. This measure is particularly important for buildings included in the ELC that must withstand the earthquake without collapsing to guarantee the functionality of the paths that connect the strategic nodes (Fig. 1).

Vulnerability is calculated for each individual Facade Unit (UF) facing the public spaces. The UF is the vertical portion of masonry of the external façade, included between two orthogonal structural walls, whose behavior is assumed to be independent of the others [31].

For each of them, by applying a dynamic structural analysis model, a "numerical indicator of the ground acceleration level capable of triggering elementary overturning kinematic mechanisms" was calculated [32]. This indicator is defined, consistently with the conceptual layout of the Technical Standards for Constructions (NTC 2008), as "the triggering multiplier of the motion due to overturning (α_0) of the wall taking into account the presence and extent of tapering, of the direction of the weaving of the floors (parallel or orthogonal to the wall), of the presence of floor chains, of the effectiveness of the clamping with the orthogonal walls [33, 34].

This multiplier is calculated for the "basic" and "varied" configuration, each referring to more or less favorable conditions as regards warping of the floors and the presence of tie-rods. The acceleration coefficient is assumed as an index of vulnerability [35, 36] of each UF, to which the works directly and indirectly connected are associated: the former are aimed at avoiding their overturn; the latter are joint works, such as those for securing elements soaring above the roofs, e.g. the chimneys, and the external and internal finishing works. This distinction is important for decisions regarding the level of completeness of the program of interventions, as discussed below.

The database contains in the rows all the UF, u_i, and in the column all the characteristics necessary to calculate the acceleration that the ground must give to the building so that the façade topples over. A low acceleration coefficient indicates a high vulnerability, and vice versa [37].

Cost calculation. Once the acceleration coefficient has been calculated and therefore the degree of vulnerability of each UF, logical and research functions associate it with safety measures, starting from the most common, up to the most consistent or invasive ones: inserting chains, filling of superficial lesions, integration of masonry damaged by passing lesions, introduction of reinforced masonry, securing of jutting and towing elements, external and internal finishing works, related to both walls and ceilings, articulated in a total of 36 items of price list.

The elementary cost associated with the interventions on each facade unit is then aggregated to calculate the total cost of each hypothesis of ELC.

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Each hypothesis of ELC is defined by varying the intensity of the interventions or their extension: the intensity depends on the overall degree of security required, with the same extension; the extension is the size of the area affected by the interventions with the same degree of safety. The result is two cost functions, one intensive, $C(b_{jk})$, the other extensive $C(l_{CLE})$ [38].

The *intensive cost function* relates the total cost and the type of intervention, which depends on the bundle of works b_{jk} associated with the single u_i. Each bundle includes works corresponding to the entries of the List of Public Works of the Emilia Romagna Region, $b_{jk} \in B$, where B is the set of all the works referable to the activities to reduce the vulnerability of the buildings included in the hypothesis of ELC.

The b_{jk} package can contain a more or less large number of works, according to their different relevance. In fact we can distinguish: those strictly necessary j_n; those of primary public interest j_p; the less invasive ones j_v; those more or less adequate j_a.

Combining the five classes of interventions j with the five degrees of security k, 25 different hypothetical strategies with increasing costs have been formed [39].

The extensive cost function is defined with respect to the degree of safety of the entire urban center in a variable range: $k_{60\%}, k_{70\%}, \ldots, k_{100\%}$; the total cost, therefore, also depends on the number of buildings involved, hence the size of the ELC: a level of security equal to $k_{60\%}$ involves interventions on the few buildings whose acceleration coefficient is very low and vice versa for the security level indicated with $k_{100\%}$.

3. Application and Results

4.1. The map of vulnerabilities and strengths, and the ELC of Brisighella

The elements identified in the context of the on field survey are represented with icons in the "Map of vulnerabilities and strengths of the urban fabric". Depending on the method of acquiring knowledge (observations from the outside), the vulnerability discussed here is related to the possible overturning mechanisms of the walls facing the street.

From the analysis emerges a general good state of conservation of the historic centre of Brisighella, which does not present cases of buildings in a structure different from the masonry one, because it was not subject to post-war reconstruction -.

The map of Brisighella shows the recurring vulnerabilities and strengths in all the five centres such as: the presence of soaring buildings, more vulnerable to the overturning mechanism due to the number of uncontained outer walls; volumes jutting out from the external fronts, more frequent in the rear facades of the buildings. Furthermore, the map illustrates some specific vulnerability factors, such as the constructional irregularities of some parts of the urban fabric due to the integration in the walls of the ancient city walls. The contiguity between very different geometrical and structural configurations (in terms of storey height, wall thicknesses, etc.) can constitute a weakness in a seismic perspective, and this should be taken into consideration in the context of a possible intervention.

The strength factors that characterize the urban fabric of Brisighella concern the widespread use of historic anti-seismic devices (metallic tie-rods and buttresses) and a good construction technique - as far as visible from the outside.

The ELC of Brisighella, unlike the other municipalities analysed, is all included in the historical urban fabric, since the main connection infrastructures cross the historical centre in a rather extended way. For this reason, it is noted a high number of interfering structural aggregates, which are those that following the earthquake could collapse on the escape routes identified in the ELC.

4.2. Intervention criteria for vulnerability reduction

The interpretation of information related to vulnerabilities and strengths allows the prefiguration of the seismic damage mechanisms that can affect the analysed urban fabric.

The recurring issues to be faced in the seismic risk prevention are clarified and the essential features of an aware mitigation strategy respectful of the constructional and urban peculiarities of the historical centres are specified. The intervention criteria are not expressed by technical details but

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rather by the objectives to which the intervention must aim, which allows a design freedom with only one indispensable restriction: the respect for the constructive logic of the masonry technique, as a guarantee of effectiveness and compatibility of the intervention with the historical building.

With reference to the vulnerabilities observed in the historic centre of Brisighella, the improvement of the seismic response is pursued by means of interventions aimed at: control of the thrusts in the roof and reducing the thrusts of vaulted elements; improvement of the connections between walls and floors with particular regard to the containment of the façade walls.

These indications are valid for the entire wall structure of the historic centre of Brisighella and allow to define a general framework of actions to be implemented for the preventive mitigation of the seismic vulnerability.

It follows that the overlapping of the levels of knowledge in terms of vulnerability, strengths and intervention criteria with the forecasts of the ELC of Brisighella can helps to identify the strategic interventions to be promoted by the public authorities within the historical centre - favouring a coordinated management of the financial resources - and to define reward mechanisms to promote the implementation of private interventions.

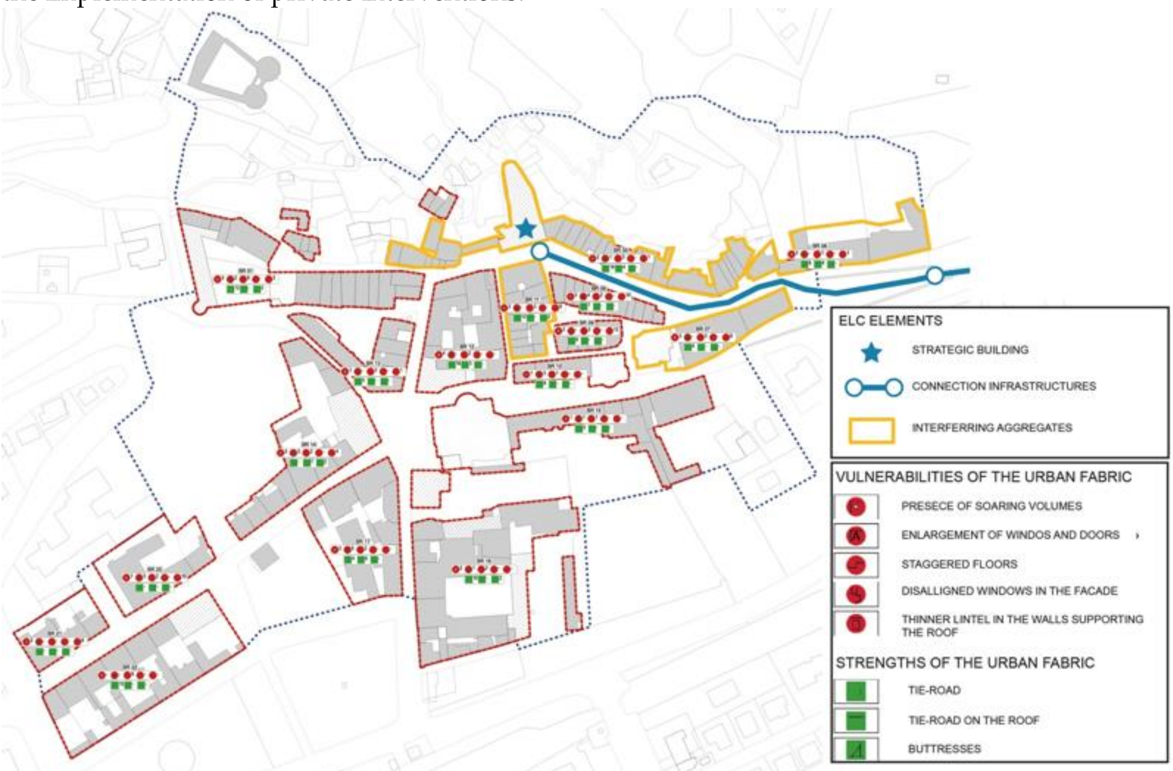

Figure 1. The Emergency Limit Condition of the historic Centre of Brisighella.

4.3. Valuation and programming of the intreventions for implementing the ELC

The information base used to calculate and select the interventions includes: identification of the UF in the building complex to which it belongs (Block and Architectural Unit); land registry identification; type; facade unit for aggregate; number of facades for each room; horizontal extension of the facade; wall thickness; room depth; surface of the room; number of floors above ground; gross surface area of the facade; heights of the different floors; average height of each floor; construction system; wall type; orientation of the structure of the floor with respect to the direction of the facade; soaring elements; braces, hypothesized if the width of the front facade is greater than 6.50 m, and the number of floors greater than 1; presence of chains; presence of injuries. The data are taken from the documentation provided by the Union's Technical Office (Municipality of Brisighella) and by the rapid investigations carried out in the field.

The tendency to overturn the façade was calculated according to: a) a pessimistic scenario, taken for the benefit of safety and referred to the basic configuration, quantified by the coefficient α_{0b}; b)

doi:10.20944/preprints201906.0230.v1

an optimistic scenario referred to the configuration changed and quantified by the coefficient α_{0v} (Fig. 2).

Figure 2. Map of the vulnerability of the Façade Units of the old town of Brisighella. The table accounts the Façade Units by vulnerability degree.

Depending on the degree of vulnerability of each of the 749 facade units analyzed (only 685 need to be secured), the model identifies the interventions necessary for securing them. It should be noted that the interventions are not activated automatically and unambiguously, but based on the type of strategy that the decision maker chooses.

Fig. 3 summarizes the model of selection of the works according to the strategy and indicates the costs of the 25 strategies according to the degree of completeness and security; the graphs below show the trade-off functions between the extension of the ELC and the overall degree of security, for each amount of the total cost.

Kind of works	Completeness degree 1	2	3	4	5
necessary	1	1	1	1	1
unnecessary				0.3	1
public	1	1	1	1	1
private			0.5	1	1
min security	1	1	1	1	1
max security		0.7	1	1	1
not invasive	1	1	1	1	1
invasive		1	1	1	1

(a)

Number of fixed Façade Units	Completeness degree 1	2	3	4	5
196	0.71	1.11	1.29	1.65	2.44
232	0.83	1.30	1.52	1.95	2.89
374	1.39	2.04	2.33	3.03	4.57
577	2.10	2.96	3.33	4.34	6.60
685	2.46	3.42	3.84	4.99	7.57

(b)

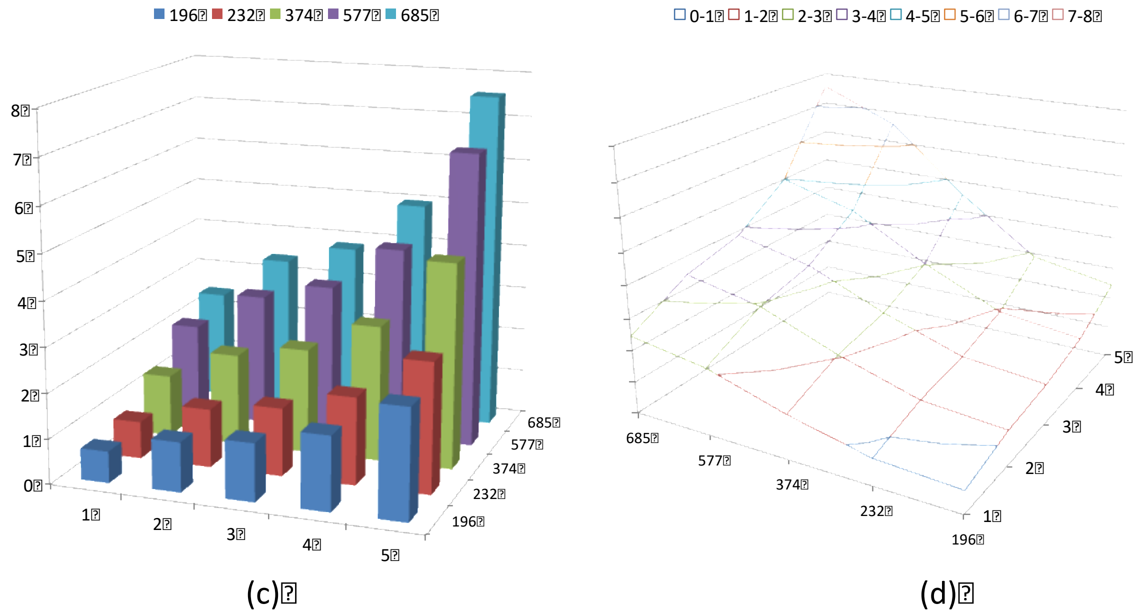

Figure 3. (a) Combination of security and completeness; (b) table of total cost for each strategy given by the combination of the two above mentioned performances; (c) Graph of the total costs of each of the 25 strategies; (d) 3D isocost functions.

A further function of the model is mapping the 25 different strategies of vulnerability reduction providing information on the FU for which the intervention is necessary (given by the position of the bubbles in the map) and a graphic representation of the cost (given by the dimension of the bubbles), as sampled in Fig. 4 displaying four of the 25 strategies. In this figure the position of the strategy on the isocost graph is shown. The sequence represents four strategies increasing in cost due to the simultaneous increase of the completeness and security degree.

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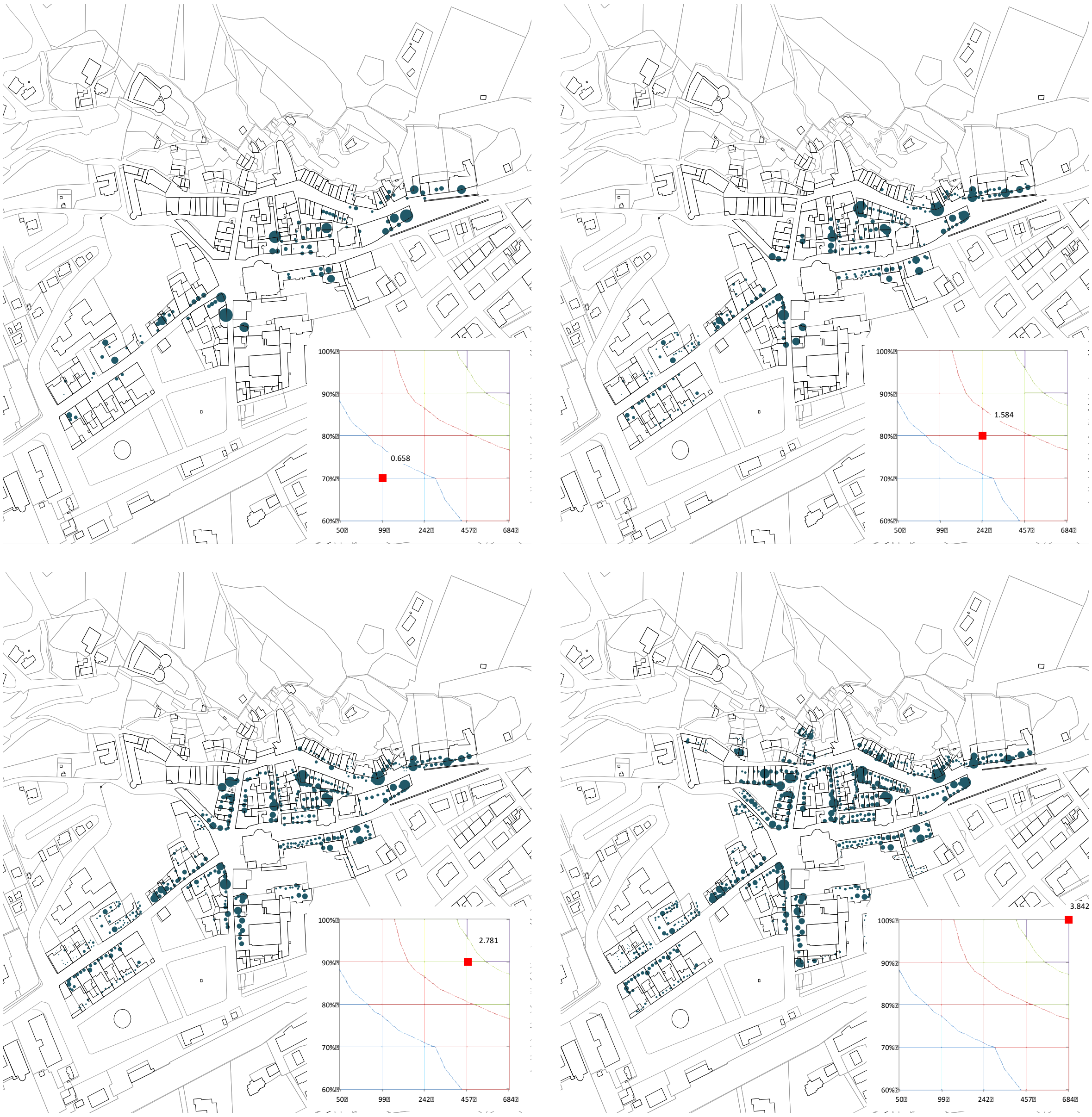

Figure 4. Mapping of the different layouts of the strategies having an increasing total cost.

In Fig. 5, instead, the strategies displayed are those having approximately the same cost so that they differ just as for completeness and security degree.

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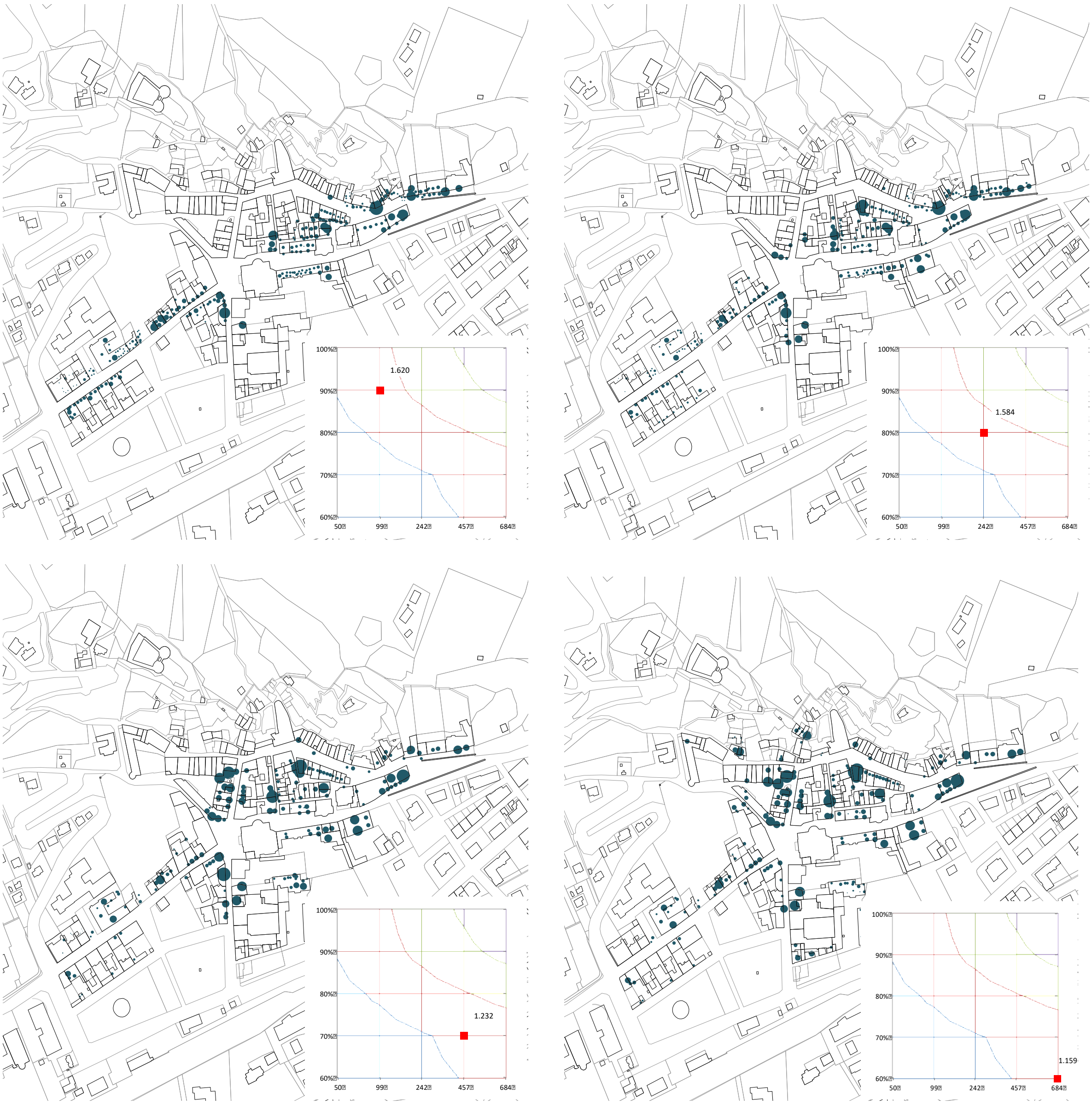

Figure 5. Mapping of the different layouts of the strategies having (approximately) the same total cost.

4. Discussion and conclusions

The proposed model outlined a wide range of possible options as to how to combine the overall degree of security corresponding to the number of buildings secured (from 196 to 685 UF of 749) and the budget to cover total costs (from 0.71 to € 7.57 million). The different possible mixes of the values contained between these extremes correspond to precise "statements" on the degree of resilience of the urban organism, on access to safety, that is on the subjects to whom the advantage of safety will be granted and to what extent, on the value that the administration recognizes the resilience of the urban organism.

The central scenario envisages that 374 FUs can be secured with average intervention solutions, having a total cost of € 2.33 million.

The table and the diagram, taken along the main diagonal, measure how the cost increases as the resilience and completeness of the interventions increase; if, on the other hand, the table and the diagram are traversed along the isocost function, the trade-off relationship between the completeness of the interventions and the degree of resilience with the same budget and for each amount of the same is shown (that is for different isocost funtions).

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The combination, integration and consequentiality of factual, axiological and decisional aspects, shows how this study considers ELC as an opportunity to go beyond its original purpose and its immediate significance: the CLE is an informative and normative device intended to provide a minimal ability to adapt to the urban fabric so that it does not lose its identity. The case of Abruzzo, in which most of the cities included in the seismic crater have been evacuated for a long time, is exemplary as regards the different ways in which responsibility can be distributed among the spheres of proactive and reactive policies [40, 41].

The two variable – costs and degree of completeness of the interventions – in fact, allow to identify the political-decisional profile of the ELC regarding the allocation of advantages and responsibilities between private and public actors.

The urban center in its entirety achieves the requirement of resilience only when the ELC is fully realized, therefore from the moment when all the buildings included in it are secured; for this reason it is necessary to coordinate the interests and motivations of all the owners of the assets involved.

Furthermore, there is no doubt about the unequal distribution of the positive externalities associated with CLE in terms of real estate value [42, 43, 44]; in particular, the sudden succession of significant catastrophic events in central Italy has made the seismic risk an evidence with significant symbolic implications.

The presence of positive externalities allows the local administration to start negotiations [45] on the public part of the works, excluding, for example, finishing works [46].

Subsequent in-depth studies of this study, aimed at measuring exposure, i.e. the value of vulnerable assets, can allow us to compare the security advantage of the building (depending on exposure, in fact) with costs [47] and define the best compromise between the works to be financed by the public (those specifically intended for the public interest) and those charged to the private subject, in particular between finishing and completion.

The presence of positive externality in the local administration of bargaining on works by the public subject, excluding, for example, finishing works.

Subsequent in-depth study of this study, aimed at the exposure test, that is the value of vulnerable assets, borne by the same costs [48] and to define the best compromise between the works that are financed by the public, in particular those of finishing and completion.

Once the hazard is known, a shrewd policy of prevention is to allocate the surplus of social capital so as to be sure that resilience is a share of urban capital.

This aspect is very important especially in historical fabrics, characterized by settlement complexity, structural fragility, typological and formal inertia, and low population density. These characteristics can decisively influence the answer to the original question: "Is it worth it?".

In this study we tried to understand how the involvement and coordination of measures, judgments and decision profiles allows to overcome the typically object-based approach implied by CLE.

This, in fact, is attributable to a "prescriptive grammar" (it says what needs to be done), while the proposed approach is attributable to the logic of "generative grammar" (it says what can be done).

This different approach implements an "axiological approach" that integrates natural, environmental and technological aspects) with cultural, landscape, and political-decision aspects; such an approach expands the way in which the original question can be answered

Author Contributions: For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "conceptualization, S. Giuffrida; methodology, S. Giuffrida, M. R. Trovato, V. Ventura; software, V. Ventura; validation, M. R. Trovato, V. Ventura; formal analysis, S. Giuffrida, M. R. Trovato, V. Ventura; investigation, C. Circo, M. Giuffrè, V. Macca; resources, C. Circo, M. Giuffrè; data curation, V. Ventura; writing—original draft preparation, all these authors.; writing—review and editing, all these authors.; visualization, all these authors.; supervision, S. Giuffrida, M. R. Trovato; project administration, S. Giuffrida; funding acquisition, S. Giuffrida.

Funding: This research was funded by the Unione della Romagna Faentina, within the Agreement signed with the Department of Civil Engineering and Architecture of the University of Catania in 03/03/2016 based on the Decision n. 132/2016; scientific responsible C. Carocci e S. Giuffrida. The APC was funded ……...

Acknowledgments: In this section you can acknowledge any support given which is not covered by the author contribution or funding sections. This may include administrative and technical support, or donations in kind (e.g., materials used for experiments).

Conflicts of Interest: The authors declare no conflict of interest.

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