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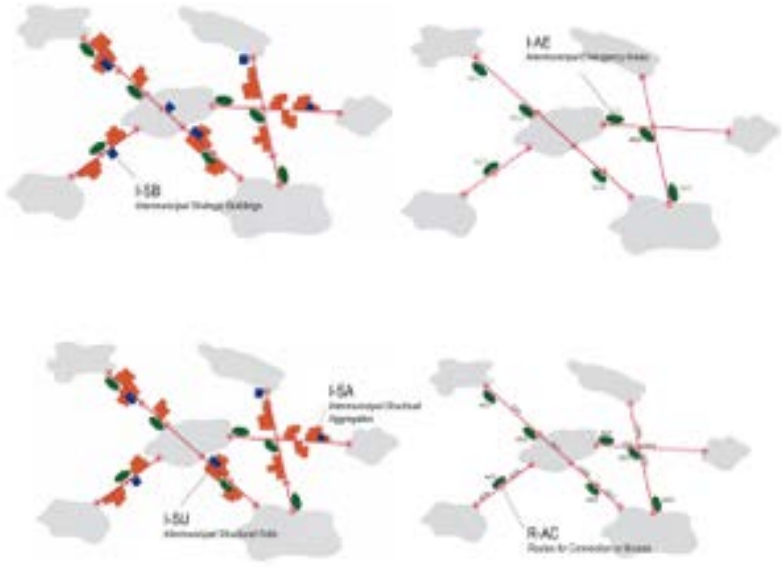

LIMIT CONDITION FOR THE INTERMUNICIPAL EMERGENCY

LUANA DI LODOVICO, DONATO DI LUDOVICO

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ABSTRACT

The traditional urban planning issues, related to the design and city shape, today are faced with those derived from safety and risk. The Emergency Plan (EP) is the result of study about risk for each context, and it allows to identify potential emergency scenarios. The paper illustrates model of analysis of Intermunicipal Emergency Plan (I-EP) through Limit Condition for the Intermunicipal Emergency I-LCE), with the purpose of large-scale assessment and mitigation of the seismic risk. This is an approach that extends the methodological principles of Limit Condition for the Emergency (LCE) to the territory, we consider that the EP, in the same way as urban planning, is not a planning activity that can be concentrated only on urban area but must work on the "territory system", especially for the effect control of natural phenomena such as seismic risk. This not only threatens a significant innovation for the LCE but also for its relationship whit the urban planning its design strategies aimed at reducing territorial fragilities. The proposed methodology is applied in the area of Sele, in the district of Salerno (Southern Italy), territory characterized by high levels of seismic and hydrogeological vulnerability. Through this case study we had the opportunity to discuss the potential of I-LCE and its additional recommended updates to increase its effectiveness and efficiency, in addition the necessary innovations of urban and territorial planning systems.

KEYWORDS:
Safety; Resilience; Urban Planning; Territorial Planning; Management Risk Plan; Prevention and Territorial Recovery Projects

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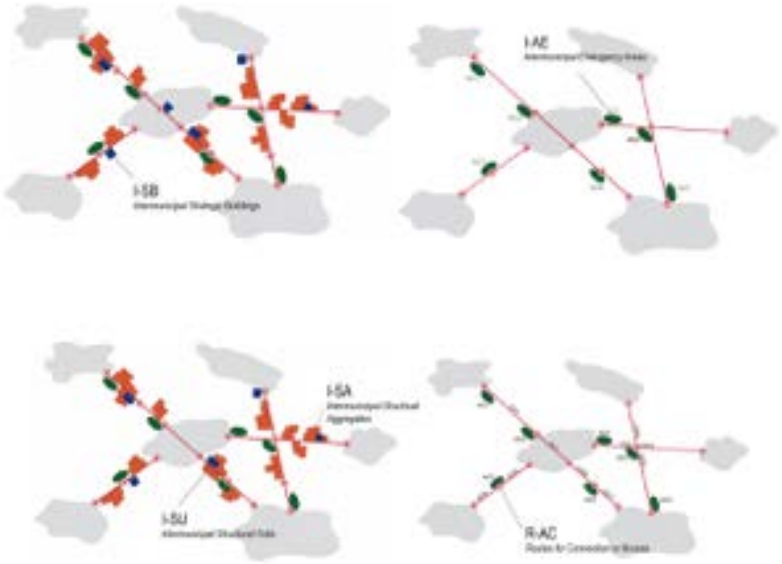

城际突发事件的极限条件

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摘要

涉及到城市的设计和形态的传统城市规划问题，今天面临着由安全和风险衍生出来的问题。应急方案(EP)是对每一种情况下的风险进行研究的结果，能够确定潜在性的突发事件。本文通过城际应急方案(I-LCE)的极限条件，阐明了城际应急方案(I-EP)的分析模型，旨在大规模的评估与降低地震危险。这是将“突然情况的极限条件”(LCE)的方法原则扩展至地域/区域的一种方法。我们认为，EP与城市规划一样，并不只是一项集中于城市地区的规划活动，而是必须作用于“地域/区域系统”上的规划活动，特别是针对地震风险等自然现象方面的效果控制。这不仅威胁到LCE的重大创新，而且还威胁到它与城市规划、旨在减少领土脆弱性的设计战略之间的关系。所提议的方法适用于地震频发和水文地质脆弱的Salerno省(意大利南部)的Sele区域。通过该案例的研究，我们有机会就I-LCE的潜在性及其附加的建议更新及探讨城市和地区规划系统的必要创新进行探讨，以提高其有效性和效率。

关键词:
安全、适应力、城市规划、地域规划、风险管理规划、预防与地域复原项目

1 INTRODUCTION

The main theme of the research is the reduction of seismic risk for resilience territories. These risks include not only natural disasters but also all the likely crises in the city (Molavi, 2018). The International Strategy for Disaster Reduction of the United Nations defines resilience as the capacity of a system, community or society potentially exposed to hazards to adapt to a new scenario by resisting or changing, in order to reach and maintain an acceptable level of functioning and structure (UNISDR, 2015). Resilience is determined by a social system capable of organizing itself to increase its capacity of learning from past disasters for its future protection, as well as to improve risk reduction measures (Cara et al., 2018). Every city can express a certain level of resilience, and the identification of its most influent elements is strategic in order to detect intervention criteria aimed to its improvement (Burton et al., 2016). More recent studies focused on the possibility to carry out seismic vulnerability assessments quickly and with limited costs, in order to extend the application to entire urban systems (Formisano et al., 2011). In this last context the Limit Condition for the Emergency (LCE) is placed. The research presented stems from an agreement of the ICEAA Department of the University of L'Aquila with the Department of Public Works, Government of the Territory and Environmental Policies of the Abruzzo Region. In particular, the agreement concerns studies on LCE and I-LCE, on Seismic Microzonation (MZS), Levels 1 and 3 and on the reduction of seismic vulnerability of strategic buildings. In particular, for the analysis relating to LCE, the research has proposed an innovation considering it necessary to experiment, at a territorial level, a new methodology for the reduction of the seismic risk components and implementation of the effectiveness and efficiency of Intermunicipal Emergency Plan (I-EP). The result of this research, which is described in this article, have then become guidelines of the Abruzzo Region: "Condizione Limite per l'Emergenza, Linee di indirizzo regionale di analisi ed elaborazione della condizione limite per l'emergenza intercomunale" (Regione Abruzzo, 2017). In these guidelines the definition of I-LCE: «Instruments designed to:

- to integrate the project interventions on the territory for the seismic risk mitigation;
- to verify the emergency management systems of the I-EP (buildings, roads, emergency areas, etc.);
- to evaluate and verify strategic choices of EP of the individual municipalities».

It should be pointed out that the analysis of I-LCE does not replace the I-EP, but aims at its own updating, or of its elaboration, with the objective to guarantee the operation of the urban and extra-urban system in the event of emergency. The purpose of the research is to extend the concept of CLE, moving from the local level to the territorial level, to analyze performance levels of territorial system, to understand the potential levels of resilience whereas the response to natural disasters must be provided by a complex system of territories and not isolated urban areas. The research proposes an I-LCE can be considered, as well as an assessment tool, a tool to support the redesign of the spatial form and then of those fragmented structures of settlements typical of the modern era/period, especially from the post-industrial era.

Using I-LCE as a project tool means to identify new rules for the spatial organization /reorganization of the territory fabric and, in case of catastrophic events, to be able to ensure the safe exodus to emergency areas and stacking, to ensure access to first aid equipment and facilities (hospitals, first aid, gathering areas, etc.) and to the strategic buildings included in the EP but also spatial planning tools. The primary objective of the EP is explicitly stated to be the reduction of the expected human losses, rather than economic losses, so that the action is especially addressed to high hazard and high-risk areas (Dolce, 2012). Instead the I-LCE can be considered as a design tool, and as such can intervene on prevention by acquiring the characteristics of a pre-disaster planning that interacts with the traditional urban planning.

The research considers two levels of analysis: local and territorial. At local level, LCE can analyze: geological and morphological analysis of sites; relationships between handworks and urban systems (hierarchical level and percentage covered by the standard); amount of users and their daily or periodic movements; vulnerability (physical) component manufactured about classification and identification of building aggregates; amount of

negative interactions between elements (building aggregates) and urban morphology; interactions of the various components and systems with basic and local hazard, hydrogeological and hydraulic hazard, status of underground storage; land use decisions on local strategic location of buildings. At Territorial level, I - LCE can analyze: distribution of the various functions in the municipality systems (performance Level); hierarchy of functional systems (networks and buildings); resource flows (people and goods); vulnerability assessment and explanation of the built system with respect to natural hazards (floods, earthquakes, etc.), land use decisions on location of territorial strategic buildings (D'Ascanio et al., 2016). Through the experimentation with the case study (area of Alto and Medio Sele) the limits of the model and the points to be perfected have been tested. Also the integration of all studies and analyzes related to the seismic risk mitigation (MZS, LCE, I-LCE, I.OPà.CLE) will be able to define a working model in such a way that the retrofit of the territories can be performed based on vulnerability, local risk and Emergency planning needs (Dolce, 2012).

2 LIMIT CONDITION FOR THE EMERGENCY (LCE) AND THE METHOD I.OPÀ.CLE

The analysis of the Limit Condition for the Emergency (LCE) of urban settlement, defined in detail by the law article 18 of the OCDC 171/2014 as «[...] that condition of urban settlement to which, following the occurrence of the seismic event, overcoming, in spite of the occurrence of physical and functional damage such as to lead to the interruption of almost all the existing urban functions, including residency, the urban settlement still retains, as a whole, the operation of most of the strategic functions for emergencies, their accessibility and connection with the territorial context». They are many legislative directives that have introduced LCE, among which we remember:

- the Legislative Decree of 28 April 2009, No. 39 (so called "Abruzzo Decree" - urgent interventions on behalf of the populations affected by earthquakes in the Abruzzo Region and further urgent interventions of Civil Protection), converted, with amendments, by the Law of 24.06.2009, No. 77;
- Ordinance President of the Council of Ministers (OPCM) No. 3907/2010 which, according to the art. 11 of the D.lgs. 39/2009 launched a multi-year seismic risk program for the period 2010-2016;
- OPCM No. 4007/2012 which introduced the analysis of Limit Condition for the Emergency (LCE) for the year 2011 in order to improve the management of emergency activities;
- order of the Head of the Civil Protection Department (OCDPC) No. 52/2013 that defines the financing modalities for the realization and/or completion of the studies of Seismic Microzonation (MZS) and of the Analysis of the Limit Condition for the Emergency (LCE) in municipalities that are part of a union and associations of municipalities, for the year 2012;
- OPDPC No. 171/2014 defines the financing modalities for the realization and/or completion of the studies of MZS and the analysis of LCE in municipalities that are part of a union and/or associations of municipalities, for the year 2013 (art. 21). Moreover, it introduces the faculty to the Regions and Autonomous Provinces to identify one or more union of municipalities on which to start a program aimed at guaranteeing the minimum conditions for management of the emergency system to obtain homogeneous results in MZS studies and analysis of LCE according to specific procedures and financing (art. 22);
- OCDPC No. 293/2015 defines the financing modalities for the realization and/or completion of the studies of MZS and the analysis of LCE in municipalities that are part of a union and/or associations of municipalities, for the year 2014 (art. 21), and reiterates the provisions of art. 22 of the OPDPC 171/2014;
- OCDPC No. 344/2016 defines the financing modalities for the realization and/or completion of studies on MZS and the analysis of LCE in municipalities that are part of a union and/or associations of municipalities, for the year 2015 (art. 21).

The operating methodology has been defined within the regional seismic risk mitigation program (Legislative Decree 28 April 2009, No. 38, Article 11). It is important to underline the importance of supporting LCE analysis

to studies on MZS to integrate all those actions aimed at the mitigation of seismic risk, to improve management of emergency activities in the phase that follows immediately the earthquake (Di Lodovico & Di Ludovico, 2015). The graph shown in Fig. 1 describes what happens in an urban settlement following a seismic event before reaching the LCE (shown in the graph with the green point), or up to suffer physical and functional damages such as to cause:

- interruption of the residential function;
- interruption of most ordinary and strategic urban functions.

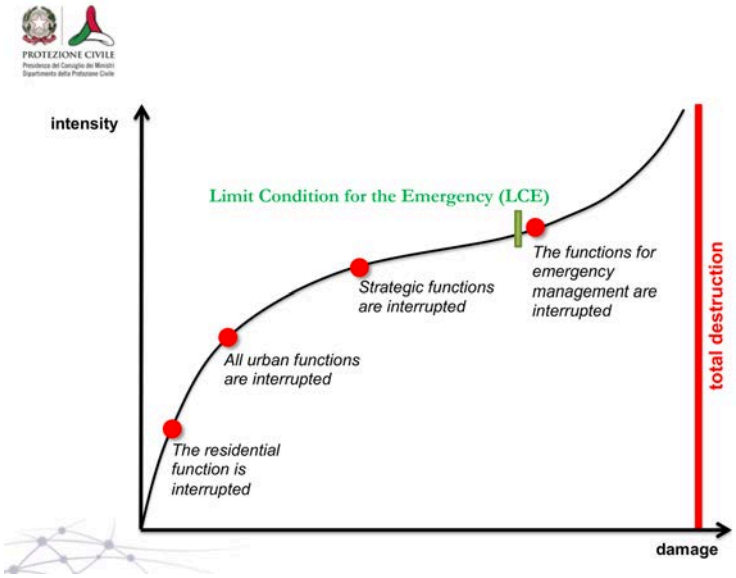

Fig. 1 What happens in an urban settlement following a seismic event before reaching the LCE

The LCE analysis involves:

- the identification of buildings and areas that guarantee strategic functions for emergencies;
- the identification of accessibility and connection infrastructures with territorial context, buildings and areas referred to in a. point and any critical elements;
- the identification of structural aggregates and single structural units that can interfere with the accessibility and connection infrastructures with territorial context (Castenetto, 2013).

The LCE analysis is performed using the forms prepared by the Technical Commission referred to in Article 5 paragraphs 7 and 8 of the OPCM 3907/2010 and issued with a special decree by the Head of the Civil Protection Department (CTMS, 2014a, 2014b). The analysis allows to identify on a basic cartography, all the minimum information necessary to evaluate the urban response to an earthquake. To this end, data archiving standards have been set up, collected in a specific form (5 types of cards) and represented on digital cartography (in shapefile format). The five relevant cards concern: Strategic Buildings, Emergency Areas, accessibility/connection infrastructures, Structural Aggregates, and Structural Units. Once computerized through the SoftCLE (a software drawn up by Civil Protection Department), the cards catalog allows to realize a first level of knowledge (level 1) on urban system quality. The next step is the analysis through GIS tools on the functionality / operation of the Municipal and / or intercommunal EP with respect to the services required to urban system during the emergency phase (CTMS, 2014a, 2017b). In fact, through the LCE analysis we can integrate interventions on territory for seismic risk mitigation. The aims of this analysis are to verify emergency management systems, conceived as a set of physical elements (strategic buildings, emergency areas, structural aggregates and structural units interfering with the connection and accessibility infrastructures), already identified in the EP, and to verify the strategic choices of the EP. It should be noted that analysis of LCE does not replace EP, especially in the identification of sites and strategic management structures of emergencies. It rather aims at its updating / adaptation. Starting from the ELC definition, in the literature, we

find other more general analysis approaches based on performance for the probabilistic assessment of damage, seismic evaluation and resilience of urban systems with reference to different levels of performance (Burton et al., 2016; Lagomarsino & Cattari, 2015). There are two models studied and compared to enrich the I-LCE model: I.OPà.CLE (Operational efficiency indices for Emergency Limit Condition – LCE) and the simplified LCE model proposed by the study group of Cara et al. (the Antiga Esquerra de l'Eixample neighborhood of Barcelona), both models for the assessment and mitigation of the seismic risk (Cara et al., 2018).

Since 2013 the Italian Civil Protection Department has developed and further upgraded the method I.OPà.CLE for the assessment of operational efficiency of an EP described through LCE tools (Dolce et al., 2017a, 2017b). This is a method proposal that has remained only in the field of study, and is interesting because it deals, in a complex manner, with the topic of the evaluation of the EP. The method is based on the formulation of synthetic probabilistic indexes that measure the operational capacity in the aftermath of the seismic event, for each physical component, and its sub-elements of the emergency system. The indices are formulated for two seismic events with different return periods (T = 98 years and T = 475 years) as well as in absence of any earthquake occurrence (conventionally associated to return period T = 0). Coherently with LCE analysis, the method is specifically conceived for assessments at municipal scales. Limitedly to the level of accuracy of input data provided by LCE analysis, the final purposes of I.OPà.CLE are to outline the potential criticalities which might inhibit the management of a real seismic emergency, so as to enable the decision maker to undertake specific measures for fixing critical elements and hence upgrading the plan (Dolce et al., 2017a, 2017b). In addition to the operational indices, the method makes it possible to calculate the probability of maintaining the functioning of the physical emergency system described through the analysis of LCE. Flexibility of analysis and modularity of results (Global Indexes - Subsystem - Element) allows information to be provided in more detail, so as to be able to easily identify specific critical issues that require priority actions, thus supporting the decision-making process (Dolce et al., 2017a, 2017b). As with the I.OPà.CLE model, a system is being structured in the research, with probabilistic indices, which allows to evaluate the performances of the I-EP functionally to safeguard life.

The case study of Antiga Esquerra de l'Eixample neighborhood of Barcelona is a simplified model to investigate the influence of the collapse of interfering buildings on the operability of strategic urban roadways, as well as the possible actions that may lead to improve their functionality after the occurrence of an earthquake. The first stage of the proposed methodology consists in the identification of interfering buildings whose damage or collapse, may affect the functionality of vital connections during the post-seism emergency (Cara et al., 2018). The damage grade of the chosen buildings is evaluated after having determined the vulnerability indexes by using the GDNT method, distinguishing masonry buildings and reinforced concrete buildings. This model mainly studies the operativity of the interfering buildings of the LCE an appropriate mechanical model whose definition allows the assessment of the reliability of the urban system crossed by the strategic road. However, it is a model that mainly analyzes the vulnerability of individual buildings without taking into account the needs and hazard present in the area examined. The same research team provides for the improvement of the survey strategies on the existing building heritage and extending it to urban infrastructures, water supply systems, pipelines, communication networks, etc. Ultimately, the improved GIS database created for Antiga Esquerra de l'Eixample can be a starting point for optimized risk mitigation measures and civil protection planning. However, it is a model whose results are extremely important for public safety or civil protection agencies to assess the impact of possible intervention strategies, as well as to optimize the management of seismic emergencies (Cara et al., 2018).

3 FROM LCE TO I-LCE: A NECESSARY CHANGE FOR A RESILIENT TERRITORY

Following an earthquake of a given intensity, urban vulnerability depends both on how individual building components are damaged, and on functional performance that these buildings provide (commercial, services,

production, energy, mobility, etc.). Vulnerability of an urban system thus measures the non-linear correlation between intensity of seismic event and extent of damage to the urban system itself, caused by exposure characteristics of its individual elements (Fabietti, 2013). The LCE allows the rapid assessment of urban vulnerability of specific strategic buildings, connecting areas and infrastructures and interfering buildings in urban area. However, analysis is a complex process because it involves different contexts from a spatial, geological-technical and functional point of view. It is therefore a multidisciplinary study that involves different technical and administrative, each with specific roles and competences, in order to optimize the activity and improve final quality of proposals for improvement / integration of EP (Fig. 2).

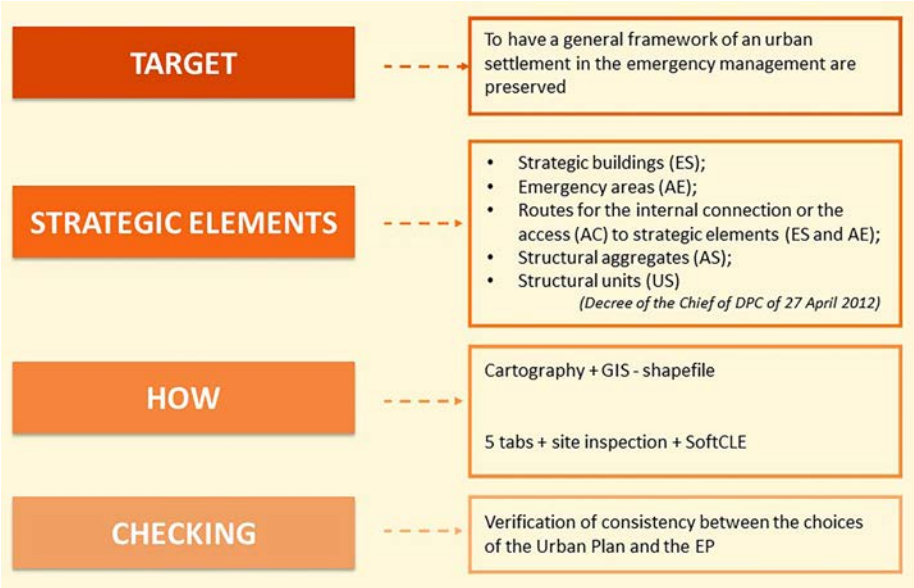

Fig. 2 The Limit Condition for the Emergency

The EP is the operational tool for the management of emergencies and for the mitigation of territorial risks. The main objective of the EP is to define the organizational model of emergency procedures, monitoring activities, risk prevention actions and assistance to the population.

The Plan is structured in three parts:

- collection of all information related to the knowledge of the territory with the identification of risks;
- planning of operations to be carried out during the pre-emergency, emergency and post-emergency phases;
- definition of the intervention model, with identification of responsibilities for the management of emergencies at the various levels.

The EP should be a dynamic and constantly updated document that should be updated and disseminated among the citizens, especially with simulations that allow you to test the contents of the plan, verify the organizational and management capacity envisaged. Because of this static and for other factors the EP and the LCE have limits:

- EP, in Italy, is static plan, sometimes not known by mayors, technicians and citizens; some Regions, such as Abruzzo, have promulgated guidelines for updating the common plans with the aim of making them become dynamic instruments;
- LCE provides analysis model that analyzes only the effects of a seismic event on the city (while the EP takes more risks into account);
- LCE does not provide for a systematic and dynamic knowledge of urban phenomena and structure;
- does not exist a platform that allows the comparison of urban planning processes, geographical information, territorial risks information and the structure of the EP;

- there is no urban analysis of the overall response to a disastrous event of a territory, which cannot be ascertained by the sole verification of the EP through the LCE.

The research also poses that of reading again and integrating experiences of pre-disaster planning (UNISDR, 2012) and mitigation planning (FEMA, 2013) to overcome these critical issues and to propose a new model of I-EP fully integrated with ordinary urban and territorial planning, connection that is possible through the construction of a digital platform for the construction and management of knowledge. The purpose is to obtain a territorial organization of the emergency able to safeguard and secure the building, infrastructural and natural heritage, which provides for the training of citizens to obtain resilient communities and territories.

Based on these concepts, and on the national laws, the I-EP has been prepared and integrated, and it has been elaborated the I-LCE. The I-EP is the reference operational support for the management of emergency situations and for the mitigation of the risk in the territory (National Law No. 100 of 12 July 2012). The I-EP is drawn up by an association of municipalities belonging to the same territorial area. It is the unitary tool of coordinated response of the local civil protection system to any type of crisis or emergency situation, making use of the knowledge and resources available on the territory. They must take into account and integrate the EP, all emergency operational plans of bodies, technical structures, public service operators and be completed with detailed technical procedures necessary for activation. It becomes a tool for the management of broad area issues, those topics, such as emergency management, risk prevention and mitigation, which need both an overview, which goes beyond or are only known the administrative boundaries of the single municipality, both of a certain autonomy, a sort of third party, with respect to local pressures and interests.

The I- LCE was conceived as a bivalent tool that allows both to assess the territorial seismic vulnerability, and to be a support element for the design / update of the I-EP. The I-LCE allows, in fact, to identify the critical issues of the plan and to reorganize the same at a spatial level in order to ensure both the safe exodus to emergency areas, and access to first aid equipment (hospitals, ready assistance, collection areas, etc.) and strategic buildings (Fig. 3). Particularly the synthesis of the information deduced by the I-LCE can be used:

to evaluate the conditions of danger and seismic vulnerability of an intermunicipal territory;

- to evaluate the effectiveness of I-EP;
- to plan further investigations and analyzes for strategic buildings and aggregates and/or structural units interfering with accessibility infrastructures;
- to establish possible methods of intervention in urban areas to guarantee accessibility to strategic buildings and / or accumulation areas and guarantee territorial accessibility;
- to ensure a coherent and comprehensive general emergency system between the municipalities of the Intercommunal Operation Center (IOC) of reference;
- to address spatial planning and land use towards safety-related modes.

A system conceived as such can to supported by a dynamic and continuous knowledge of urban contexts and of the phenomena that generate risks, assessed through a few effective indicators of functionality and operation, managed through a digital platform. This platform must be connected to mobile networks designed to maintain service even after disasters. In Abruzzo, through the extension of this research, we are proceeding to the creation of a regional knowledge platform that will be used for the preparation of the Regional Plan of Civil Protection (Article 11, Law No. 77/2009). Spatial planning is a fundamental tool: only by thinking about the evolution of an area as a whole, without fragmentation, one can well govern its development and its security.

3.1 METHODOLOGY

The methodology behind I-LCE derives from the forms prepared by the Technical Commission (Article 5, paragraphs 7 and 8, O.P.C.M. 3907/2010) for the analysis of LCE (CTMS, 2014a), revised and expanded to be able to identify strengths and weaknesses of the EP. The whole model is described in the regional Guidelines

for the analysis and processing of I-LCE drew up by the DICEAA in collaboration with the Abruzzo Region (Regione Abbruzzo, 2017). The I-LCE facilitates integration between the Local EP and I-EP in a logic of multi-scalar risk, is also related to the co-planning that requires an integration of risk planning and disasters with other levels of risk. In general, the I-LCE model provides:

- analysis buildings and areas aimed at strategic management of emergency for a union of municipalities (strategic buildings and emergency areas);
- analysis infrastructures between the municipalities and the territorial context, buildings and areas referred to in point a) and any critical elements;
- analysis structural aggregates and individual structural units located in extra-urban areas that can interfere with infrastructures of territorial connection and emergency areas (art.18, O.P.C.M. 4007/2012);
- analysis strategic choices of I-PE;
- setting up of territorial knowledge frameworks to identify the elements of fragility through a shared platform;
- analysis of the vulnerability of natural, territorial and urban systems through synthetic indicators of performance.

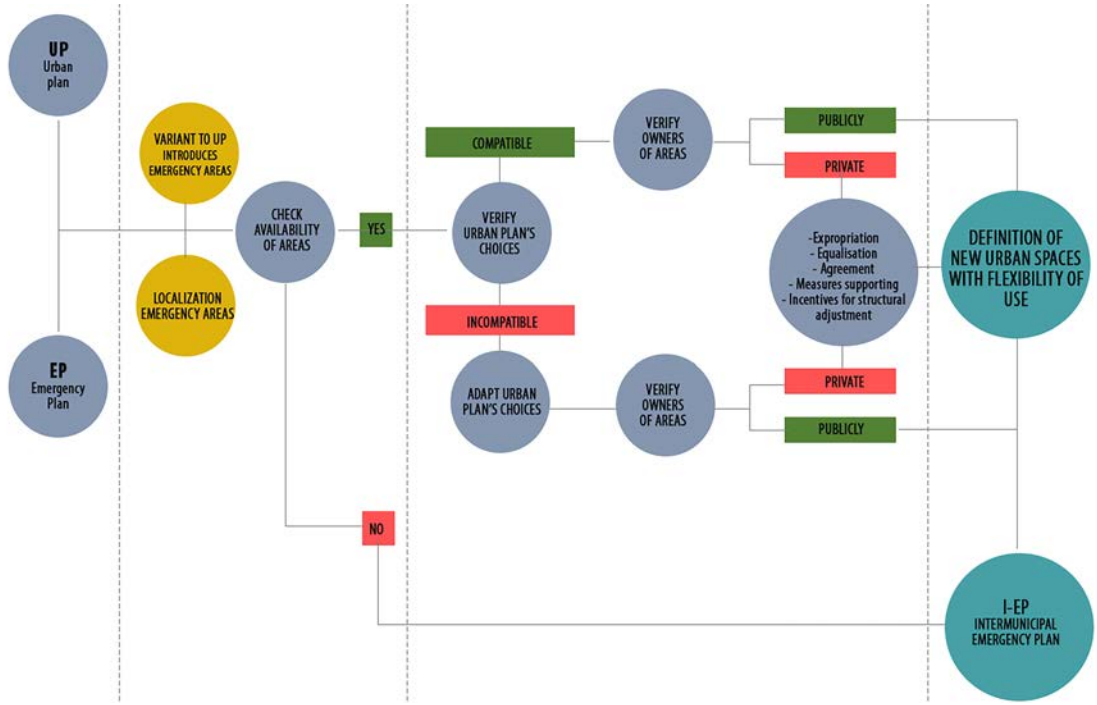

Fig. 3 Relationship between I-LCE, I-EP and urban plan

The final result of analysis makes it possible:

- to express a judgment on the functionality/operation of the I-EP respect to performances required to extra-urban system during the emergency phase, through performance evaluations of the individual elements;
- verify that the choices of the I-EP are compatible with spatial planning and urban planning;
- to identify an accurate image of the territorial risks and therefore of the critical areas through the know of a database to be put into a system with a regional / state platform, such as "Carta dei Luoghi e dei Paessaggi - CLeP" of the Abruzzo Region (Di Lodovico & Di Ludovico, 2014);
- to direct and to improve the strategic choices of the EP and the I-EP deriving from the latter.

- but, in innovative terms compared to the LCE, establish planning guidelines for the modification of spatial planning and land use. In this sense, the research intends the I-LCE also as a design tool and not just an evaluation tool.

To build a decidedly adequate digital platform when it comes to dynamic phenomena, such as risks, which change over time even abruptly, we need to consider many endogenous and exogenous factors. This platform can be addressed to the co-planning, to the verification of the knowledge system, to the dissemination and education of citizens on the Regional Management Risk Plan and the Local Mitigation Planning and finally to the governance of civil protection operations and to the verification of the risk management capacity. An example of a platform, which is being implemented in another line of research, is Hub Risk Data of the Abruzzo Region, elaborated starting from the geographical knowledge bases of the regional Geoportal. By a system whit EP/I-EP, LCE/I-LCE and a Platform of knowledge (of hazards, vulnerabilities and exposures, but even environmental and landscape components) we can:

- build multiple risk scenarios (multi-risk concept), to be used as a basis for territorial prevention and recovery projects in more fragile areas;
- addressing the strategic choices of emergency and ordinary planning;
- evaluate the performance and criticality of the local and regional emergency systems (which must relate to each other);
- work through a co-planning system;
- mitigate and prevent the effects of territorial risks;
- guarantee access to information for all.

These are issues that are only partly dealt with by the emergency planning and the LCE, and which are absolutely necessary to make the critical issues emerging from these instruments effective. Our proposal tries to follow this path towards integration (Di Lodovico & Di Ludovico, 2014).

4 CASE STUDY: THE AREA OF ALTO AND MEDIO SELE

The study area taken into consideration is that of Alto and Medio Sele, in the district of Salerno (Campania, Italy), and we considered in particular the municipalities of Buccino, San Gregorio Magno, Palomonte, Ricigliano and Romagnano al Monte (Fig. 4).

It is a homogeneous territorial area from the geomorphological, cultural and socio-economic point of view, essential prerequisite for implementing integrated planning. The study area is bounded to the north by the Monti Eremita-Marzano, Nature Reserve, and to the south by the mountain range of the Alburni Mountains, washed south by the river Platano – Bianco, tributaries of the river Tanagro, the main left tributary of the river Sele.

Over the centuries, the study area has faced multiple emergency situations:

- it was the epicentre of the earthquake that struck Irpinia in 1980 which caused extensive damage to people and property;
- it was affected by periodic phenomena of hydrogeological instability, including the most recent one dating back to 2011, when the territory to the north was invaded by muddy debris flows, damaging building and agricultural heritage.

Although the municipalities have provided emergency plans, the latter are already inadequate for initial analysis and identified resources. Five cognitive frameworks have been developed for the area: environmental, infrastructural, urban plans, risks.

That allows to identify the intrinsic and extrinsic characteristics of the territory, to analyze its vulnerabilities and exposure as well as to verify the system of management of emergencies in force in the individual municipalities. From this first phase of analysis it has emerged that on the territory of the study area there are

many risk factors (through exposure, vulnerability and hazard analysis), a lack of functionality of the current emergency management system.

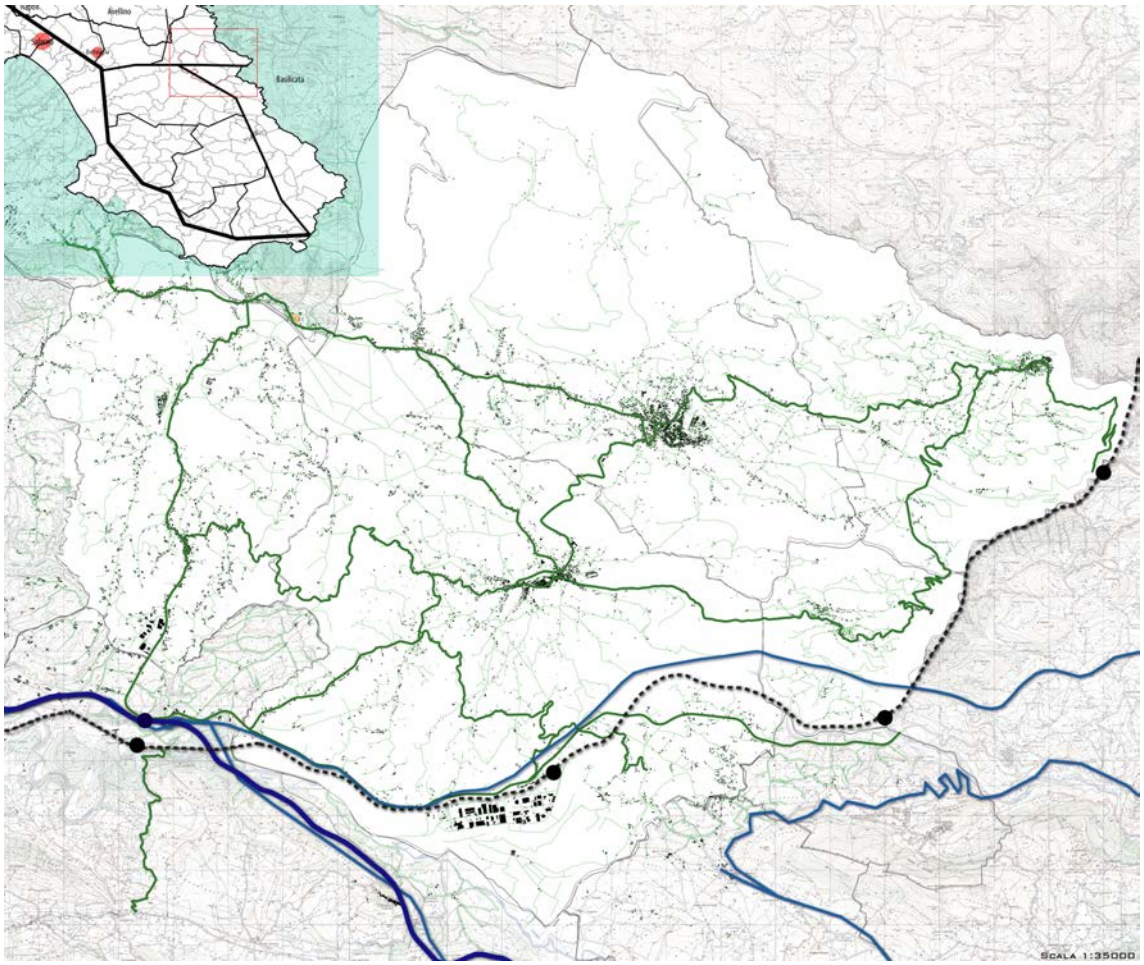

Fig. 4 Case study: the area of Alto and Medio Sele

The construction of the hazard map was very useful, the identification of all areas with different levels of hazard determined by natural and environmental factors. Particularly it was found that in the study area there are a total of 19,184 people, of which 3% are under 5 years of age and 11% are over 75 years old, about 2,795 residents move daily outside the municipalities for work and study. The inflows of people entering are 1,333 units. The territory is characterized by a medium-high seismic risk.

In addition, about 80% fall into areas at risk of landslides, while the hydraulic risk affects only the part south bounded by river effluents. The emergency management system limited to the municipal area (EP analysis) is undersized: all five municipalities have insufficient space and resources.

In particular, all the Emergency Areas identified by the Civil Protection Plans of the individual municipalities, in addition to not covering the needs required for the number of resident populations, fall into areas subject to danger, for which no mitigation action is planned (Tab. 1). It is evident that in the selection of emergency areas the criteria outlined by the Civil Protection guidelines have not been respected (Tab. 2).

Municipality	Max Users [US1]	Min Users [US2]	EP Waiting Areas [sqm]	Max Area [Standard, 2.5 sqm/US1]	Min area [Standard, 2,5 sqm/US2]	Max Deficit [sqm]	Min Deficit [sqm]
Buccino	7,224	5,474	8,691.39	18,060.00	13,685.00	-9,368.61	-4,993.61
San Gregorio Magno	5,892	4,939	10,001.00	14,730.00	12,347.50	-4,729.00	-2,346.50
Palomonte	5,450	4,339	4,273.00	13,625.00	10,847.50	-9,352.00	-6,574.50

Ricigliano	1,479	1,260	2,430.00	3,697.50	3,150.00	-1,267.50	-720.00
Romagnano al Monte	472	377	1,769.00	1,180.00	942.50	589.00	826.50
TOTAL	20,517	16,389	27,164.39	51,292.50	40,972.50	-24,128.11	-13,808.11

Tab. 1 Analysis table of the critical issues of Waiting Areas of Emergency Plan

Municipality	Max Users [US1]	Min Users [US2]	EP Meeting and Shelter Areas [sq.m]	Max Area [Standard, 17.50 sq.m/US1]	Min Area [Standard, 17.50 sq.m/US2]	Max Deficit [sq.m]	Min Deficit [sq.m]
Buccino	7,224	5,474	7,665.00	126,420.00	95,795.00	-118,755.00	-88,130.00
San Gregorio Magno	5,892	4,939	30,791.25	103,110.00	86,432.50	-72,318.75	-55,641.25
Palomonte	5,450	4,339	6,546.00	95,375.00	75,932.50	-88,829.00	-69,386.50
Ricigliano	1,479	1,260	6,135.00	25,882.00	22,050.00	-19,747.50	-15,915.00
Romagnano al Monte	472	377	1,686.00	8,260.00	6,597.50	-6,574.00	-4,911.50
TOTAL	20,517	16,389	52,823.25	359,047.00	286,807.50	-306,224.25	233,984.25

Tab. 2 Analysis table of the critical issues of Meeting and Shelter areas of Emergency Plan

Furthermore, in some urban areas, no emergency areas have been identified at all. There are many factors of exposure, vulnerability and risk and poor functionality of the current emergency management system, the results of the analysis suggest the need, for the municipalities under study, to have an I-EP based on the coordination of actions and procedures, on the sharing of spaces and resources.

Municipality	Max Users [US1]	Min Users [US2]	EP - Waiting Areas [sqm]
Buccino	7,224	5,474	101,366.00
San Gregorio Magno	5,892	4,939	120,020.00
Palomonte	5,450	4,339	83,468.00
Ricigliano	1,479	1,260	32,186.00
Romagnano al Monte	472	377	22,295.00
TOTAL	20,517	16,389	359,335.00

Tab.3 Project recovery areas for I-EP of Intermunicipal Emergency Plan

The aim of the project will be to define a new planning, territorial and emergency methodology that integrates safety with the theme of urban development (Tab. 3). These results were used to prepare I-EP of the area: a plan that allows coordination of actions and procedures to be implemented in an emergency phase that also includes sharing of spaces and resources. First of all, accessibility of the area was studied, identifying the main infrastructures for accessibility to the territory, determining in the GIS environment the travel time from the railway stations and the toll booths.

It is more than two hundred I-LCE tabs to were compiled to analyze:

- I - SB: Inter-municipal Strategic Buildings, essential for the emergency management (such IOC, hospitals, operational centers, etc) on a territorial scale, one of these buildings may become the headquarters of the DICOMAC[1];
- I- AE: Intercommunal Emergency Areas, such a meeting and shelter areas, as well as deposit areas where national Civil Protection can settle (National Mobile Column of Civil Protection);

[1] DICOMAC is a National Coordination Center of Civil Protection Operational Components and Structures activated in the territory affected by the event, if deemed necessary, by the Department of Civil Protection in case of national emergency.

- RAC: Routes for Access or Connection to strategic elements (I-ES, local Strategic buildings, Intercommunal and local Emergency Areas), analyzing primarily the functionality of the route, potential instability, structural aggregates potentially interfering with the route in case of structural collapse.
- I-AS: Intermunicipal structural aggregates, along paths whose collapse can interrupt their functionality or interfere with Emergency Areas (including SE);
- I-SU: Intermunicipal Structural Units.

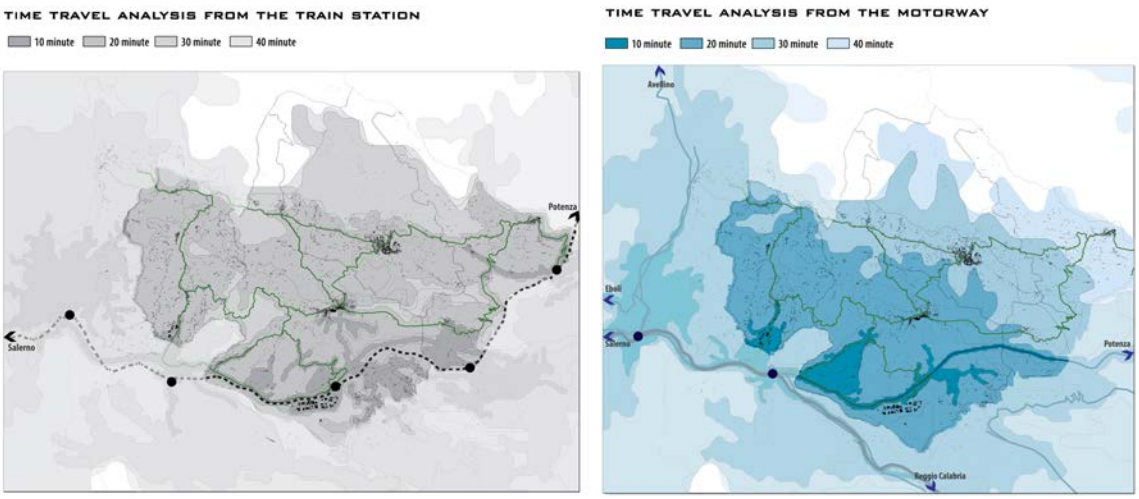

Fig. 5 Analysis of territorial accessibility from strategic transport elements

Information about these elements has been collected in a database and represented on digital cartography (in shapefile format) to understand the critical issues of the emergency system. Moreover, a verification was made about accessibility considering that in 40 minutes it is possible to reach all the areas of interest of the territory, starting from the main accessibility points (Fig. 5). The I-EP proposed for the union of municipalities consists of:

- a collection area for rescuers and inter-municipal resources located near the motorway exit in the territory of Buccino, with a size of 18,160 square meters;
- a storage area for rescuers and resources for each municipality;
- 51 areas of total population hospitalization distributed over the territory and sized according to the number of inhabitants and maximum users present in the area, considering the standard of dimensioning 17.5 sq.m/user.

The buildings that are part of the emergency management system have also been identified, in accordance with the DGR 438/2005 of the Abruzzo Region. Buildings are divided into:

- strategic, whose functionality during an event assumes fundamental importance for the purposes of civil protection;
- relevant, buildings that can become relevant in relation to the consequences of a possible collapse.

Among the strategic buildings, were located: in the municipality of Buccino, IOC, quickly reachable from the motorway exit; in each municipality a MOC (Mixed Operational Center) and a MOC (Municipal Operational Center).

Then it was possible to identify the strategic infrastructures, divided into:

- accessibility infrastructures which interconnect the emergency management system with the external territory sized in such a way as to allow rescue vehicles use;
- connection infrastructures connect strategic buildings and emergency areas.

Once the emergency management system has been defined, the same has been verified in terms of functionality and compliance of the areas and buildings with the criteria defined by the Civil Protection guidelines. For this purpose, the Inter-communal Emergency Plan was superimposed with maps of hazard and municipal urban plans, structuring a verification abacus. For each area and each strategic project building of interest, the location, characteristics, dimensions and level of dangerousness were indicated, and the travel times from each area and strategic building were calculated in the GIS environment. The emergency management system, emergency areas, strategic buildings, strategic infrastructures, were verified through field inspections that allowed the compilation of related experimental analysis forms defined in the I-LCE field. The sheets, duly completed, were computerized, so as to outline a first qualitative level of knowledge of the emergency management system. That permits to evaluate the functionality and operation of the plan regarding services required in the emergency phase, to define characteristics of individual areas, relationships between them and with the territory.

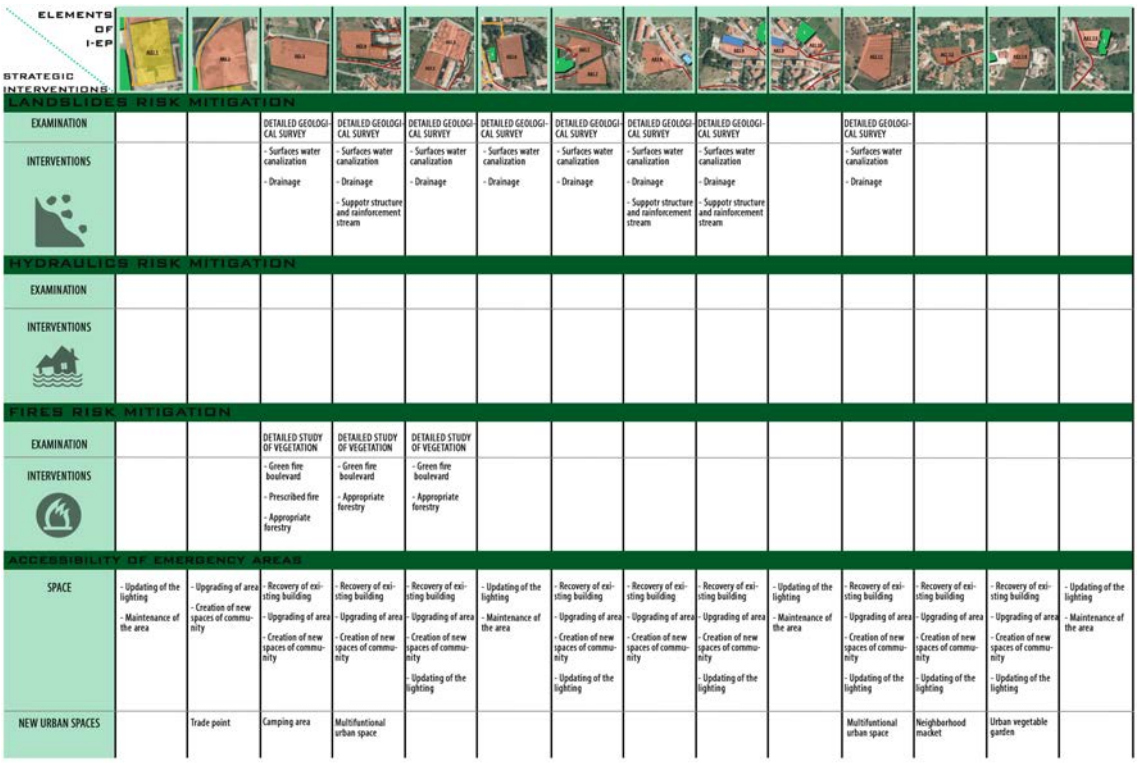

Fig. 6 Matrix of interventions for the elements of the I-EP

The building stock was then analyzed, determining any interference with the strategic areas and infrastructures. For each interfering structural aggregate, the degree of vulnerability was defined considering the year of construction, the main structural typology, the maximum number of floors and the state of conservation. To create a system for the design actions on emergency spaces, strategic buildings and connecting elements, it was drawn up a matrix of interventions for the elements of the I-EP (Fig. 6).

The matrix establishes interventions for each emergency area, strategic building and strategic infrastructure to be implemented to make the I-EP operational and functional, to respond to the territorial development objective, to generate processes of re-functionalization that will allow revitalization and recovery of the territory. In fact, "families of interventions" have been identified for: risk mitigation, hydraulics, landslides and fires, expansion and territorial development, through the definition of new urban spaces with flexibility of use that respond to the need to make up for the shortage of territorial services and the lack of areas necessary for the management of emergency phases. For each element of the I-EP in the matrix, interventions aimed at guaranteeing accessibility and making available the necessary spaces have been indicated, including: updating

of the lighting, recovery of existing buildings, maintenance and upgrading of the area, creation of new spaces of community.

To ensure coordination between urban planning and EP were identified a multifunctional areas destined in ordinary time to community spaces, and in emergency phase to a I-AE. In the case study, the new multifunctional areas are of the "F" type of the Urban Plan (Fig. 7). In these areas the use in ordinary time must be such as not to reduce or compromise characteristics of the area: they must be designed as territorial equipment, territorial centralities with a socio-economic and cultural value. For these reasons, they represent the places of resilience and experimentation to regenerate and reconvert with new functions and activities. At micro level, open spaces, if properly upgraded or in a suitable state of conservation, provide a range of benefits (Esopi, 2018).

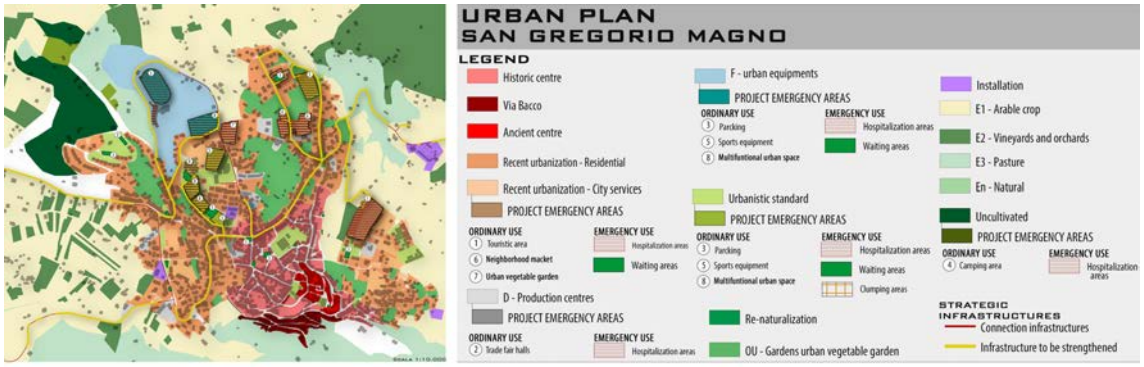

Fig. 7 Example coordination between urban planning and emergency planning

5 CONCLUSION

In the aftermath of a severe earthquake, one early priority in civil protection terms, is to guarantee the management of the emergency phase, which might be seriously inhibited when physical components of the contingency plan (critical buildings, emergency areas and lifelines) are either damaged or unusable (Dolce et al., 2017a, 2017b). The aim of the study is to define a new planning, territorial and emergency methodology, which integrates safety with the theme of urban development. The Plan will re-define or define a model of evolution and development, which is going to shift vulnerability and fragility of these territories to resilience (Rizzi et al., 2017). From this first experimentation we can point out that the analysis model of I-LCE thus identified allowed us:

- to have an overall picture of the emergency management system functioning when it results from urban settlements of associated municipalities and synergies between the choices and resources of individual municipalities;
- to integrate interventions on the territory for the mitigation of seismic risk;
- to verify the emergency management system, together with strategic buildings, emergency areas, connection and accessibility infrastructures identified by the I-EP;
- to verify choices for I-PE and EP of the individual municipalities;
- to verify the consistency between the choices of the I-EP and the real needs to respond to the emergency phase;
- to verify the consistency and compatibility between the choices of the I-EP and the strategic ones of the urban and spatial planning;
- to identify the most fragile areas on which to intervene;
- to use the "intervention matrix" prepared in the study for the I-EP elements to mitigate local and territorial risks and support changes in planning, retrofit and improvement of urban planning and spatial planning;
- to guarantee access to data for citizens, technicians and institutions through a shared database platform.

The next step concerns implementation and setting up of the system digital network platform, starting from the regional database, introduced previous paragraphs. This regional platform, it is currently under construction: only the cognitive part has been completed which will shortly be made accessible to everyone on the opengeodata (Regione Abruzzo, 2018). The data contained in the platform will be accessible for administrations, institutions and professionals and it will have a double goal: to create a dynamic knowledge of the territory and help and support decision makers in generate efficient policies and plans which support a sustainable development and increase resilience of the territories (Di Ludovico et al., 2017). A project of a digital platform will be developed (Damalas et al., 2018), addressed to the governance of civil protection operations and to the evaluation of the risk management capacity (EC, 2013), to the sharing of information (the cognitive framework), the Prevention Projects or the modalities of emergency intervention, and the communication and participation of citizens (Crawford et al., 2018; OECD, 2003; Poljanšek et al., 2017).
The I-LCE wants to be an integral part of this platform at the base of a planning model that is able to put into a system the urban planning issues, from the big scale to the local one, and the risk mitigation themes. It is a model that allows to define intervention strategies that, through the use of the most modern techniques and technologies, permit to identify and plan territorial interventions (regeneration, safety, etc.) according to shared priorities, certain times and costs (Di Lodovico & Di Ludovico, 2017). Therefore, a planning model based on the principles of caution, responsibility and prevention, in which the strategies for mitigating risks from earthquakes and floods must be understood as the responsibility of everyone. However, an effort to push forward decision making and to enhance cooperation with different members of community is necessary to restore affected territory and recreate the opportunity for future evolution of built-up area and evacuation sites (Mashiko et al., 2017). The encouraging results obtained from the first applications of I-LCE suggest continuing the experimentation on further settlements with different characteristics (size, complexity, problems), in order to test the sensitivity of the evaluation model on which we are still working, and which must be still perfected through the introduction of synthetic indexes. In addition to testing the model, we want to define more precise intervention matrices, with many types of risk mitigation measures. Furthermore, the use of platform allows us to create, what David Weinberger calls "The Smart Room": a system of knowledge that relates to the Internet of things, with an increasingly connected world. It is necessary to create a shared knowledge room that is filtered on several levels to improve decision-making, to allow the dissemination of knowledge to citizens and above all to be used to cooperate and share information and projects on several levels and to several stakeholders. This system wants to integrate models of territorial prevention with models of development of spatial and land-use plans to create a network of resilient territories.

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IMAGE SOURCES

Fig. 1: Civil Protection Department; Fig. 2: Author; Fig. 3: Roberto Fiaschi, Marco Natali, Francesca Tommasoni, Francesco Alberti, Figg. 4, 5, 6, 7: Nadia Robertazzi

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