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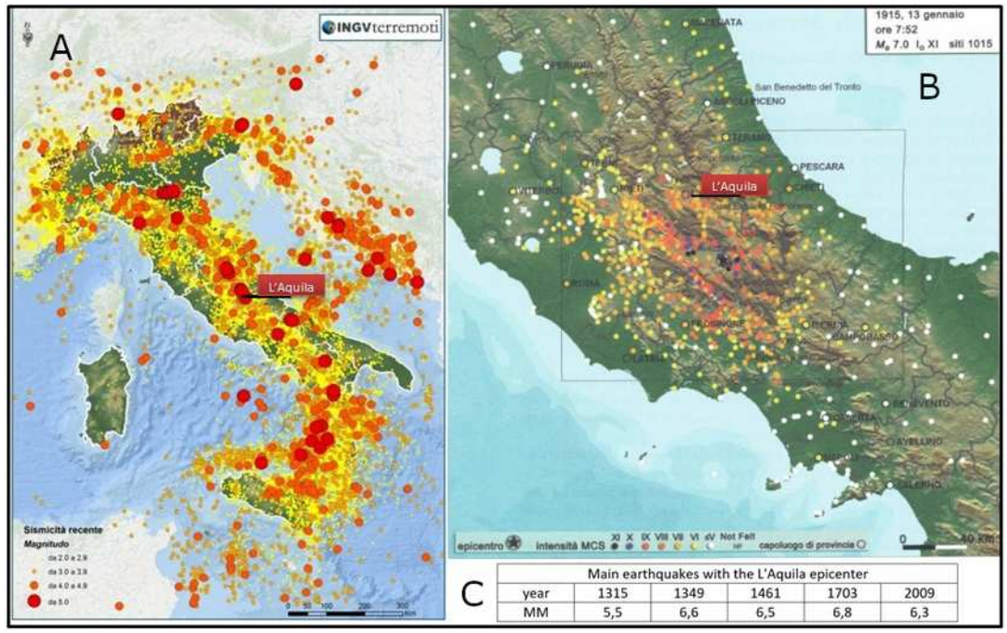
EVOLUTION OF A SEISMIC MEDIEVAL CITY. THE CASE OF L'AQUILA

Abstract
The history of the city of L'Aquila is charactised by frequent urban planning and building cycles caused by earthquakes. This research aims at exploring in depth the existing relations between the cyclic physical and social reconstructions and the urban planning tools that were mainly used. The "percolate" of the answers that society has given to the theme of the post-earthquake reconstruction, can be seen in the stubborn permanence in the chosen place and in the persistence of the urban approaches that have led the way for the physical reconstruction work.

Keywords: L'Aquila, earthquake, construction, medieval plan.

Introduction
Historically there have been destructive earthquakes in the central area of the Apennines [1]. In fact, the seismic activity in such a vast mountain area is one of the strongest in Europe and this makes it hazardous (Fig 1). Every violent earthquake renovates in society the awareness of living in a risky environment and causes an impressive restoring activity that involves on average 70 municipalities [2]. The 1915 earthquake, for instance, launched a series of building activities in many towns of Central Italy that ranged from repairing buildings to the replacement of entire city centres (Fig.1): on the rubbles of medieval Avezzano a new modernist town was re-built with a spatial and functional organization aimed at preventing seismic risk [3]. The possibility of losing one's life and material goods is handled by society through the awareness that the initiatives following a natural disaster are aimed at reducing the risk and at making it acceptable in everyday life [4]-[5]. From the natural event of the earthquake arises a social response that leaves a sediment and it implements itself overtime as it derives from the re-occurring of the same kind of event on average within a few years. In fact, from 1254, year of the foundation of the city of L'Aquila, to the present day 137 earthquakes measuring 5 or more on the magnitude scale (Fig.1), have contributed to the "disaster culture" and promoted the constant updating of buildings. [6]. In other words, the kind and the degree of social disintegration of everyday life, caused by the same destructive agent, produces a "disaster culture" which feeds itself cyclically and contextualise itself, in its expressive forms, in the urban landscape [7]. The mountain area in Abruzzo where the city lies, has repeatedly



Main earthquakes with the L'Aquila epicenter

year	1315	1349	1461	1703	2009
MM	5,5	6,6	6,5	6,8	6,3

Fig. 1 A: Earthquakes from 1985 to 2014 (source INGV); B: Municipalities involved in the 1915 earthquake (source Guidoboni and Valensise, 2011); C: Main earthquakes with the L'Aquila epicenter (source: Fabio Andreassi).

undergone demolition and re-building processes [8]. In fact, living in a historically hazardous territory stratifies a risk awareness that produces physical facts and cultural approaches traceable in the urban history and in the territorial organization [9]. In other words, earthquakes produce building and urban planning cycles whose effects can be observed in the forms of the buildings, of the open spaces and in the shaping of the urban landscape [10].

Strategies, methods and prevention tools
The post-earthquake re-building is characterised by the inhabitants' response to the damages suffered by the city and by the persistent awareness of living in a hazardous city. In fact, the context conditions produce inflexions or improvements in the quality of the response to the earthquake, with effects on the urban landscape that can reduce or increase risks [11]. Having to respond to the damage caused by earthquakes and not by other natural disaster such as floods, draughts or landslides, promotes an increasing "specialization" in the local expertise, as the inhabitants are cyclically required to assess and evaluate the effectiveness of solutions adopted in the previous disaster. In this way there is an implementation of the competences of society concerning risk reduction: local players translate the awareness of living in a risky environment by adopting preventive approaches regarding the management of the city to be repaired or to be newly built. (Fig. 2) Risk is therefore faced bearing in mind the organizational aspects of re-building, the knowledge acquired through experience and the themes of transcendence (Fig. 2).
The organization of the re-building - or in the case of L'Aquila, its Angevin foundation - is entrusted to the central government, through a designated delegate, who defines the initial settlement strategies as far as financial, fiscal and permit-granting aspects are concerned; whereas the definition of the spatial and functional urban design, as well as the priorities and actions is entrusted mainly to the local players [12] amongst whom the clergy, the prominent citizens, and nobles emerge for their importance and authority [13]. The disaster can also be governed centrally in case it is necessary to relocate an urban area that has been destroyed [14].
Another aspect driving the urban development of a seismic city in the Middle Ages is the implementation of the knowledge gained through experience. The ability of the public city to withstand a disaster is tested through various aspects: the dimensional test on built-in

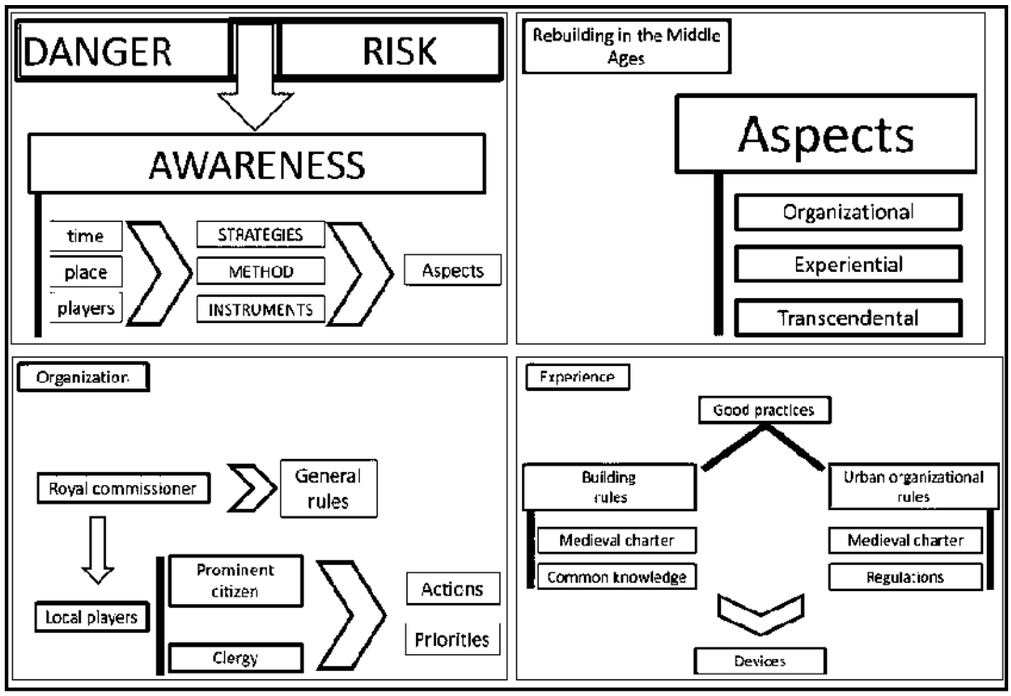


Fig. 2. Steps for the re-building of a city at risk (source: Fabio Andreassi).

and open spaces, the satisfactory provision of gathering open areas, the provision and correct localization of strategic buildings and public open areas dedicated to the sorting of goods; the smooth movement of people and means of transport within the destroyed city and, finally the possibility of food provisioning during the emergency. One can confirm localization choices based on response to the earthquake, from which arises the re-construction *in situ*, or one can delocalize single buildings or the entire city. The settlement choices are therefore dictated by verifying the damages produced by the earthquake in the buildings, as well as the emergency response of the urban organization. The construction and structural themes are dealt with an experiential approach, from which a refinement in techniques, materials and construction details derives. In this way a set of good practices takes form which were regulated in the medieval city charters and dealt with the production aspects of building, architectural and urban planning materials [15].

Sin and God punishment, secondary themes in this article, have a relevant importance in medieval society: one needs to wait for the tens of thousands of victims of the 1775 Lisbon earthquake to start replacing Alexander Pope's "all is good" with Rousseau's enlightenment approach [16].

In general, in the local knowledge the experiences of those who survived the frequent eartquakes that have historically hit the city, together with the analysis of the damages to the urban configuration and organization, introduce innovative themes concerning the definition of preventive and adapting strategies necessary to repair a city centre or the building of a new town. The physical redundancy of spaces and functions dedicated to the emergency and the phase following the disaster, shape the urban landscape: terrains that have responded insufficiently to the tremors because of the presence of cavities for instance, are excluded from re-building; the water system is amplified to allow the satisfaction of vital needs in case of partial interruption of water supply; open public spaces are where the surviving population can gather distributing it capillary in the city centre, to increase the probability of use in case of emergency if some become unavailable; the number and size of strategic buildings is increased so that one can manage emergency procedures from them. Therefore, redundancy allows to tolerate the lost or the failure of parts of the city: the replication of spaces and functions of public settlement solutions increases the resilience of the urban organization to the possible failures caused by earthquakes. In this way the urban landscape starts to take shape in a decisive way [17], [18].

L'Aquila. The evolution of a city at risk

In the second half of the 13th century general historical conditions and the context promote the epiphany of the city of L'Aquila under construction by the victorious Angevine king, Charles I [19]. The building initiative, informally started in the first years of the 13th century with the contribution of the papal power, was abruptly interrupted in 1259 by the Swabian destruction ordered by Manfredi [20]. The subsequent Angevine foundation follows a renewed synechism, involving the inhabitants coming from the pre-existent villages in line with the best and contemporary Northern experiences [21] even if the city, being at the border of the Kingdom of Naples, does not represent the reality of the South, which in turn was more linked to internal conflicts in the city centres between wealthy citizens and urban farmers [19]. In this brief local summary of *rinnovatio urbis* [22], contextualised in the medieval European urban boom [23], the inhabitants involved in new construction of the city can adopt organizational, morphological, functional urban solutions which tackles the subject of seismicity in a preventive way, renewing local knowledge thanks to the introduction of the Angevine expertise who introduced the French concept of the *bastide* [20]. Furthermore, the medieval urban planning culture requires a complex response to the subject of seismic risk through a series of anti-seismic structural devices and good practices envisaged also in the city charters. The 13th century Angevine initiative anticipates a preventive urban "plan" in order to build a city that will need to respond to thousands of future earthquakes and to undergo a continuous process of building repairing or replacing. The seismic organization of the medieval city provides urban anti-seismic structural devices to respond to the needs of preventing and managing the emergency and that anticipate, as a matter of fact, a seismic safety "plan" of the city (Fig. 3).

The founding elements of the "Plan" are:

- the regular road network, which overcomes the orographical obstacles in order to achieve the urban safety goals;
- the dimensional hierarchy of the straights which takes into account the presence of the served polarities and direct connection with the city gates;
- between the edge of the built-in area and the wider perimeter of the medieval city walls;
- vast agricultural near urban areas, located close to the city to be easily accessible in case of a seismic emergency, well irrigated thanks to the river Aterno and equipped with water mills to provide flour. In this way one can respond to the emergency supply needs;
- urbanized open public spaces to assembly the population, provided with public buildings for the emergency and re-building management.

This special attention towards urban planning issues persists through time.

- control on the height of the buildings as far as the private part of the city with rules indicating the type of one-family houses (terraced houses with a vegetable back garden and maximum height of two floors);
- the widespread presence in the urban fabric of neighbourhood support point consisting of an open public space to be used as assembly point in case of an earthquake (square), equipped with a fountain and with a multifunctional public building from which one can organize emergency procedures and post-earthquake re-building (church). It is an expensive solution for public finances as it implies an hyperdotation of the public city.

Other good practices aim at increasing the seismic resistance of the buildings (Fig. 4):

- the construction of expansion joints between private buildings with separating spaces (vernacular ruetta) between the Gothic lots: an expensive solution as it imposes the construction of double walls in stones and no occupation of private ground left free;
- wall continuity between blocks to absorbs horizontal seismic waves through linking arches over public streets.

Finally, the shacks building system, the staked truss, rootings and wooden chains are all examples of good prevention practices introduced in building techniques to limit the damages that earthquakes produce on stone walls [26].

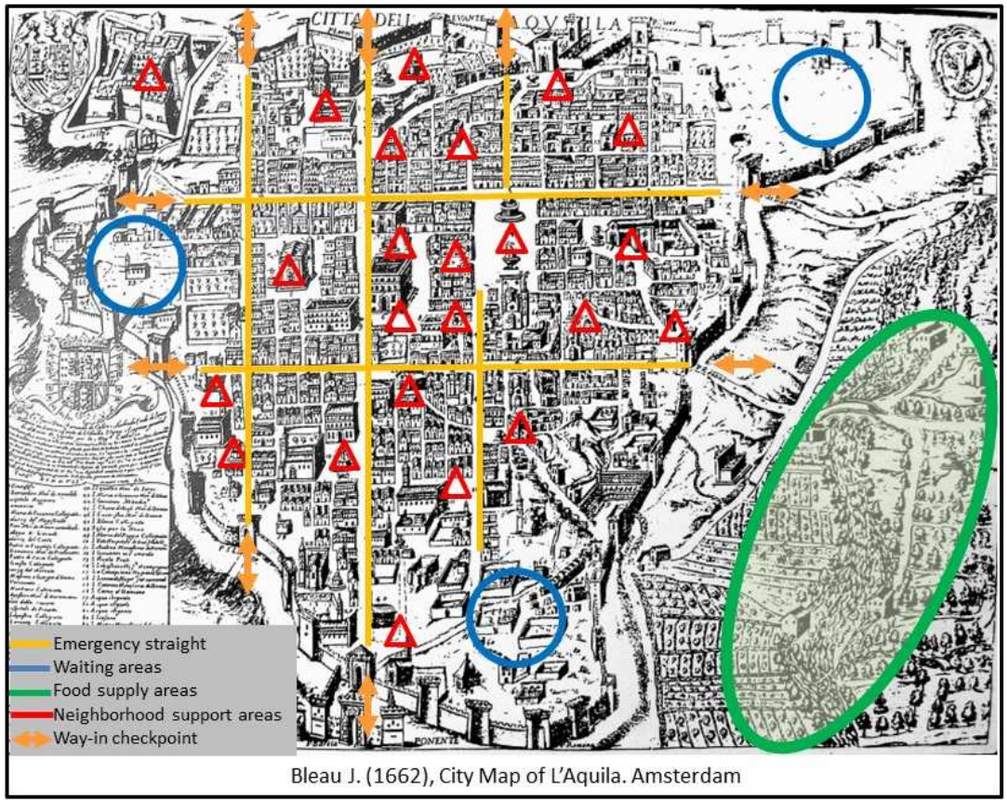


Fig. 3. Elements for a medieval plan of seismic prevention (source Fabio Andreassi).

The Baroque re-building after the 1703 earthquake was addressed with the tax deduction of income from work, which encouraged a process of self-determination of choices on the part of the local élite (clergy, prominent citizens and nobles), from which it derived a renewed spatial organization incorporating the Medieval foundational fragments and the Renaissance reconstructive ones [19]. Funding of the re-building works is borne by the owners: central government and the local council take care of public buildings; that of religious edifices is self-funded by the Church selling or mortgaging wealth and goods, as well as with the help of noble families in exchange for the patronage on private chapels and the possibility of being buried in churches near the altar; re-building of private homes is borne by the owners.

In more recent times, one could mention the vast free waiting area located close to the gate "Porta Napoli" which remained undeveloped until 1915 when it was chosen to develop a new anti-seismic district after the earthquake in Avezzano [24], as well as the widespread presence of squares equipped with public water within the historic fabric of the city [25].

The 2009 earthquake was not followed by urban planning approaches aimed at improving the urban layouts which were in place before the earthquake. Priority was given to the cohesion of the social fabric through the direct involvement of the home-owners in the management of public funding for the re-building of private properties. Furthermore, the fragmented property rights of the residents or of the historical centre blocks, the difficulty to modify the perimeter or the height of the buildings, the concern for the legal consequences that modifications to the pre-earthquake status could have, shifted the attention towards "quieter" themes such as construction sites and technology [11]. On the other hand, the public city pursued productive objectives building about 7,000 temporary homes without consulting the inhabitants [27] and without raising the awareness of living healthily and safely through the reconstruction of the quality bond between inhabitants and places [28].

Cynically, one waits for the benefits deriving from the cathartic removal of the trauma which helps the population living in a hazardous city, but alternating it with heroic memories of the re-building also thanks to a media campaign aimed at glorifying the commander's problem-solving skills [30].

Conclusions

The cyclical nature of earthquakes, the subsequent damage repairing actions, also preventive of future ones, produce a social and settlement vulnerability-resilience which is varied and specific to each emergency. This feature allows to swing between the pre-earthquake assumptions and the post-earthquake verifications and defuses the fatalist approach in favour of a stratified and informed understanding which in turn produces contextualised and variable actions. Therefore, a disaster is not a singularity but a complex process which includes periods of incubation and acceleration in the settlement transformations perceived in the urban landscape.

The price of progress in disaster risk is the continuous vigilance [31]. In fact, the evolution of the spatial and functional organization of the city derived also from the hazard awareness on the part of the inhabitants: the initial medieval foundation adapted the Angevin expertise to the local seismic conditions through the redundancy of the neighbourhood support areas. The subsequent Renaissance and Baroque re-building took place with the experimental verification of previously adopted solutions and with process innovations (building regulations, fiscal policies and self-determination). Finally, the rebuilding after the 2009 earthquake introduced new themes (such as the cohesion of the social fabric), though limiting the innovation of the urban layouts.

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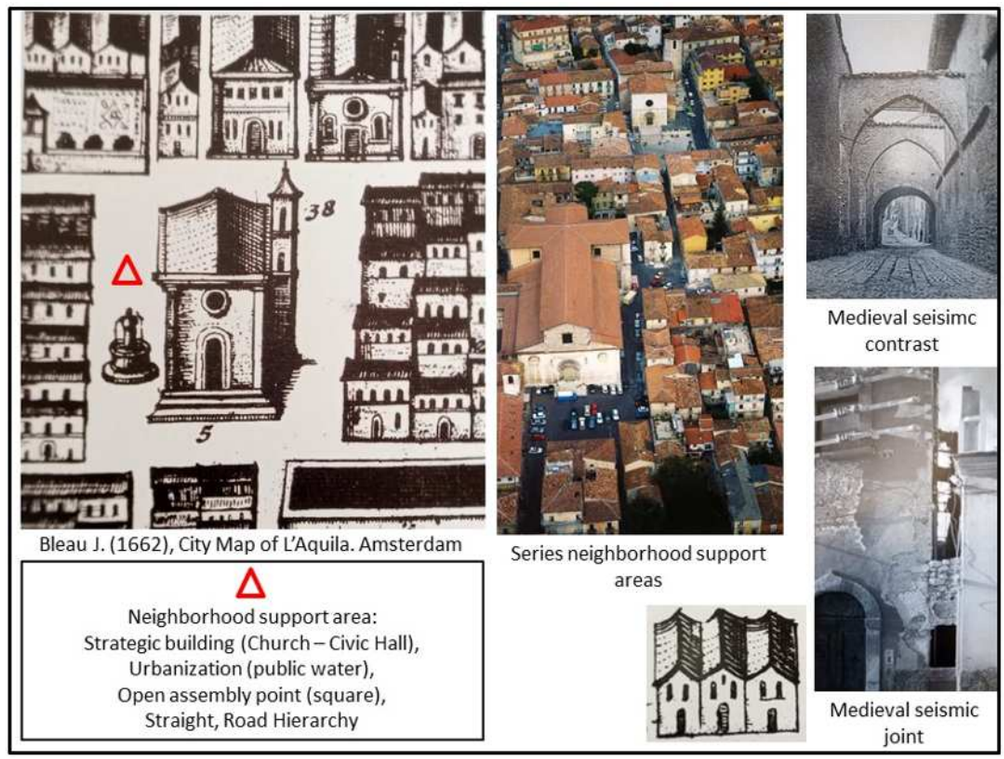

Fig. 4. Medieval urban device in a city a risk (source Fabio Andreassi).

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