



Lack of spatial resilience in a recovery process: Case L'Aquila, Italy



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ABSTRACT

The lack of coordination between government agencies, involvement of the collaboration networks existing in the community, and incorporation of spatial planning in the location of the new settlements around L'Aquila (Italy) after the 2009 earthquake has delayed reconstruction of the city centre. The displaced population was relocated to 19 new settlements. These new settlements are characterized by a lack of urban facilities. The aim of this paper was to analyze the relationship between urban facilities, collaboration networks and lack of spatial resilience in the recovery process in L'Aquila. Specifically, we focused on the preferences of inhabitants to search for alternative housing sites to the settlements they were originally relocated to, as a proxy for dissatisfaction in the new settlements around L'Aquila. Our approach consisted of three steps: 1) fieldwork, 2) survey and 3) correlation/regression analysis. The results demonstrated a strong relationship where preference to search for another housing site decreases with increasing number of urban facilities in the settlement and increases with travel distance to the urban core of L'Aquila. We can conclude that the allocation of facilities was oriented to supply basic services, but neglected other needs of the community during the recovery process, which reduces its resilience.

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1. Introduction

On 6 April 2009 a magnitude 6.3_{M_w} earthquake struck the Italian city of L'Aquila. The epicentre was located 3.4-km to the southwest of the city at a depth of 10-km. L'Aquila is the capital of the province by the same name and a major centre in the Abruzzo region with a population of 72,800. Its location and a map of ground motion intensity during the earthquake are shown in Fig. 1.

The historical city of L'Aquila was badly damaged, with 308 fatalities, 1500 people injured (202 seriously), 67,500 homeless (Alexander, 2010a), and about 100,000 damaged buildings. The cost of the damage to buildings/infrastructure was estimated to be 16 billion Euros (UNIFI, 2010). Reconstruction programs such as, Complessi Antisismici Sostenibili ed Ecocompatibili (C.A.S.E) and Moduli. Abitativi Provvisori (M.A.P), constructed housing units for the homeless population in 19 new settlements distributed in various locations on the outskirts of the city: Sant'Antonio, Sant'Elia, Coppito 2, Sant'Elia2, Gignano, Coppito 3, Bazzano, Sassa, Pagliare di Sassa, Paganica Sud, Cese di Preturo, Paganica 2, Tempera, Roio Poggio, Roio 2, Collebrincioni, Camarda, Assergi 2, and Arischia (Contreras et al., 2013). In the C.A.S.E project 11,776 displaced residents from L'Aquila were resettled, while in the

MAP project 2468 were resettled. 4276 were receiving a special economic contribution for housing, while 478 were paying rent at special rates (Ambrosetti and Petrillo, 2016).

The location of these new settlements is shown in Fig. 2.

The main criteria for new relocation sites normally are: low hazard risk, closeness to infrastructure and land tenure ownership (Davidson et al., 2007). Nevertheless, this expensive housing resettlement solution was located in conservation lands or farmland (Alexander, 2010b). They were located in isolated places far from the core city of L'Aquila with problems such as lack of urban facilities (e.g. churches, schools, pharmacies, post offices, supermarkets, social centres, sport centres), lack of spatial connectivity (Contreras et al., 2013), social fragmentation (Ambrosetti and Petrillo, 2016; Geipel, 1979; Forino, 2014) and functional living, and questionable ecological values (Alexander, 2010b; Özerdem and Rufini, 2013). Some of the resettlements have been abandoned due to these reasons, the reduced size of the apartments and their condition, despite their recent construction in 2009 (Spalinger, 2016). The Italian State is the owner of the land. This artificial resettlement 'sprawl' did not consider either the social or spatial characteristics of L'Aquila, or its centuries-old relations between the historical centre and its surrounding neighbourhoods (Forino, 2014; Özerdem and Rufini, 2013). Additionally, the mismanagement and the slowness of the institutions due to political issues (Arens, 2014; Vale and Campanella, 2005) delayed the allocation of financial resources for the reconstruction, impairing livelihood functioning (UNU-EHS et al., 2013).

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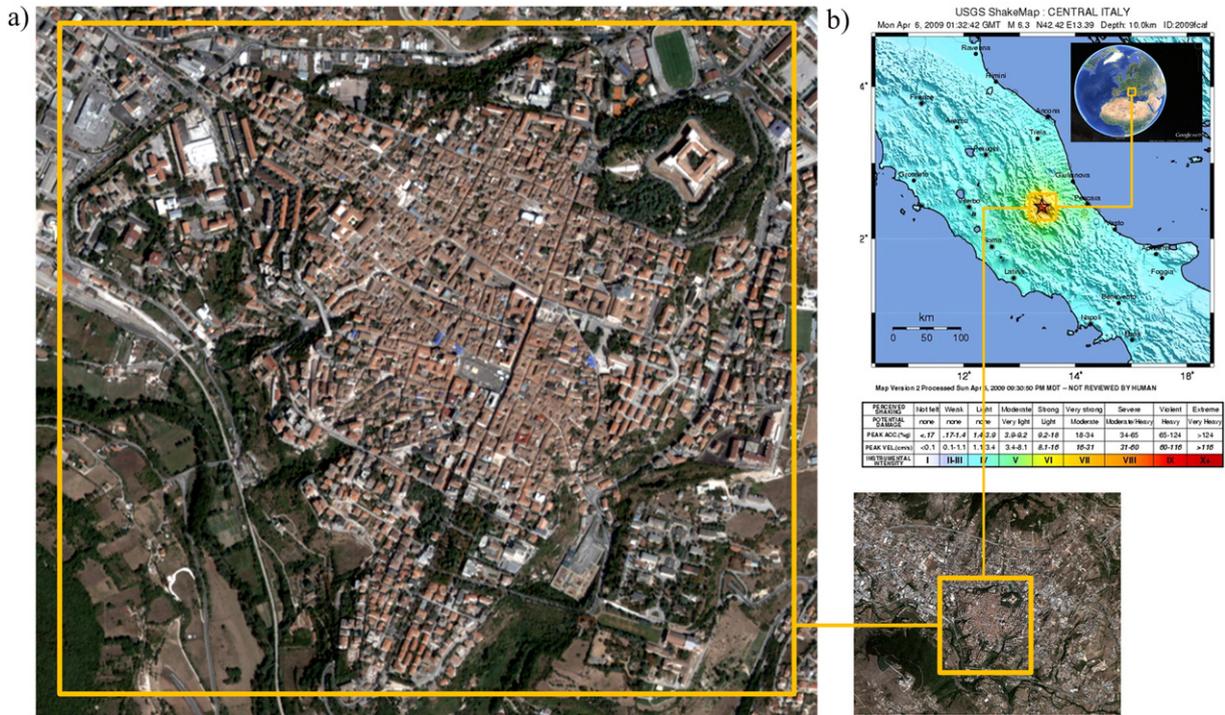


Fig. 1. Case study area: L'Aquila (Italy). (a) Location. Source: Google Earth – QuickBird/DigitalGlobe, distributed by European Space Imaging on 11 September 2011. (b) Map of the ground motion intensity during the earthquake in L'Aquila. Source: USGS.

There is no agreement on the definition of 'recovery' from a disaster due to natural phenomena. In the context of this paper, recovery is defined as: a complex multidimensional long-term process involving planning, financing, decision making and reconstruction aimed at restoring sustainable living conditions to a community or an area, strongly

influenced by vulnerable conditions in the physical, social, economic, institutional, cultural and ecological dimensions that existed prior to the event. Other than reconstructing buildings and infrastructure, the recovery process must also address the interaction among a variety of groups and institutions, with the aim to rebuild people's lives and

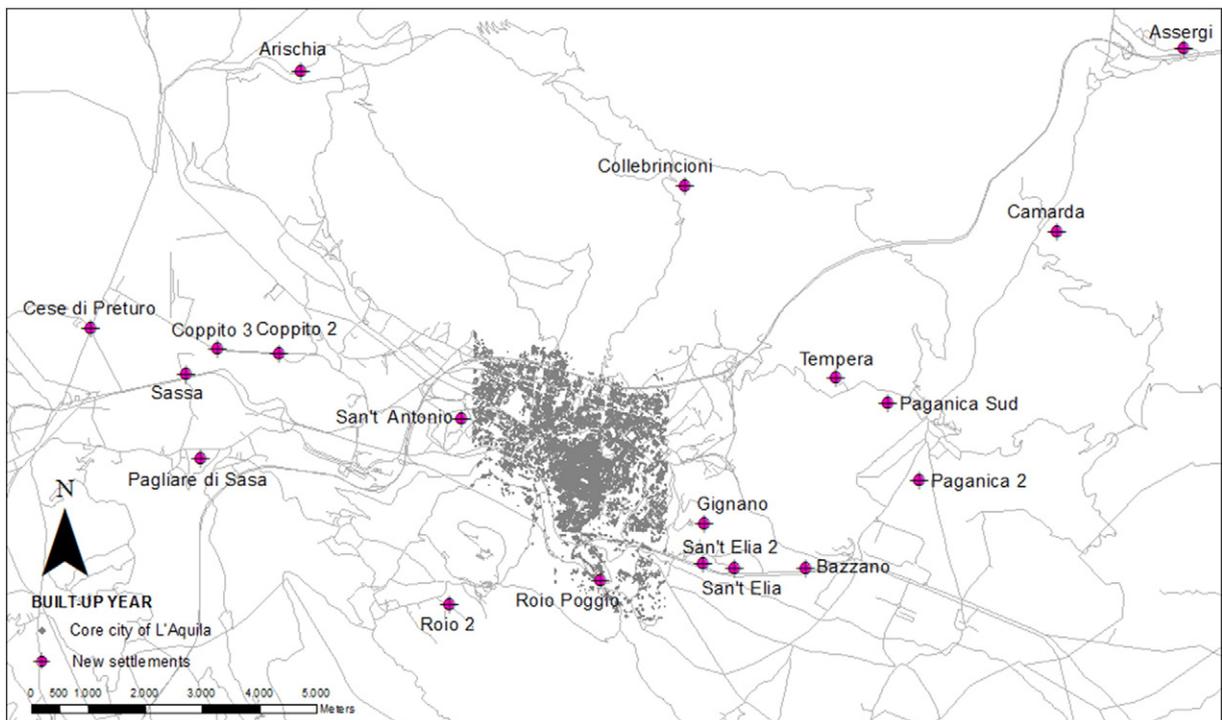


Fig. 2. Location of new settlements, inner city and old town in L'Aquila. Servizio per L'informazione Territoriale e la Telematica – Ufficio Sistema Informativo Geografico – Regione Abruzzo. MICRODIS Project – Commission's Sixth Framework Programme.

livelihoods, restoring cultural assets and ecological conditions (Contreras et al., 2014).

Some communities have problems to meet basic needs such as shelter and employment, while others bounce back quickly (Fletcher, 2010). Each recovery case may vary due to the pre-existing conditions existing before the disaster event, which are the result of the exposure, the susceptibility and fragility, and the lack of resilience of the affected community (Birkmann et al., 2013).

We adopt the concept of resilience formulated in the framework of the MOVE Project, a project with the aim to improve vulnerability assessment methods in Europe. In the MOVE project, resilience was defined as the capacity to anticipate, to cope and to recover from disturbances such as natural phenomena (Birkmann et al., 2013).

The remainder of this paper is organized into six sections. The literature review starts with the concepts of resilience and urban resilience, the consequences of relocation after disasters and collaborative networks. The next section presents the hypotheses. The methodology section describes the fieldwork, the survey of the new settlements and the statistical analysis. The results of the correlation and regression analysis are presented in the next section with the corresponding discussion and conclusion sections at the end.

2. Literature review

2.1. Resilience concept

The term resilience has been used in many disciplines, including psychology, natural and human ecology, engineering and geography; however, there is not an agreed upon definition of resilience. This concept is multifaceted and adaptable to several context and disciplines (Forino, 2014; Adger, 2000). Holling (1973) defined resilience as the time required for an ecosystem to return to equilibrium following a perturbation. Later, Timmerman (1981) elaborated on the concept, and defined it as the “capacity to adapt to absorb and recover from the occurrence of a hazardous event”. Godschalk (2003) associates resilience with redundancy, efficiency, autonomy, and adaptability. Davoudi and Strange (2009) cited by Lu and Stead (2013) define resilience in terms of connectivity, fluidity, contingency, and multiplicity. Vale and Campanella (2005) consider resilience as the capacity of a zone to rebound from destruction, while UNISDR (2009) describes it as the ability of a system to recover in an efficient manner. Zhou et al. (2010) explained the concept as the capacity to face loss after a disaster and to recover from it (Forino, 2014). Pelling cited by Guo (2012) formulated the definition of resilience as “capacity to adjust to threats and mitigate or avoid harm”. Aldrich (2012) defined resilience in the context of the community, as the capacity of the neighbourhoods to address crises through coordinated efforts and cooperative activities to achieve effective and efficient recovery. According to Alexander (2013) the term used in the context of disaster risk reduction means: “The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including the preservation and restoration of its essential basic structures and functions” (UNISDR, 2009).

In the framework of the Resilience Academy 2013–2014, one of the highlighted definitions of resilience was the power or ability to return to the original position, structure or function, after being disturbed, shocked or impacted by stress (UNU-EHS et al., 2013). Recovery in the resilience paradigm is easier when you have the capacity to anticipate and cope with stress (Aldrich, 2012).

Vale and Campanella (2005) posed questions about how urban resilience should be developed during the reconstruction process and “Who should recover which aspect of the city, for whom, in what intention and by what mechanism.” They argue that a resilient city is a constructed phenomenon in all dimensions, not only the bricks. Urban resilience is a framework proposed by leaders, discussed and later approved by citizens. In an urban reconstruction process, there should be more social

and spatial coherence with respect to the urban fabric, systems and livelihoods (Guo, 2012). According to Guo, the goal of post-disaster reconstruction, rather than the restoration of the previous condition of the city, should be to go beyond and improve the urban environment, through the infrastructure, the seismic considerations in the design and construction of houses and an efficient urban design. There is a problematic relationship between rapid reconstruction and urban resilience. To promote urban resilience it is necessary to use the resources provided by the government to design urban projects which fulfil the needs of the community (Guo, 2012).

2.2. Urban resilience

According to Coaffee et al. (2009) resilience is part of urbanism and it is a goal for cities exposed to hazards (Guo, 2012). In the city of Duijiangyan, China, after the Great Sichuan Earthquake or Wenchuan Earthquake, the reconstruction process was taken as an opportunity for territorial development in the economic dimension. Davidson et al. (2007) argue that housing reconstruction projects face the same challenges as low-cost housing in developing countries such as: chaotic scene, resources are in scarce and supply, the project must be completed as soon as possible and it is necessary to take the opportunity to reduce the vulnerability. Nevertheless, the top-down approach (Özdem and Rufini, 2013) of planning usually takes into account neither the complexity of the cultural landscape, nor the needs or potential of the local conditions and users (El-Masri and Kellet, 2001). Therefore this kind of approach produces socio-spatial incoherence: massive urbanization without any continuity to the urban history of the city (Guo, 2012; El-Masri and Kellet, 2001) and therefore the alteration of the social, economic, environmental and the identity of the territory (Özdem and Rufini, 2013). In addition, the absence of stakeholder involvement in the government-led reconstruction efforts produced a problematic urban fragmentation (Guo, 2012). Only the strategies for recovery and reconstruction formulated by affected people will respond to their real needs (Maskrey, 1989). The literature regarding the performance of housing projects, including post-disaster reconstruction projects highlights the role of community participation (Davidson et al., 2007). Three main aspects of post-disaster urban reconstruction were highlighted by Guo (2012): 1) socio-spatial coherence in the urban plans and projects, 2) temporal continuity of the urban interventions, and 3) interdisciplinary multi-stakeholder integration and communication. These post-disaster aspects link to the concept of spatial resilience formulated by Cumming (2011), who defines resilience as “maintenance of key components and relationships and the continuity of these through time” (Ifejika Speranza et al., 2014). To achieve these goals, it is necessary to go beyond repair or reconstruction, to elaborate on urban components, elements, networks, dynamics and capacities. It is essential to deal with scales, tools, approaches and intensity of the intervention regarding planning and design (Guo, 2012).

According to Ganor and Ben-Lavy (2003) the basic ingredients of community resilience, termed as the “Six Cs” are: communication, cooperation, cohesion, coping, credibility and credo. McCreight (2010) defined five characteristics of resilience in the post-disaster phase: Personal and familiar socio-physical wellbeing, organizational and institutional restoration, economic and commercial resumption of services and productivity, restoring infrastructural systems integrity and operational regularity of public safety and government.

2.3. Relocation processes

Relocation represents a change in the ‘place’ where people lived and worked. Oliver-Smith (2009) stated that displacement affects every aspect of life, hence it needs careful planning, in order to build successful communities (Fernando and PUNCHIHEWA, 2013). Relocation projects which are not a participatory process usually have adverse results. The property-owner should have priority in the decisions regarding the

reconstruction of the affected areas (Forino, 2014; Bowden et al., 1978). Manyena (2006) provides guidance on including local communities in the decision-making process during the recovery, in order to respond to the spatial, socio-economic and cultural needs of the affected zone (Forino, 2014). According to Fernando and Punchihewa (2013), due to the lack of planning by the authorities, relocated communities tend to be impoverished. These conclusions were based on the results of the Colombo City Flood Prevention and Human Environment Development Project (FPHEP), implemented by the government of Sri Lanka (GoSL) to relocate shanty dwellers as a strategy to reduce the flood exposure of the population. In the case of Badowita in Colombo (Sri Lanka) which was the largest relocated settlement, besides other problems, the residents complained about the condition of urban facilities such as poor road access, lack of street lights and community centres. According to Fernando (2006), residents complained about the 'Home Owner Driven Approach' of the project, because it did not exist. In fact, some of the displaced people sold their allocated land and left the settlement, in order to improve their socio-economic conditions (Fernando and Punchihewa, 2013). The lack of involvement of the homeless community due to the earthquake and therefore the inadequate selection of the new sites for relocation lead to the rejection of the new settlements. In the case of permanent post-disaster houses (PDHs) built-up with the financial support of the Ministry of Public Works and Settlements after the earthquake in Turkey in 2000, some beneficiaries refused to move into the new settlements due to the distance from the villages and/or lack of proper roads. Research has demonstrated that the participation in housing projects play an important role in empowering community members, therefore they become part in the decision-making process (Davidson et al., 2007).

2.4. Collaboration networks

Networks are understood as structures depending on social relations between members interested in building shared values, trust and mutuality in order to carry out collective actions (Keast and Brown, 2002). A network could be a set of nodes and ties representing a relationship between them (Brass et al., 2004). Provan et al. (2007) define a network as a group of organizations connected to achieve a common goal.

Collaboration is defined by Bodin and Nohrstedt (2016) as exchange of information, common planning, coordination of activities and discussion about common tasks. These authors identified eleven tasks: public information, mass-media contacts, psychological care, intra and inter organizational relations, evacuation, situation awareness, infrastructure, fire extinction, logistic and supply, and public donations. Nine components of collaboration were identified by Mayer and Kenter: communication, consensus, decision-making, diverse stakeholders, goals, leadership, shared resources, shared vision, social capital and trust (Mayer and Kenter, 2015). The aim is to develop "a collaborative advantage in which several organizations together achieve a goal that individual organizations cannot achieve alone (Huxham, 2003). The method used by actors to select collaboration partners after a disaster is not random. The interdependency of the tasks, influence the selection of collaboration partners (Bodin and Nohrstedt, 2016). As soon as the benefits of collaboration are visible for the participants, it "simply happens". The origin of the collaborative difficulties is the uncertainty coming from the changing environment (Brandenburger and Nalebuff, 1997). Baker et al. (Ellen et al., 2011) suggests that knowledge and other important resources are accessed and created through collaborative relationships.

Humanitarian organizations define collaboration networks as the system-wide structure of inter-organizational coordination (Charles et al., 2010; Moore et al., 2003). There are three kinds of categories of collaboration in the context of relief operations: Coordination by command, when there is a central coordination and common territorial areas of responsibility; command by consensus, when there are inter-agency meetings; and command by default, which involves regular

communications between desk officers and civil military operations centers. The last is the more common collaboration during the recovery phase. Collaboration networks regarding humanitarian organizations must include local governments. The selection of the most suitable collaboration mode is always difficult especially in the cases of humanitarian crisis (Charles et al., 2010).

Inter-organizational networks do not guaranty positive outcomes (Ellen et al., 2011). Networks can fail, and formally constructed networks tends to fail more than networks emerging out of prior relationships (Provan et al., 2007). It is expected that increased collaboration leads to an improvement in performance (Ellen et al., 2011). Natural disasters pose challenges beyond the capacities of single actors. There is a consensus that the collective actions are more effective when they are undertaken in the framework of collaborative governance networks supporting development of joint solutions, resource sharing, and coordination avoiding duplication of work (Bodin and Nohrstedt, 2016). Multi-organizational coordination and collective action is required by the governance of a disaster management network. The effectiveness of cross-sector collaborative networks in dealing with disasters was already demonstrated (Vasavada, 2013; Eide et al., 2013; Menya and K'Akumu, 2016).

The main barriers to implement collaboration networks are: lack of mutual understanding due to the diversity of actors, lack of transparency and accountability, insufficient commitment on all levels, lack of clarity on roles and responsibilities, lack of change management and lack of funding for activities that have no direct, visible and dedicated field application. The respective solutions are: choice of the right ecosystem of factors, incentives for shared information on mutual experiences and existing initiatives, involvement of key actors of the value chain, develop clear and jointly agreed roles and responsibilities to encourage commitment of actors (Charles et al., 2010; Boughen and LeTurque, 2008; Faucher, 2009; Van Wassenhove, 2006). Based on other research three mechanisms are essential for effective networked responses for disaster management: high level of confidence among key actors, high coordination with clearly defined authorities and configuration of the right type of organization in the network (Vasavada, 2013; Moynihan, 2007; Moynihan, 2009; Boin and 't Hart, 2010). Vasavada (2013) considers five sectors in disaster management networks: Government, academia, business, international funding agencies and non-profit sector. A large number of organizations are required to come together for recovery efforts after an earthquake (Menya and K'Akumu, 2016; Kapucu and Garayev, 2011). The network size pose a challenge for the coordination of Non-profit Organizations (NPOs), the implementation of policies and projects and the needs or information sharing and resource management according to the level (Vasavada, 2013).

Community is defined as a group of people, who in difficult situation such in the post-disaster phase, are able to independently collaborate and develop strategies for sustainable recovery. Yasui contends that population recovery is an essential part of post-disaster recovery (Yasui, 2007). Moreover community resilience is termed as a bottom-up approach based on collaborative and independent organization, local knowledge, skills and resources, which are focused on improving the social dynamics of the community and secure the sustainability after the disaster (Fois and Forino, 2014)

Forino considers grassroots, defined as non-profit groups that use the association form of organization, as a collaborative network option for the case of L'Aquila (Forino, 2014). According to Coles and Buckle (2004), the engagement of grassroots is unavoidable in affected places, and in fact is an action that encourage spatial ethics, improves recovery and builds social capital (Chandrasekhar, 2012; Jha et al., 2010). During February 2010, hundreds of volunteers worked each Sunday to remove debris from streets of the city centre as a demonstration against the slowness of the reconstruction that delayed their return to the city centre (Özerdem and Rufini, 2013). However, these kind of organizations need external support from national and/or international organizations to manage resources, and often do not influence the decision-making

processes (Forino, 2014). Moreover, engaging grassroots is not a panacea and contradictory effects can reduce the impact of local engagement (Davidson et al., 2007), resulting in individualism, instead of collective initiatives (Fois and Forino, 2014; Chandrasekhar, 2012). The grassroots in L'Aquila are identified as emergent groups (EGs) and they are made up of citizens who work together in order to achieve common goals relevant to disasters, but without any formal organization (Forino, 2014; Saunders and Kreps, 1987; Stallings and Quarantelli, 1985; Kreps, 1984; Kreps and Bosworth, 1993).

Homeless people were relocated in hotels on coastal areas far away from jobs and families, eliminating the opportunity to regain pre-existing collaborative networks. The same practice was implemented after the 1976 earthquake in Friuli and the result was the same: alteration in collaborative networks and modifications of the habits of the community (Forino, 2014). The urban planning of the CASE project in L'Aquila did not include any collective place that constitutes the matrix of the social and relational system, such as local shops, squares or any kind of public space, where people use to socialize and meet (Forino, 2014; Hajek, 2013). As an example of the importance of the urban facilities, Oktari et al. (2015) highlight the important role of schools in the development of knowledge for building resilience in a coastal community in Banda Aceh, Indonesia. These authors brought into the light the collaboration between the school and the community to improve school services and based on their findings they propose the School-community Collaborative Networks (SCCN) model. As small advance, the collaborative networks developed by some EGs in L'Aquila found funding to build up a multifunctional centre (auditorium, library and playground for children) in order to have a social space and avoid the immigration of young people (Forino, 2014). Another example of the success of collaborative networks to pursue resilience was the community of Pescomaggiore, which rejected the housing solutions proposed by the government after the earthquake in L'Aquila and developed a self-built ecovillage (Fois and Forino, 2014).

3. Hypothesis

The resettlement in the disaster recovery process for urban cities is problematic because of high land values and competing uses (e.g. conservation land, farmland, etc.). Contreras et al. (2013) demonstrated a positive correlation between the level of dissatisfaction with the place people relocated and the distance and travel time to the city centre in L'Aquila. In the present paper, we want to demonstrate the lack of spatial resilience in the recovery process in L'Aquila emanating from the lack of involvement of the collaboration networks existing in the community to produce livable settlements. Our research hypothesis is the dissatisfaction of the displaced population in the resettlements is related to the lack of enough supporting urban facilities in the resettlements. Urban facilities are not only sources of services, they constitute sources of information and employment, and the absence of these facilities generates the desire to migrate as expressed in the site surveys (UNIFI, 2011). Services and facilities contribute not only to the functioning and the cohesion of a community, but also to build-up social capital, a significant element in a successful post-disaster recovery (Brown et al., 2010). This absence of urban facilities does not facilitate the development of collaborative networks among the communities located there. According to Chamlee-Wright et al. (Chamlee-Wright and Storr, 2009) community centres, as anchoring organizations provide 'club goods' to communities in the post-disaster phase (Aldrich, 2012).

We also consider the number of inhabitants per settlement, and again distance and travel time as part of our methodology to confirm that if the attachment level to the new settlements is low, it hinders the recovery process and hence the resilience of the city.

As a result of the relocation, inhabitants must commute each day by private car or local buses to the city centre, or to other cities nearby. The consequences of the population displacement may increase

socioeconomic vulnerability due to the lack of basic services and sources of employment.

4. Methodology

This research included three steps: (1) fieldwork, to inventory the urban facilities in the resettlements, (2) surveys of the displaced population, and (3) statistical analysis using correlation/regression analysis to test and examine the relationship between distance, travel time, urban facilities, inhabitants, access to urban facilities, location satisfaction, and lack of resilience. Our measure of "dissatisfaction" is the preference to move to another site obtained from a survey.

4.1. Fieldwork

The case area included the core of L'Aquila and the new settlements for the displaced population. In 2010, one year after the earthquake, five new settlements visited were: Cese di Preturo, Coppito 2, Coppito 3, Sassa y Pagliare di Sassa.

The nine resettlements visited in 2012 were: Sant'Antonio, Sant'Elia, Sant'Elia2, Gignano, Bazzano, Paganica sud, Tempera, Camarda and Assergi2. The final five resettlements were visited in fieldwork conducted in 2014, five years after the earthquake: Paganica 2, Roio Poggio, Roio2, Collebrincioni, and Arischia, located to the north, south and east of L'Aquila. The monitoring schedule, tools and methods is presented in Table 1.

The housing includes solar cells either on the roof or balcony rails, seismic isolation at the base, and the ground floor is always used as a parking space (see Fig. 3a and b). In all new resettlements there are some basic urban facilities (see Fig. 3c and d). With the exception of Sant'Antonio which is close to the core of L'Aquila and had pre-existing facilities before the earthquake, the supporting urban facilities around the new settlements are scarce. In Sassa and Camarda there is one multipurpose centre (see Fig. 3e); and in Sant'Antonio, Gignano and Bazzano there is a basketball court (see Fig. 3f).

Three new settlements – Assergi2, Collebrincioni and Arischia – have almost no urban facilities. Despite being the farthest settlements from the core of L'Aquila, there is only one bus stop, a park and one or two more urban facilities. The frequency of urban facilities available in each new settlement is presented in Fig. 4.

The fieldwork observations were supported by searching in Google Maps for the existing urban facilities around each new settlement, which were within a 10 min walking distance (457,2 m) (Mesev, 2007). This parameter was established by Mesev to determine the level of segregated land use; however, this paper uses an adapted version of this concept to determine segregated building use, as all new settlements there is exclusively contain housing.

4.2. Survey

The MICRODIS project (UNIFI, 2010), was a project carried out by the University of Florence, with the aim to study the epidemiological, social and economic effects of the earthquake in L'Aquila. This project included a survey of the inhabitants of the new settlements. In the course of the MICRODIS project, the new settlements to which homeless people from L'Aquila were relocated were geo-referenced. MICRODIS (UNIFI, 2011) extracted data from a housing demand census, where 153 people from different households were requested to rank their preference of searching for a new settlement. The MICRODIS project compared the number of families located in resettlements that were not in their first choice, and also interviewed people, who considered the site in which they were relocated, as the worst option and were currently looking for a new place to live. Based on the data collected and processed, the index of site preference was derived. The households were relocated in the new settlements, far away from their former houses, because

Table 1

Monitoring schedule of the post-disaster recovery progress in L'Aquila, Italy.
(Source: Adapted from Contreras (2016) (Contreras, 2016).)

Timeline		Remote sensing			Ground observations		Geographic information system Software/Applications
N ^a	Year	Month	Sensor	Analysis	Month	Tools	
1	2010				April	GPS Analogue maps interviews	Arc GIS 9.3–10 Google Earth Google Maps
3	2011	September	Quickbird	OBIA GIS			
5	2012				September	GPS Analogue maps	Arc GIS 10.1 Google Earth Google Maps
7	2014				April	GPS Analogue maps interviews	Arc GIS 10.3 Google Earth Google Maps
10	2016 2023 ^b	April	Quickbird	OBIA GIS	July April	GPS Analogue maps interviews	Arc GIS 10.4 Google Earth Google Maps

^a Number of years after the earthquake.

^b Fieldwork planned.



Fig. 3. New settlements built around L'Aquila (Italy) to accommodate the homeless survivors of the earthquake in 2009. a) Collebrincioni (2014). b) Sant' Elia 2 (2012). c) Roio 2 (2014). d) Arischia (2014). e) Camarda (2012), and f) Gignano (2012). Photos: Diana Contreras.

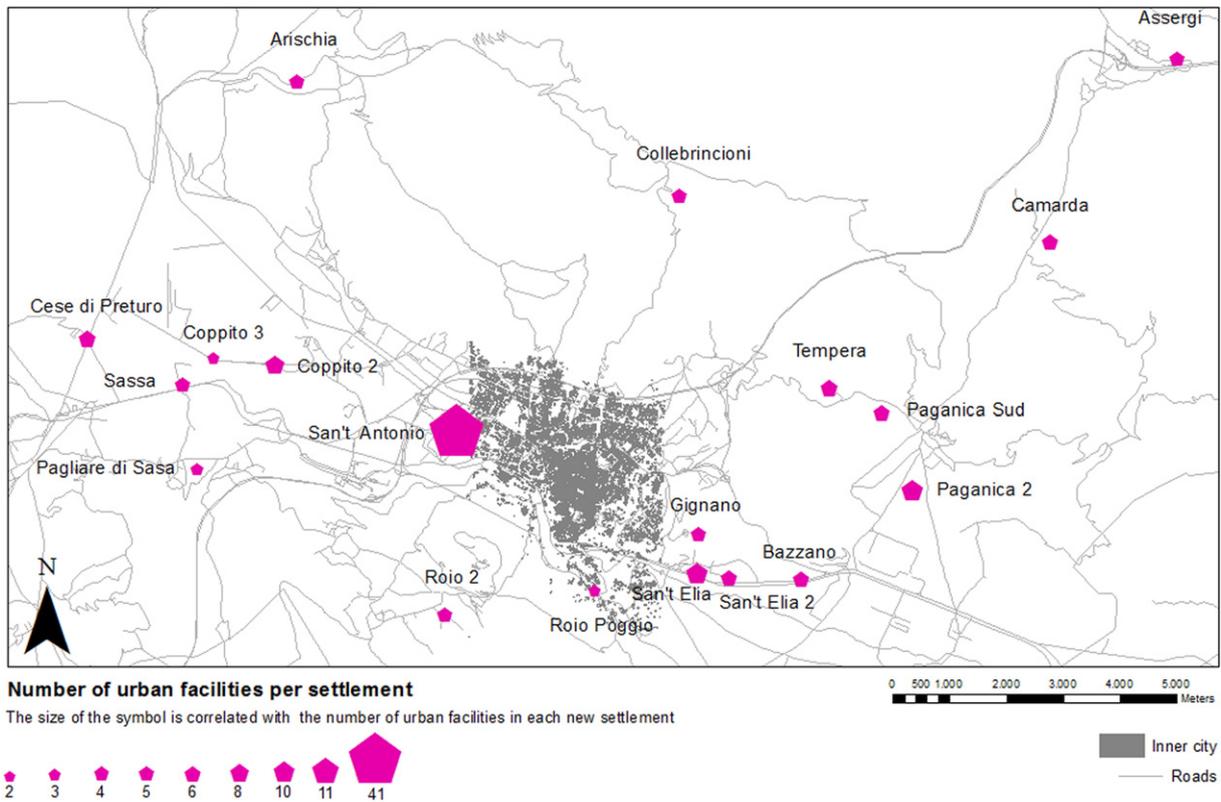


Fig. 4. Number of urban facilities available in the new settlements in L'Aquila (Italy). Source: Authors' own: Based on 'Servizio per L'Informazione Territoriale e la Telematica' Ufficio Sistema Informativo Geografico, Regione Abruzzo, MICRODIS project, Commission's Sixth Framework Programme.

they were originally located inside the restricted zone (Contreras et al., 2013).

In this survey three age groups - elders (people 65 years and above, so called 'transport captives'), adults with children (aged 19 to 64), and teenagers (aged 15 to 18), were asked to evaluate also the importance

of different types of urban facility through allocating weights based on this importance. The results of this survey are utilized here to examine the relationship between, and preferences to search for another site (levels of satisfaction/dissatisfaction), the number of urban facilities at the new settlement, the number of inhabitants per settlement, and the

Table 2
Comparison of the distance and travel time to L'Aquila core (Italy), the number of inhabitants, and the number of urban facilities per settlement with the preference to search for another site (interpreted as the level of dissatisfaction with current settlement). Source: Authors' own.

No.	Settlements	Distance	Travel time	Inhabitants	Urban facilities	Preference to search for another site (Dissatisfaction)
		Km	Minutes	Number	Number	Value
1	Sant'Antonio	3	6	634	41	4
2	Sant'Elia	8	10	403	11	5
3	Coppito 2	8	13	288	8	5
4	Sant'Elia2	9	12	230	5	5
5	Gignano	8	12	230	4	6
6	Coppito3	8	14	1037	2	6
7	Bazzano	9	11	1430	5	6
8	Sassa Zona Nsi	10	15	1037	4	8
9	Pagliare di Sassa	9	14	634	3	8
10	Paganica sud	11	16	230	5	8
11	Cese di Preturo	13	16	1152	6	8
12	Paganica2	12	18	1440	4	8
13	Tempera	11	16	518	6	9
14	Roio Poggio	5	8	346	1	9
15	Roio2	8	13	346	2	9
16	Collebrincioni	11	19	307	3	12
17	Camarda	25	21	451	5	12
18	Assergi2	22	19	230	4	12
19	Arischia	15	18	600	3	13

proximity (distance and travel time) to the city centre of L'Aquila (see Table 2).

In this particular research, we only use responses from the adults with families group, because these people constitute the group in productive age. We use the assumption this group will require more urban facilities for both services and employment than young people or elders. The weights allocated to each category of urban facilities by adults with families are shown in Fig. 5.

These data was compared with the facilities available in the new settlements (see Fig. 6). While commercial, education, health and religious facilities were given high importance by those surveyed the majority of available urban facilities in the new settlements were parks (amenity facilities) and bus stops (transport facilities), followed by a much lower occurrence of restaurants, hotels and stores (commercial facilities), then in decreasing frequency sport facilities, health services, banks, office facilities and other urban facilities.

4.3. Statistical analysis

We express the relationship between variables statistically in two analyses: correlation and regression. We removed one observation - Sant'Antonio - from the analysis, as the urban facilities were available here pre-earthquake and it was clearly a statistical outlier (considerably more urban facilities than all other resettlements) in the statistical analysis.

We used bivariate correlation to test for the strength of the correlation, assuming a linear relationship. The test was one-tailed as we have one directional hypothesis: the less number of urban facilities in a new settlement the greater the preference to move to another place. Finally, we performed a multiple regression analysis to test the relative predictive power of each variable in a set. The correlation coefficient does not give any indication about causality *per se*. However, we interpret the coefficient of determination R^2 as a proxy for the overall explanation of statistical variation (Field, 2005).

5. Results

The correlation between distance and travel time to the city centre of L'Aquila and the preference to move to another place was demonstrated in previous research (Contreras et al., 2013). However, in this research

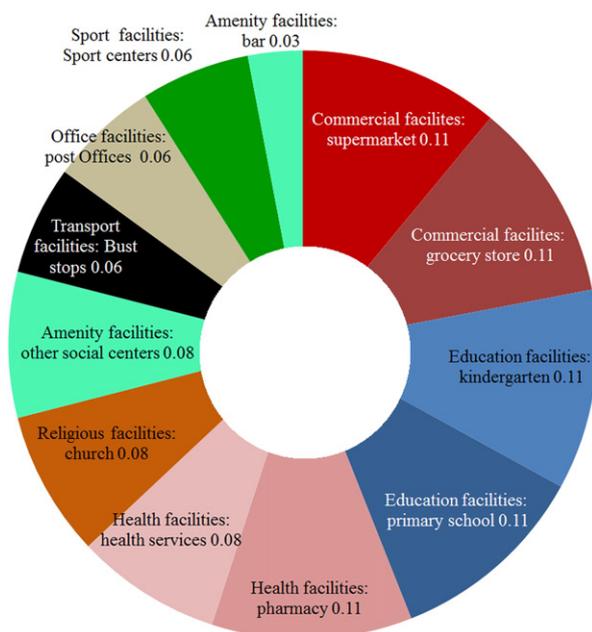


Fig. 5. Relative weights allocated to each category of urban facilities by adults with families (with larger values indicate a greater importance). Adapted from: Contreras et al. (2014).

we explore the hypothesis that dissatisfaction is a function of both proximity (distance and travel time) to the city centre and the number of inhabitants and number of urban facilities in the new settlements.

5.1. Correlation analysis

We demonstrated statistically the correlation between the lack of urban facilities around the new settlements with the preference to search for another site, interpreted as level of dissatisfaction with the relocation and the distance to central L'Aquila (see Table 3). As the number of urban facilities in a settlement increases the preference to search for another site (dissatisfaction with the relocation) decreases ($r = -0.445$). There is a strong positive correlation between the preference to move to another site (level of dissatisfaction), distance ($r = 0.703$) and travel time ($r = 0.716$) to the city center. There is no correlation between the number of urban facilities in a resettlement and distance to the centre in L'Aquila ($r = 0.005$), travel time ($r = -0.116$) or the number of inhabitants ($r = -0.068$) in the resettlement. As distance and travel time to the city centre are highly correlated (i.e. representing the same concept) we only used travel time in the multiple regression as it is more intuitive and with a slightly higher correlation with dissatisfaction (0.716 versus 0.703). It would be expected the number of urban facilities is monotonically related to the number of inhabitants. However, for the L'Aquila settlements, the number of urban facilities is unrelated to the number of inhabitants ($r = -0.068$ and $p = 0.394$; see Table 3).

5.2. Regression analysis

The multiple linear regression model (Table 4) relating dissatisfaction to travel time to the city centre, the number of inhabitants in a settlement, and accessible number of urban facilities was statistically significant with a high correlation coefficient (0.849). The value of R^2 (0.722) demonstrates that travel time, the number of inhabitants, and the number of facilities together account for 72% of the variation in the preference to move to another site (level of dissatisfaction). All three independent variables were statistically significant (i.e. different from 0.0) at the 0.1 probability level. Travel time to the city centre is clearly the most important predictive variable as the significance level was very high (0.000) and the standardized beta weight (0.622) was higher than the number of inhabitants (-0.277) or number of urban facilities (-0.371). The number of accessible urban facilities is the second most important followed by the number of inhabitants. Interpretation of the coefficient sign indicates dissatisfaction increases with increasing travel time and decreases with increasing number of urban facilities and number of inhabitants.

When the number of urban facilities in the new settlement decreases, the preference to search for another living location increases.

6. Discussion

In this research we examined the preference to move to another site (dissatisfaction) jointly with the number of facilities and number of inhabitants in each new settlement and travel time to the city centre. The correlation between the lack of urban facilities in the new settlements and the preference to move to another place, interpreted as dissatisfaction, confirms our hypothesis of lack of spatial resilience, because there is neither recovery, nor resilience in a city where relocated people are not willing to stay due to the lack of employment and services. This fact hinders the recovery and then the resilience of the community. The result of the regression analysis in which travel time to the core L'Aquila, the lack of urban facilities, and number of inhabitants accounts for over 72% of the variation in preference to look for another housing location, also confirm our hypothesis of lack of resilience. These factors generated a preference for residents to search for another site (as a proxy for dissatisfaction), which confirms previous research,

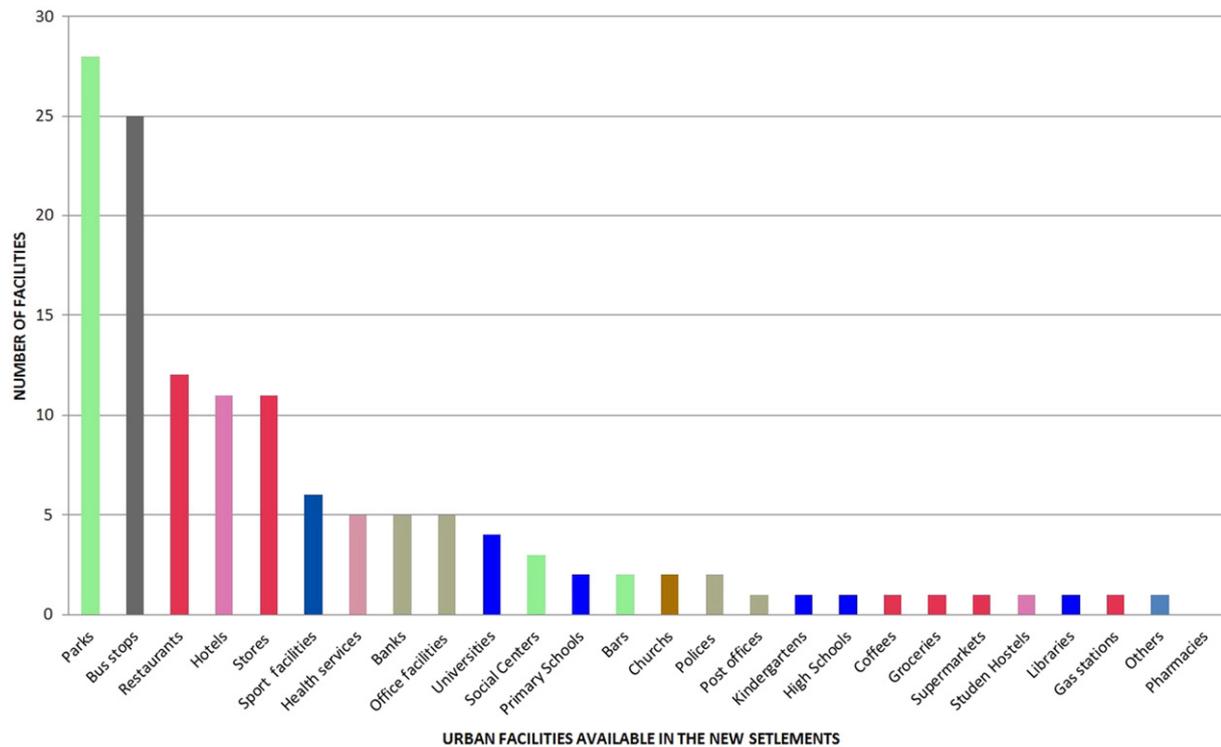


Fig. 6. Urban facilities available in the new settlements built to accommodate the displaced population from the earthquake in 2009. Source: Authors' own.

demonstrating adverse results of the relocation process in which the community is not involved (Fernando and Punchihewa, 2013). This fact supports the statement from Davidson et al. (2007), who claims that the lack of early involvement of the community in the decision-making process produce a high level of dissatisfaction and UNDR0 (1982) which declared that the key to success is the participation of the local community. There was a “100% campaign” launched by the citizens' committees in L'Aquila for demanding 100% participation, reconstruction and transparency. These committees emerged in the camps, community centres, parishes, political movements and the university (Özerdem and Rufini, 2013). This is a kind of collaborative network which should have had more influence in the recovery process avoiding the top-down approach implemented by the government. The method used by actors to select collaboration partners after a disaster is not

random. The interdependency of the tasks, influence the selection of collaboration partners. The actors have freedom not only to select the collaboration partners, but also the tasks on which they want to be engaged (Bodin and Nohrstedt, 2016). The top-down approach did not include enough urban facilities to satisfy the needs of education, health, recreation and meeting of the inhabitants in the new settlements causing the correlation between the preferences to move to another site (dissatisfaction) with the number of facilities and discouraging the emergence of collaborative networks inside the new settlements and/or among them and the core city. The problem is that the typical collaboration network coordinated by command (Charles et al., 2010) of the national government, structured for the relief phase (Contreras, 2016) continued working during the early recovery and the recovery phases, when the coordination by consensus (Charles et al., 2010) among the

Table 3
Pearson's one-tailed bivariate correlation between the number of urban facilities in the new settlements, the preference to search for another site (dissatisfaction), the distance and the travel time to the L'Aquila core (Italy), and the number of inhabitants in each settlement. Source: Authors' own.

		Urban facilities	Preference (Dissatisfaction)	Distance	Time	Inhabitants
Urban facilities	Pearson correlation	1	-0.445*	0.005	-0.116	-0.068
	Sig. (1-tailed)		0.032	0.493	0.324	0.394
	N	18	18	18	18	18
Preference	Pearson correlation	-0.445*	1	0.703**	0.716**	-0.173
	Sig. (1-tailed)	0.032		0.001	0.000	0.246
	N	18	18	18	18	18
Distance	Pearson correlation	0.005	0.703**	1	0.824**	-0.053
	Sig. (1-tailed)	0.493	0.001		0.000	0.417
	N	18	18	18	18	18
Time	Pearson correlation	-0.116	0.716**	0.824**	1	0.064
	Sig. (1-tailed)	0.324	0.000	0.000		0.401
	N	18	18	18	18	18
Inhabitants	Pearson correlation	-0.068	-0.173	-0.053	0.064	1
	Sig. (1-tailed)	0.394	0.246	0.417	0.401	
	N	18	18	18	18	18

The bold figures in the table are the most representative values for the research.

* Correlation is significant at the 0.05 level (1-tailed).

** Correlation is significant at the 0.01 level (1-tailed).

Table 4

Results from regression analysis between preference to search for another site (dissatisfaction), and number of urban facilities in the new settlements, the number of inhabitants, the distance to the core L'Aquila (Italy), and the travel time from the new settlements to the city center of L'Aquila. Source: Authors' own.

Model	Variables entered	Variables removed	Method			
1	Time, Inhabitant, Urban facilities		Enter			
^a Dependent variable: Preference (dissatisfaction)						
^b All requested variables entered						
Model summary ^a						
Model	R	R ²	Adjusted R ²	Std. error of the estimate		
1	0.849	0.722	0.662	1.5023		
^a Predictors: (Constant), Time, Inhabitants, Urban facilities						
ANOVA ^a						
Model		Sum of squares	df	Mean square error	F	Sig.
1	Regression	81.861	3	27.287	12.091	.000 ^b
	Residual	31.595	14	2.257		
	Total	113.456	17			
^a Dependent variable: Preference (Dissatisfaction)						
^b Predictors: (Constant), Time, Inhabitants, Urban facilities						
Coefficients ^a						
Model		Unstandardized coefficients		Standardized coefficient		Sig.
		B	Std. error	Beta	t	
1	(Constant)	3.814	1.908		1.998	0.065
	Urban facilities	−0.411	0.157	−0.371	−2.610	0.021
	InhabitantS	−0.001	0.001	−0.277	−1.962	0.070
	Time	0.496	0.106	0.663	4.663	0.000

^a Dependent variable: Preference (Dissatisfaction).

community and the local authorities should started addressing all the necessary actions for the recovery.

Moreover, the statistical analysis demonstrated that there is no correlation between the number of inhabitants per settlement and the number of urban facilities in each one, which is an unacceptable mistake in urban planning. Therefore, the urban facilities available in the new settlements do not meet the needs of its inhabitants neither in quality nor in quantity.

According to the definition of resilience adopted by us, the new fragmented urban morphology of L'Aquila does not contribute to the spatial resilience of the city. Relocation of people into conservation land or rural farmland (Özdem and Rufini, 2013; Fois and Forino, 2014; Alexander, 2012), results in a high land resource impact (LRI) (Mesev, 2007). It demonstrates the lack of capacity to anticipate the occurrence of an earthquake in a middle hazard seismic zone and to efficiently cope with the needs of land for housing. This poor planning may explain as well the lack of urban facilities in the design of the new settlements, as well as the unreasonable public transport frequencies and route connections to L'Aquila (Castellani, 2014). It demonstrates that collaboration arrangements that fail to meet structures and scales of the institutional and the biophysical environment results in negative outcomes (Bodin and Nohrstedt, 2016).

The slow recovery in the city centre and the lack of urban facilities in the new settlements after eight years demonstrate a limited capacity to recover, which is a component of resilience. These arguments demonstrate a lack of capacity to address the impact of the event in several dimensions and a lack of resilience based on the segregated use of the buildings in the new settlements. This segregation locates people far from their places of employment (livelihood) and away from other key services. This reduces their capacity to cope with and to absorb the impact of the earthquake, both of which are elements of resilience (Birkmann et al., 2013). An example of a coping capacity used in the

new settlements in response to the lack of urban facilities is that residents use cars as 'mobile stores', which sell fish, vegetables and fruits. People may also use tents as market stalls or as multipurpose rooms, for example to host dance courses (see Fig. 7 a, b, c, d, e and f). Importance of specific urban facilities varies by age group. We cannot forget that community resilience cover four interrelated dimensions: economic, social, organizational and technical (Bruneau et al., 2003; Jung and Song, 2015). High levels of resilience encourage mitigation, response, and recovery (Jung and Song, 2015).

7. Conclusions

Resilience should be the main principle in guiding urban reconstruction to reduce emerging vulnerability in urban environments. The lack of spatial resilience in L'Aquila is demonstrated in the lack of ability to return to at least the original situation before the earthquake (UNU-EHS et al., 2013). It is unlikely that L'Aquila can be considered a resilient city, where the reconstruction of the most affected areas of the city is still ongoing and where people express dissatisfaction of the place where they were relocated. Some residents even abandon their new houses (Spalinger, 2016), because of the distance and the travel time to the inner city, the condition and the size of the apartments and the lack of facilities in this place. According to several authors, every livelihood system has the capacity to adjust to shocks, impacts or distortions, absorb them and later return to their functionality. Nevertheless, livelihoods can go beyond tolerance thresholds and stop functioning temporarily or permanently (UNU-EHS et al., 2013). In the case of L'Aquila, the city has been malfunctioning for 8 years. From the characteristics of resilience listed by McCreight (2010) with respect to resilience in the post-disaster phase, only the restoration of infrastructural systems (Esposito et al., 2012) and the regularity in the operation of public safety has been achieved in L'Aquila (Aldrich, 2012; Contreras, 2016). There is awareness among the government in L'Aquila about this situation and they are working to solve these problems.

Authors such as Dacy and Kunreuther (1969) consider that the rapid inflow of capital for reconstruction may benefit a community affected by a disaster (Aldrich, 2012). Unfortunately this was not the case in L'Aquila. In 2006, Zandi et al. (2006) stated that if government support does not arrive quickly after the event "confidence rapidly flags, businesses are not reopened, and residents leave the region" (Aldrich, 2012), this has been the case in L'Aquila in the last 8 years.

As in the case of Sichuan (China), the government in L'Aquila was focused on solving the housing problem quickly, without a holistic approach which considered the urban history (Guo, 2012). The housing solution in L'Aquila was decided 22 days after the earthquake during the relief phase (Contreras, 2016). This decision addressed the problem of quantity, but negatively impacted quality of life and closed the door to any mechanism of community participation (Alexander, 2010a; Özdem and Rufini, 2013; Guo, 2012). The great paradox in L'Aquila lies on the fact that the C.A.S.E. project, conceived as "temporary housing"; eventually resulted in a permanent housing solution characterized with a series of unchangeable facts (Forino, 2014; Özdem and Rufini, 2013; Alexander, 2012).

The urban morphology of L'Aquila after the earthquake with the new 19 settlements around the core city is a typical case demonstrating the dysfunctions and inefficiencies of urban sprawl (Mesev, 2007), in which the socio-spatial coherence (Guo, 2012) is broken and stimulates the use of the private car. While people in productive age would like more supermarkets, childcare facilities, primary schools and pharmacies; the most prevalent urban facilities available in the new settlements are parks and bus stops, followed at a much lower volume by restaurants, hotels and stores. Another approach would be a correlation analysis including the weights allocated by the community to each facility according to their relative importance. It will allow us to not only to measure resilience but also the progress of recovery based on the indicator of building use proposed by Contreras et al. (2014).



Fig. 7. Supplementary urban facilities in the new settlements. a) Sport furniture in Gignano (2012); b) Mobile furniture store in Camarda (2012); c) Mobile grocery store in Camarda (2012); d) Mobile grocery store in Paganica 2 (2014); e) Mobile fish market in Paganica 2 (2014); f) Small scale crops in Roio Poggio (2014). Photos: Diana Contreras.

The top-down approach adopted by the Italian Government closed the door to grassroots involvement, justified in the urgency of provide housing solutions (Forino, 2014). The spatial fragmentation (Forino, 2014) of the city and the lack of common facilities for inhabitants to meet impedes the development of collaborative networks necessary to build-up resilience. It might be possible to create collaborative networks inside each new settlement, but they need at least a facility to gather and according to our observations, there were only two tents that serves as churches in Coppito 2 and 3 (2010) and one multifunctional room in Camarda in 2012. Collaboration is a method to solve complex societal problems (Bodin and Nohrstedt, 2016) and could be a solution for the problems in the new settlements in L'Aquila. This is because any of the tasks in collaboration networks identified by Bodin and Nohrstedt (2016) relevant for the case of L'Aquila such as public information, mass-media contacts, intra and inter-organizational relations were not considered by the actors involved in the recovery of the city.

All the collaborations components listed by Mayer and Kenter (2015) were ignored.

The main barriers to implement a collaboration network in L'Aquila were the lack of mutual understanding (Charles et al., 2010), confidence and coordination (Vasavada, 2013) due to the diversity of actors, because the Mayor of the city for the time of the earthquake belonged to the opposition party of the government. The lack of change management (Charles et al., 2010) or the right organization of the network (Vasavada, 2013), which could had been solved with a participatory approach. Nevertheless, the main barrier was the lack of transparency and accountability (Charles et al., 2010) along the whole recovery process in the city.

We can conclude that the allocation of facilities was oriented to supply basic needs, but neglected other ones, which reduced community resilience. Despite the human loss and damage associated with earthquakes and disasters, these events can provide the opportunity not only to apply best practices in city planning and building construction,

but also to encourage the development of collaborative networks and therefore, community resilience, during the recovery process. This opportunity has been missed in the case of L'Aquila.

However, the supplementary forms of urban facilities developed by the community shows social resilience, defined as the capacity of the community to search for and create options (i.e. proactive capacity) (Ifejika Speranza et al., 2014) in reaction to the lack of adequate urban facilities in resettlement locations.

It is also important to remember that a livelihood is sustainable when it can cope and recover without undermining natural resources (Ifejika Speranza et al., 2014), which unfortunately is not the case in L'Aquila. In the physical dimension, the inclusion of seismic isolation on the basement of the blocks of the new settlements built in the context of the C.A.S.E project can be considered a form of capacity to anticipate, and demonstrates resilience. However, the quality of these devices included in the buildings has been questioned.

Lack of resilience is a problem in countries with low capacity to anticipate, to cope and to recover. The post-disaster phase offers an opportunity to reduce the existing vulnerability and improve the conditions of the community in the physical, social, economic, cultural, institutional and environmental dimension. It means to build a resilient community, through application of lessons learned. Nevertheless, it seems that this opportunity has not been harnessed yet in L'Aquila.

This research is a contribution to the study of the long-term effects of disasters, which according to Gigantesco et al. (2013) contribute to the better understanding of the factors that increase resilience, reduce vulnerability and improve the design of prevention strategies. Unfortunately, there is a gap in empirical research related the influence of complex patterns of task interdependency in collaboration patterns and engagement during disasters, and the effectiveness of collaboration conditions. Multi-level network modelling would be an option to solve the lack of empirical research on this aspect (Bodin and Nohrstedt, 2016).

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