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Urban Planning and Mobility Critical Issues in Post-Earthquake Configuration: L'Aquila City Case Study

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Abstract

This paper reviews the critical issues of the current urban planning, mobility and accessibility in the post-earthquake (2009) settlement configuration of L'Aquila urban area (Italy), the medieval centre of which has a unique architectural and artistic heritage. The purpose of the study is to analyse the L'Aquila urban planning experiences in order to trace the relationship between the mobility and the spatial structure of the city.

The current scenario is considered both as the result of the historical evolution of the settlement and as a dynamic system in which a mix of natural forces, decisional choices and technical expertise have operated. The result of the research is a preliminary proposal for the implementation of the public transportation system that is obtained by integrating a re-designed existing railway line with a sustainable concepts of mobility based on a "dense grid" network.

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Keywords: Urban mobility, urban planning, earthquake disaster, post-earthquake reconstruction, public transport system, urban morphology;

1. The area under study

L'Aquila is a small-sized city with about 70,000 inhabitants located on the Apennine mountains in the central Italy; it was hit in 2009 by an earthquake rated 5.9 on the Richter magnitude scale. L'Aquila with its significant historical heritage is both an important cultural/university pole and the main political center for Abruzzo region.

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The post-earthquake urban planning dynamic has given a centripetal action and new location of all the social and settlements functions in a wide territorial area. A high fragmentation of the facilities localizations and a very low population density have been obtained in a very short time (about two years).

Due to the transport demand fragmentation, the current public transport system, based on the exclusive use of buses, is absolutely inadequate and therefore the use of private vehicles is significantly increased, bringing problems of the environment and transportation costs. As a result, the accessibility and mobility of the residents were strongly worsened. The study area is also covered by an intra-city railway line which serves a very modest percentage of the traffic streams. It can therefore be confirmed that almost the entire mobility of the area is assured by private vehicles. Serious traffic congestion occurs, mostly along the East-West main road n. 17 that is not adequately sized.

The purpose of the study is to analyse the L'Aquila urban planning experience and to trace the relationship between the mobility/accessibility and the spatial form and organization of the city (Geurs K. T., van Wee B. 2004; Preston J., Rajé F. 2007).

This study examines how the public transport system can be planned by integrating a re-designed existing railway line to a sustainable concepts of mobility based on buses network and cable car line. To obtain such results the authors have used the concepts of the "dense network" transport system (D'Ovidio 1996) of inter-connected mobility-hubs (La Rocca 2013a) that has been conceived in order to resolve the mobility problem in the urban areas with the principle aim of satisfying a great part of the requirements with the public transport system.

2. Effects of the 2009 earthquake

L'Aquila is a city founded in the mid-thirteenth century, as a result of a territorial cohesion process between many centers and castles in the Aterno valley, in the inner area of Abruzzo region. For this reason, L'Aquila is defined as a City-territory, a concept that considers the city and its territory as a single system.

When the earthquake hit in 2009, most of the economic system of L'Aquila was already in crisis. Overall, the local system economy in L'Aquila recorded a sudden decline in the period prior to the natural disaster. From 2007 to 2010, the number of employees of companies decreased by 18.3%. In the period from 2001 to 2009, the industrial value added fell by 23% compared to the growth, albeit modest, in the rest of the regional territory. The service dynamics were rather weak and saw a drop in employees' productivity. In 2009, L'Aquila has a population of 69,108 and an urban area of 27.90 km2 distributed along a valley, one of the largest municipal areas of Italy with 473.91 km2, and with an Urban Dispersion Index (the ratio between the number of urban fragments and their total extent) of 10 fragments per km^2.

The pre-earthquake crisis in the L'Aquila City-territory was characterized by a sluggish economy and urban development which over the last 20 years had been subject to post-urban structures (Choay 1992) that were difficult to understand and even more difficult to govern (Di Ludovico, Properzi, Santarelli 2014). This crisis coincided with an ungoverned post-earthquake situation, when polycentrism was strengthened further by the creation, during emergency, of the so-called "New towns", the CASE projects (Anti-seismic, Sustainable and Eco-Compatible Buildings), the MAP (Temporary housing units), the MUSP (provisional modules to scholastic use) and numerous small wooden houses scattered throughout the territory, which established a new City-territory context. Alongside this phenomenon, we find many dispersed settlements, unforeseen sprawl over the agricultural mosaic, rarefaction, high land consumption, fragmentation of the environmental continuity, as well as damage to urban and peri-urban landscapes. After the earthquake, this new urbanization has increased urban soils by 6.7% (29.78 km2), it has increased the Urban Dispersion Index (from 10 to 12 fragments / km2), while in 2015 the population only increased by 1.0% (69,797 inhabitants). Thus, the population density calculated on the urban area decreased from 2,476 inhabitants / km^2 at 2,343 inhabitants per km^2.

3. Towards a new urban form

The construction of new urban areas in the post-earthquake emergency phase (CASE, MAP and MUSP) has aggravated some typical aspects of post-urban cities such as urban fragmentation, inconsistency of fabrics and urban morphologies, but also incomplete infrastructure systems, with large energy consumption, characterized strong

environmental impacts (Di Ludovico 2013). At these critical points must be added a growing social distress due in part to the lack of a social model of development and in part to the aforementioned fragmentation that has effectively separated the social groups in the city. In addition, the city now has a surplus of housing, built in the emergency phase, which could accommodate 25,000 inhabitants, over the existing ones, and it has two large industrial zones, located at the two opposite corners of the linear city, with an important economic crisis.

The impact of the earthquake on L'Aquila urban system has significantly increased the fragmentation of the city. This phenomenon is corresponded to a disintegration of the centrality and identities and the successive, spontaneously, re-composition of new centralities (La Rocca 2013b) organized along the main road n. 17, transforming L'Aquila in a linear city, 15 km long. (Fig 1).

In this new linear city based on a polycentrism logic, the infrastructure system refers not only to mobility but also to transport, communications, and more generally to the development of the relationships (including social). A wide dispersion of urban population, a spread of settlement patterns with high consumption of land and energy, a large fragmentation of mobility attractors with the addition of important geographical constraints are the main results of the post-earthquake urbanization scenario. In terms of mobility, some issues must be solved. In fact, the current mobility is achieved almost entirely by private automobile, there is a high traffic congestion along the n. 17 road, and finally the traffic flow along East-West is not enough to justify the installation of an efficient public transport system (subway type).

For these reasons, it appears difficult to plan a public transport system that could efficiently cover all the O-D points in order to reduce costs and environmental pollutions.

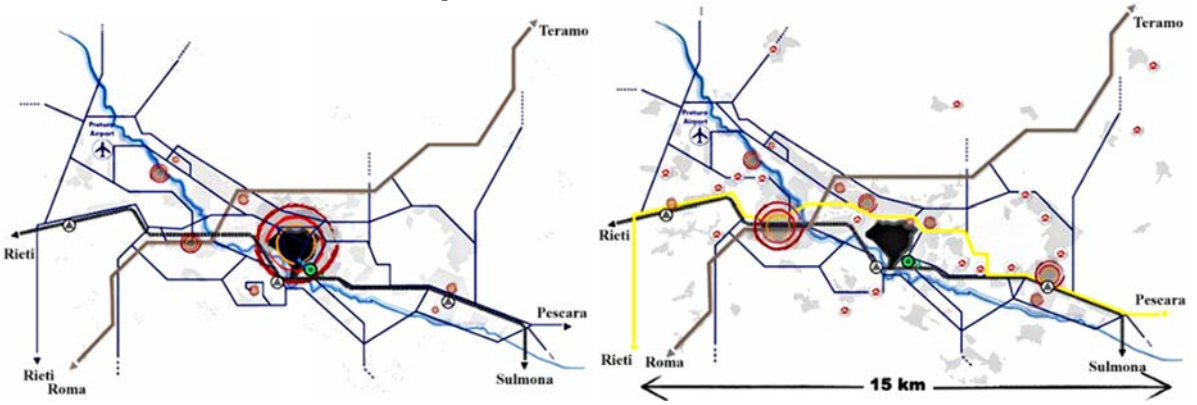

Fig. 1. L'Aquila city before (left) and after (right) the earthquake. With double circles in red are indicated the centralities, reorganized after the earthquake on the main road n. 17 (in yellow).

4. Towards a new urban form

The aim of the study is to define the layout of a sustainable future mobility of L'Aquila, based on the implementation and development of a public transport system.

In order to resolve a great deals of the problems, the proposal is conceived on three interconnected transport components (Fig.2): (i) the local railway line, re-designed to urban use; (ii) the "dense grid" public buses transport network, composed by two sub-systems: suburban network with traditional buses and the City Centre network, provided with electrical small-size buses); (iii) the planned cable car line.

The system foresees the realization of a public transport grid, within the urban area, which is sufficiently dense having high operating frequencies so that the user can easily articulate every distance. The buses system converges onto the stops of the long distance railway line in order to assure the flow exchange between the two complementary systems (Fig. 3). Competitive transport times with private cars are so obtained, even for long distance. A crown of four inter-modal and car-parking hubs and minor car parks, located around the Historical Walls, ensure the joint connection between the transport components. Moreover, the hubs represent a control system of the entering and leaving traffic flows across the Walls, in order to permit only to electric buses to move within the City Centre.

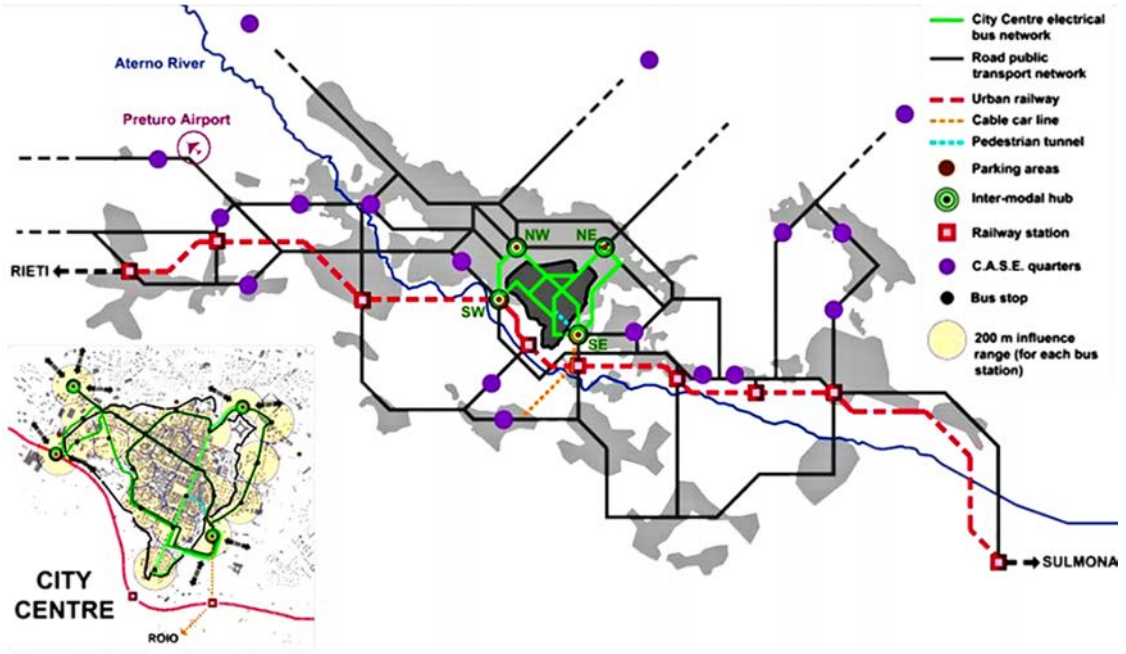

Fig. 2. Proposed public transport network layout within the Territorial-City of L'Aquila.

Fig. 3 shows the layout of the three components of the public transportation systems and their interconnections with relation to the main urban polarities. The South-East Hub, which corresponds with the current buses terminal, will host the starting station of a cable-line service able to connect the City Centre with the University polarity of the Faculty of Engineering located on Roio Hill. An intermediate cable-line stop will correspond with to the n. 6 of the urban railway line. The existing railway line is a part of the regional rail network. It runs along East-West direction at South of urban area; for this it is located in a decentralized way respect to the main mobility attractors and settlement areas of L'Aquila. At present, it consists of a not electrified single track and four stations; the service is characterized by a low frequency (1 train/h) and a very low economical profitability.

The line section considered in this study is comprised between the borders of the urban territorial system with a length of 23 km. Our proposal consists in the reconversion of the existing railway line to an urban use. In order to achieve this target, the number of stations was increased to ten, providing each one of them with double tracks. In this way, a maximum frequency of 4 train/hour per direction was obtained, as shown in the train transit timeline represented in Fig. 3. The "dense network" transport system offers a shuttle buses service, with high operating frequencies, articulated on a grid network and extended over almost the entire urban territory, with a maximum distance of 400-600 m. In this way, the urban territory will be conceived as a summation of pedestrian areas connected in a barycentric way, by the public transportation system, being the maximum access distance to the stops in not more than 300 m. The proposal plans to use the public buses network as connecting system for the suburban neighborhoods of the city and as a feeder system for the railway line, connecting the two services at every railway station, in whose there will be inter-change hubs. This service uses traditional buses with a rush hour frequency of 4 bus/h and covers a great part of the settlement.

For the City Centre, a dense-grid of small-sized (21 passengers) electric buses, supplied by a hydrogen power unit (D'Ovidio, Masciovecchio, Rotondale 2014) and characterized by a high transit frequency (7-8 bus/h), are proposed. A capillary distribution of the bus stops allows to create a wide pedestrian zone able to cover more than 80% of the City Centre (Fig. 2).

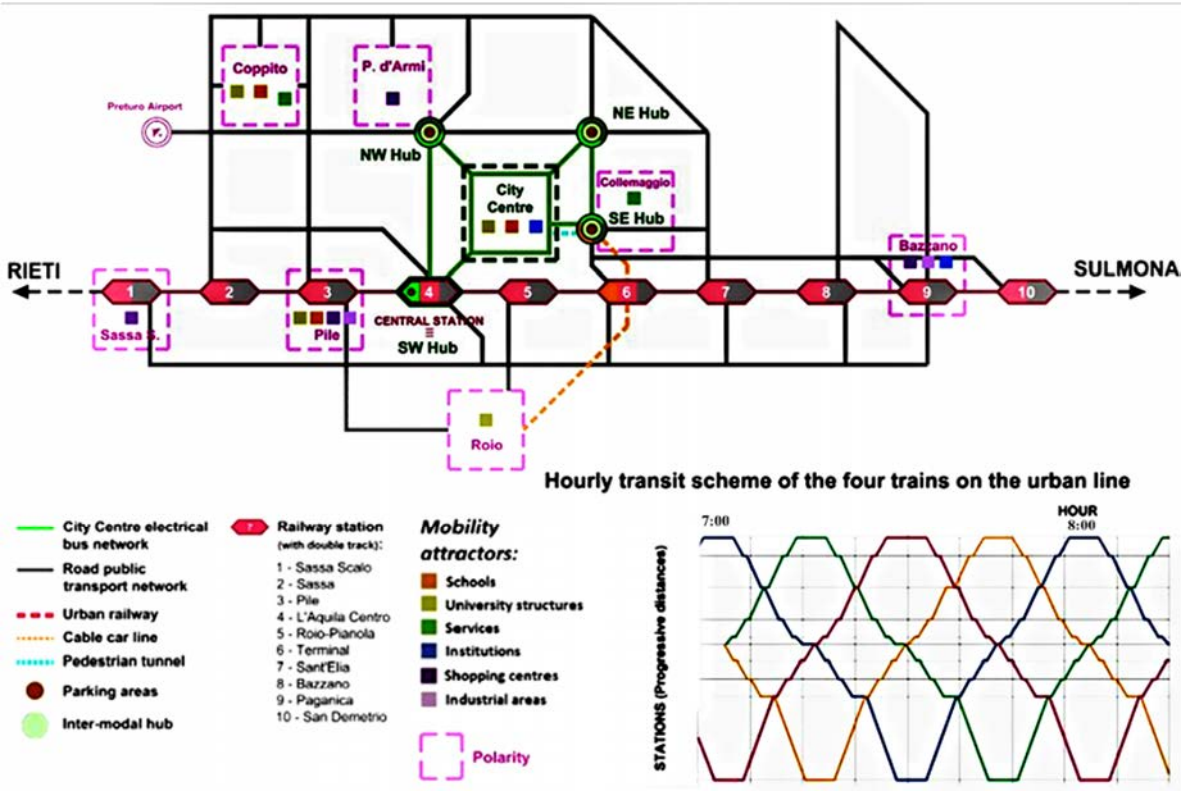

Fig. 3. Scheme of the proposed public urban transportation system and train transit timeline.

5. Conclusions

This study has analysed the L'Aquila urban planning experiences in order to review and analyse the urbanistic and mobility critical issues related to the spatial structure of L'Aquila urban area after the 2009 earthquake.
As result a proposal for the implementation of the public transportation system has been designed with a sustainable concepts of mobility based on a "dense grid" network with pedestrian accessibility to the bus stops.

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