Increasing Urban Resilience of Athens' Historic Center

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SUMMARY

Rapid urbanization challenges in recent decades require a global urban reform concerning natural disaster risk reduction measures and consideration of other important social and financial aspects. The concept of a "resilient city" arose in order for urban areas to become more flexible and efficient in facing natural and manmade disasters, protecting lives and properties and promoting economic and social development. Athens which is the capital and the most developed metropolitan area of Greece recently reconsidered its planning principles mainly due to the severe economic crisis that has resulted in significant unemployment rates. However, in the near future social, environmental and economic vulnerability of Athens will increase due to the expected increase of population caused by the continuing and rapidly rising refugee movements both from Asian and African regions. In addition, the large number of old and poorly maintained building stock may result in even lower safety levels for the residents of Athens, as Greece is in a zone of high seismic activity. As a result, a large scale urban intervention should be planned and implemented in order for the city to become more resilient; this reform may act as a long-term risk management plan. The objectives of this study are focused on increasing resilience and reduction of the risks of natural disasters at the historic center of Athens with an emphasis on earthquake and flood threat. A literature review of the concept of a resilient city is undertaken together with the principles related to resilient urban planning. A brief analysis of the current situation of Athens' center is conducted, as a case study, by collecting primary and secondary data. Spatial analysis tools, like Thiessen Polygons, mapping and case studies review are the methodologies that have been applied. An urban resilience spatial guide focusing on planning for more efficient use of open spaces in the case study area, is proposed.

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1. THE CONCEPT OF A RESILIENT CITY AND ITS CHARACTERISTICS

Resilience is defined by the United Nations Office for Disaster Risk Reduction (UNISDR) as: "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 through the preservation and restoration of its essential basic structures and functions", (UNISDR, 2009). In recent years, the concept of resilience, primarily used in ecology (Hebert, 2016), is used in a range of scientific areas with a number of interpretations (Meerow and Newel, 2015; Meerow et al., 2016).

In urban planning terminology, resilience relates to the ability of cities to respond to crises and improve their services towards their residents and visitors (Melkunaite and Guay, 2016). However, there is a variety of opinions regarding the definition of urban resilience; almost 25 versions of this term have been presented in the literature review throughout the decade 2003-2013 (Meerow et al., 2016). Generally speaking, the term "resilient city" is defined as a sustainable network of human communities and physical systems (Godschalk, 2003; Watson, 2016;), which helps the city to be prepared in order to absorb disasters and to recover from any shock, while maintaining its identity, its structures, its main functions, its adaptability and its level of development, despite the constant changes (UNISDR, 2010; Lerch, 2015).

Physical systems include the city's infrastructure and its natural environmental components. According to Godschalk (2003), "the physical systems act as the body of the city, its bones, arteries, and muscle" and in case of an emergency it is those which, if they can operate under extreme stress, can continue to contribute to the functioning of the city. Regarding populated communities, the same scholar (Godschalk, 2003) notes that, because they are the social and institutional components of the city and, therefore, "act as the brain of the city, directing its activities, responding to its needs, and learning from its experience", they must be able to survive so that the decision making process can be performed as smoothly as possible. The approach of Meerow et al. (2016) is similar, differing in the fact that they perceive the city as a complex urban system divided into socio-technical and socio-ecological systems. Their emphasis on the city's social nature converges in opinion with Godschalk (2003), who argues that, unlike in the past when the resilience programs focused on physical systems, today, mitigation programs should focus on human communities, as they are the ones responsible for urban resilience.

Cities, therefore, in order to become resilient, required long-term and integrated strategies that needed to be approached in an integrated and systematic manner so as to reduce vulnerabilities and risks. Such strategies also concern urban design and planning interventions since these increase the city's capacity to better address the natural disasters as well as the various social, economic and structural pressures that it will face. Indeed, Evans (2016) lists

11 principles to be utilized in resilient cities in terms of urban design. Table 1, bellow, groups these principles in four key sectors.

Resilient cities and neighborhoods should:		
1.	Urban Planning	Embrace density, diversity and mix of uses, users, building types, and public spaces.
2.		Focus energy and resources on conserving, enhancing, and creating strong, vibrant places, which are a significant component of the neighborhood's structure and of the community's identity.
3.		Plan and design for redundancy and durability of their life safety and critical infrastructure systems. Planning and design of these systems will aim for levels of redundancy and durability that are commensurate with the increasing environmental, social, and economic stresses associated with the impacts of climate change.
4.	Transport Sustainable Mobility	Prioritize walking as the preferred mode of travel, and as a defining component of a healthy quality of life.
5.		Develop in a way that is transit supportive.
6.		Provide the needs of daily living, within walking distance (a 500 m radius).
7.	Environment	Conserve and enhance the health of natural systems (including climate) and areas of environmental significance, and manage the impacts of climate change.
8.		Enhance the effectiveness, efficiency and safety of their technical and industrial systems and processes, including their manufacturing, transportation, communications and construction infrastructure and systems to increase their energy efficiency, and reduce their environmental footprint.
9.		Develop building types and urban forms with reduced servicing costs, and reduced environmental footprints.
10.		Will grow and produce the resources they need, in close proximity (200 kilometer radius).
11.	Community Engagement	Will require the active participation of community members, at all scales in the development plans.

Table 1: Evans's principles for the Resilient City and Neighboorhood (Evans, 2016)

Through the examination of these principles it can be concluded that, resilient cities have aspects in common with compact cities. Both principles mentioned in the transport sector and some which are included in the environmental sector emphasize the need to promote coherence and to create high-density urban neighborhoods and simultaneously promote a less energy-intensive city. According to Vlastos and Milakis (2006), a compact city may be considered less energy intensive as long as an appropriate microclimate is created, sustainable mobility is largely used and an integrated and varied public transport system is implemented (Burton, 2000; 2001; 2002; Portokalidis and Zygouri, 2011). At the same time, the resilient city also focuses on socialization and its function as a polycentric core of civilization, production, habitation and development, as suggested by the Resilient City Research Report (GROSVENOR, 2014). In each case, physical systems are quite important because their quality is related to the quality of urban life (Psatha, 2012; Psatha and Deffner, 2013) and the city's responsiveness in case of emergencies.

According to the Sendai Framework for Disaster Risk Reduction 2015-2030, adopted at the Third UN World Conference on Disaster Risk Reduction in Sendai, Japan, on March 18,

2015, there is a need for focused action within and across sectors by States at local, national, regional and global levels in the following four priority areas:
Priority 1: Understanding disaster risk
Priority 2: Strengthening disaster risk governance to manage disaster risk
Priority 3: Investing in disaster risk reduction for resilience
Priority 4: Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction, (UNISDR, 2015).

2. AN URBAN RESILIENCE GUIDE CASE STUDY FOR ATHENS' CENTER

2.1 Aim and Objectives

Within the Sendai framework, this specific study aims to increase awareness about disaster risks and the need for enhancing disaster preparedness and improving responsiveness of the Athens' historic center in case of natural disasters, like earthquake, fire or flood. The main research objective posed is to prepare an urban resilience spatial guide for the historic center to reduce risks and achieve good management during urgent situations. This issue is very broad, however. First, the research interest focuses on the preparation for protection against negative impacts of a possible disaster such as a flood, earthquake, or fire in this area. Always taking into consideration that Athens as well as most of the Greek cities, may be vulnerable to earthquakes, emergency action plans may include: (a) diversion of population out of closed spaces/evacuation, and/or (b) concentration of population in open and safe spaces. For this particular scope, the following spatial parameters are investigated:

- Which are the free spaces in the center of Athens and what locations may be utilized as potential and temporary gathering spaces in case of emergency?
- Which is the zone of influence that may be efficiently served by each of these selected potential gathering spaces?
- Which are the shortest pathways/routes that may best serve specific types of vehicles in case of emergency?

2.2. Methodology

Methodology includes the following steps:

- *Selection and delineation of the case study area*: As shown in Figure 1, the area under study is the central historic zone of Athens surrounded by Pireos Str, Stadiou Str and Ermou Str. The area is the historic center of Athens where the traditional morphology of the 18th Century is largely preserved, however there are also a few linear neoclassical influences from the 19th Century mostly concentrated in the northern part of the area (Kourkakis, n.r.) A special and very compact neighborhood has been developed here due to the existence of tall buildings constructed in relatively small plots with narrow streets. This compact neighborhood, along with its "centrality", are the main criteria for the selection of this area. The area accumulates large numbers of visitors, tourists and local people daily.
- *Analysis of the current situation*: Primary data regarding the geometrical characteristics of the street network, land uses, and numbers and nature of existing open spaces are collected (by students: Milioni Tatiani, Manasaki Theodosia and Chantzimina Niki for the purposes of this undergraduate course: "Development of Cadastral and Land Use Systems"-9th semester, in the School for Rural and Surveying Eng., NTUA) combining crowdsourcing

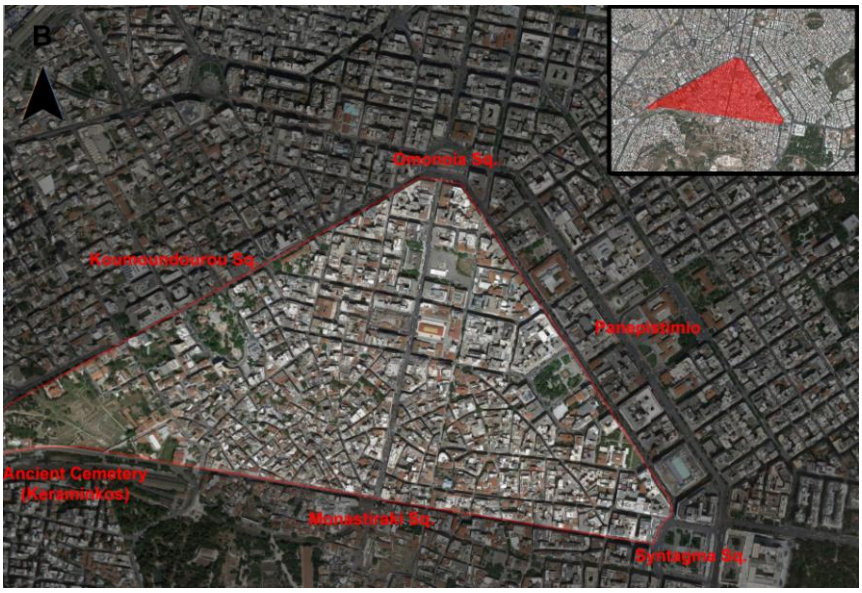

Figure 1: The Study Area consists of the central and historical core of the Greek capital. Source: Own Elaboration (Google Maps).

data collection techniques with professional methods (Mourafetis et al, 2015). Data are assessed in order to identify the character of the area, its specific attributes as well as its problematic zones and elements which: (a) may make the study area a rather vulnerable place in terms of disasters, and (b) must be dealt in the optimal economic and environmentally friendly way. Literature review and collection of secondary data are also used for the fulfillment of the above. Regarding methodology, spatial analysis tools, like Thiessen Polygons, are used. For mapping purposes AutoCad, GIS and Photoshop CS5 tools are used.

- *Findings-Proposal*: Following assessment of the current situation, an urban resilience spatial plan for the case study area is proposed. A proposal is focused on the identification of the hosting potential of the various open public urban spaces (road and street network and urban squares) including the open private spaces (even those that operate as parking areas), and their possible usage in case of emergency situations. Scenarios are also studied in order to investigate some best practices for improving the degree of urban resilience in the area under study.

2.3. Brief Analysis of the Existing Situation in the Area under Study

The study area concerns the central historic zone of the Greek capital city, with high density and traditional urban morphology as previously noted. Taking this into account and given the fact that dealing with urgent situations demands the efficient movement of emergency vehicles (ambulances, fire trucks, etc.), the geometric characteristics of the road network have been explored in depth. In order to better manage the data, the existing street network is classified into four categories, as shown in Figure 2. A large number of streets - due to their width, as depicted in Figure 3, may be considered as accessible by emergency vehicles, however the on-site research has found that: (a) the actual operational width of some streets is substantially limited due to both legal and illegal street parking, even on narrow streets, and (b) emergency vehicles, due to their size, when moving through such streets face additional difficulty caused by a lack of proper signage (Figure 4).

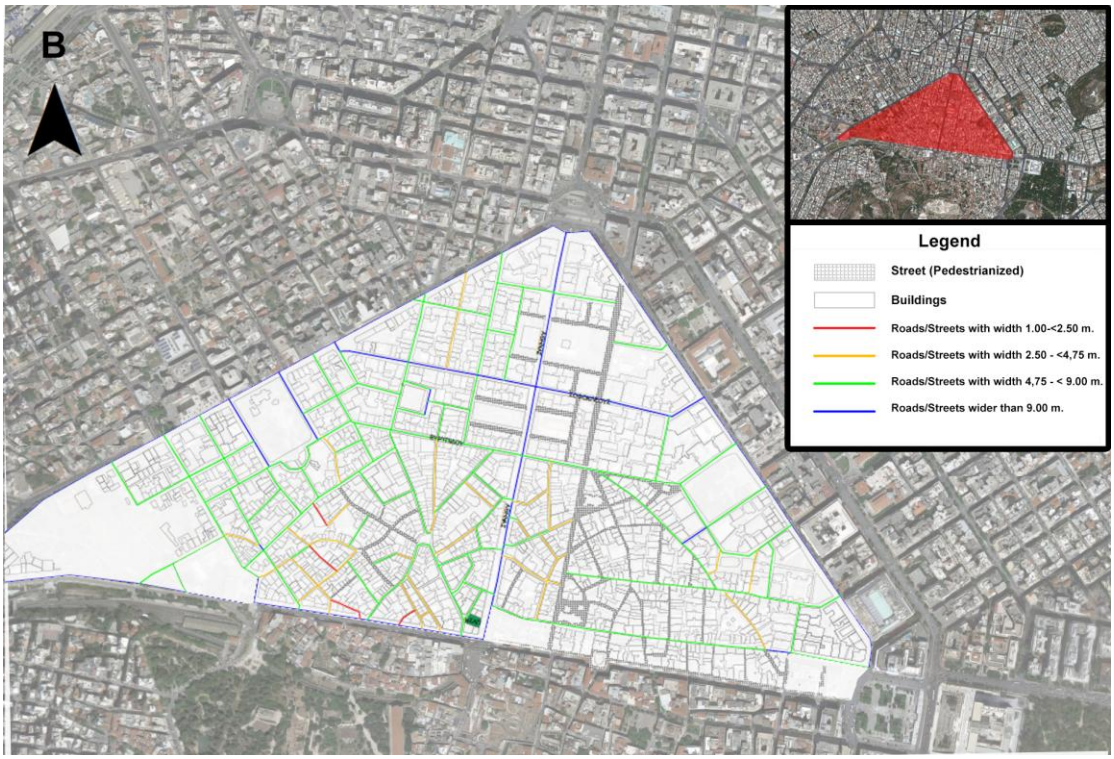

Figure 2: Roads classification (according to their width) in the Study Area.
Source: Milioni T., Manasaki Th. and Chantzimina N. (fieldwork), Own Elaboration (Google Maps).

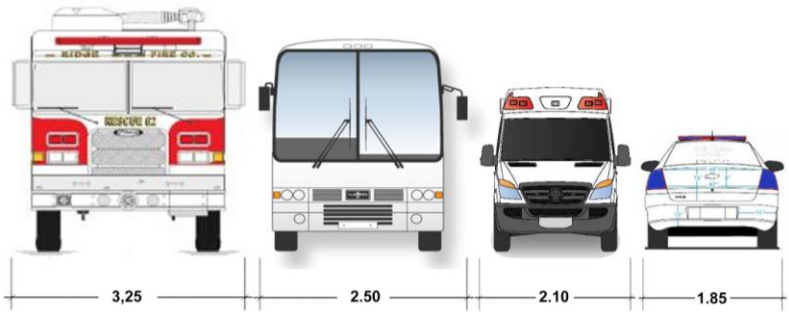

Figure 3: Dimensions for specific vehicles. Source: Own Elaboration.

On-site land use research concluded that three key parameters should be taken into account: (a) The large number of buildings that are currently vacant, abandoned or underused, as shown in Figure 5, which in many cases are due to poor maintenance. This creates additional safety concerns about the stability and the probability of severe damages in case of earthquakes. (b) The number of open spaces (thirteen) and maybe also the number of open parking spaces (assuming that they are not always fully occupied by cars) that exist, as shown in Figure 5, mostly in the south-western part of the study area where the population accumulation is usually higher. (c) The number of buildings accommodating health centers (ten), that may provide useful services in case of injuries. Parameters (b) and (c) are important because they contribute to the local resiliency since they allow both the development of a network of open spaces for public emergency gatherings and provide suitable and direct health services.

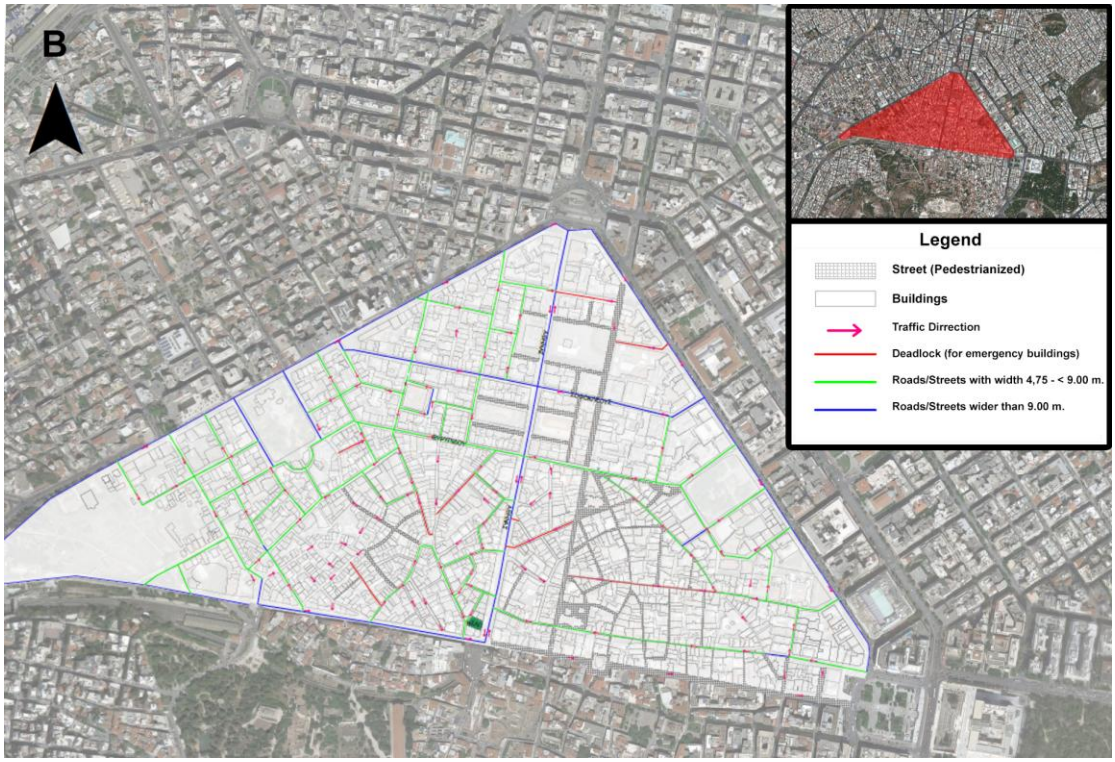

Figure 4: Some roads are "dead ends" for emergency vehicles.
Source: Milioni T., Manasaki Th. and Chantzimina N. (fieldwork), Own Elaboration.

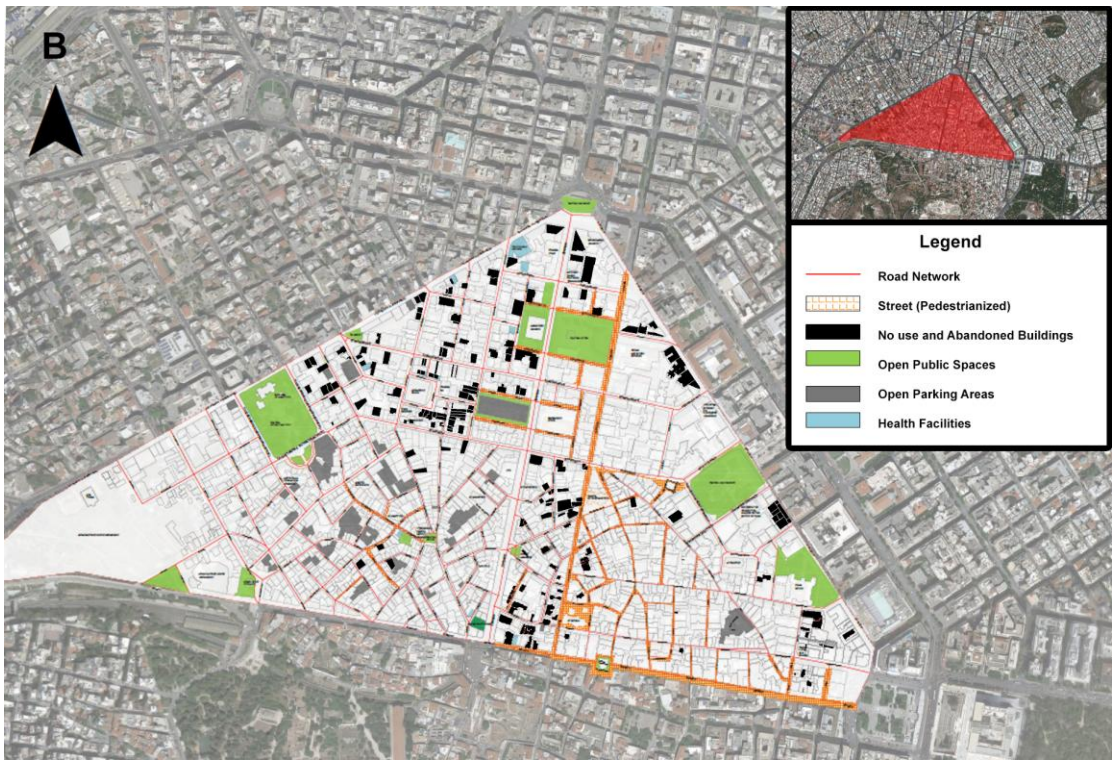

Figure 5: Open spaces (public and private) – health facilities and buildings with no use. Source: 1. Milioni T., Manasaki Th. and Chantzimina N. (fieldwork), 2. Bakogiannis et al., 2016. 3. Own Elaboration.

2.4. Findings and Proposals

The areas shown in Figure 5 may be considered as potential temporarily gathering spaces for the local population in case of emergency. However, there is a need to assess the efficiency / appropriateness of such spaces. How large should a space be in order to efficiently serve each particular part of the total urban area under study?

The extent of the urban population that each open gathering space may serve efficiently in case of an urgent need is an issue that may be addressed in various ways. Thus, most important spatial parameters to be taken into consideration may be the following: (a) The ratio between the surface area of the open space and its population capacity. (b) The height and condition of the neighboring buildings and the safe distances between them. (c) The shortest route from a certain location to an open space. In the context of this study, only the latter (c) parameter is chosen to be considered.

First the distribution of open spaces within the urban fabric is examined. The results show that their distribution presents a certain uniformity and applicability. More open spaces exist in the denser areas and although their spaces are small, the number of them may be sufficient. The study as such focuses on improving the resilience capacity of the selected region generally, not on serving a seismic management scenario yet. In order to serve for seismic purposes, the

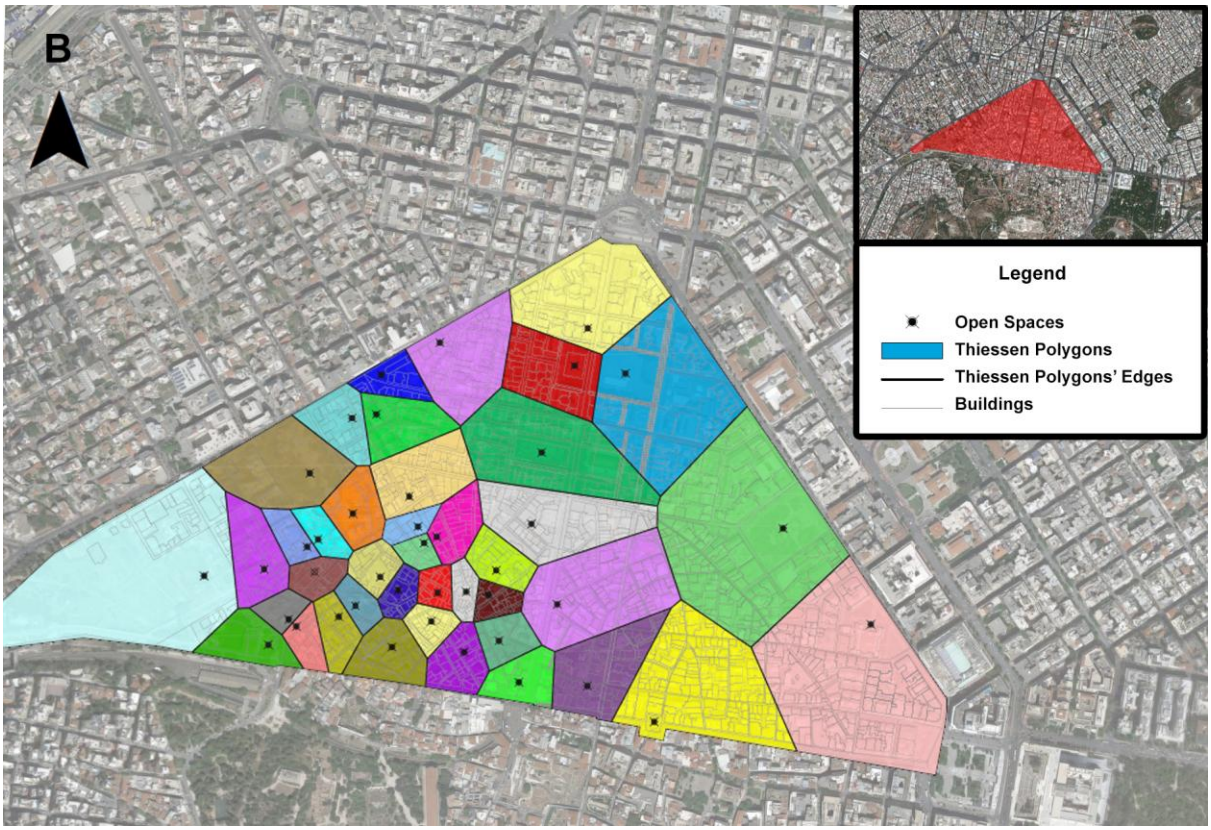

Figure 6: Thiessen Polygons – Open Spaces
Source: Milioni T., Manasaki Th. and Chantzimina N. and Own Elaboration.

parameter related to the height / condition of the buildings and the safe distance between them should also be considered. However, given the structural vulnerability of Greece to earthquakes, it is our intention in the next phase of this study to continue the research in this regard, as well.

In order to explore the shortest distance ratio between the " temporary gathering spaces" and other buildings in the area under study, the Thiessen polygon methodology was chosen[1]. This methodology is broadly used in a series of investigations that look for similar effects (Gambo, 2016; Delrieu and Gibson, 2017; Wang et al., 2017), through the evaluation of the distances without counting other parameters (Cantent, 2017). Figure 6 shows the open spaces while the colored polygons depict the areas which can be well served in them, related to proximity.

However how are people to be aware of the closest safe location? Solution may be provided through special signage in two different ways. The first proposal includes the fitting of special luminous strips on sidewalks, like the ones in airplane corridors. The use of arrows is needed in order to determine direction. It is important to note that such luminous strips have been used in several streets and sidewalks in the Netherlands for drawing the attention of pedestrians when crossing the streets. This infrastructure could be equipped with specific sensors measuring change in regard to e.g., seismic activity, and would only be activated in

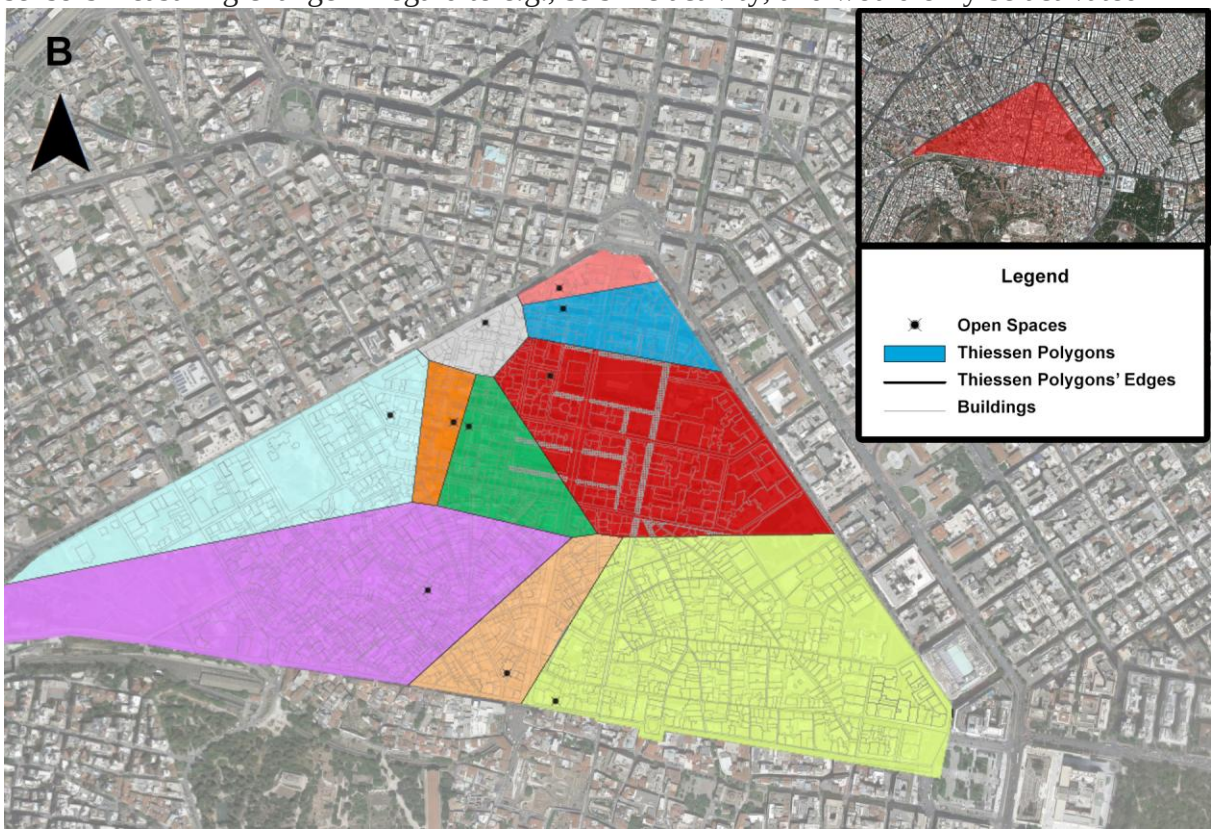

Figure 7: Thiessen Polygons – Hospitals and Health centers.
Source: Milioni T., Manasaki Th. and Chantzimina N. and Own Elaboration.

[1] The research based on proximity was created by plotting the open space locations in a Geographical Information System and generating Thiessen polygons.

case of emergency. It should be noted that in case of a power outage, a generator allows such luminous strips to function normally.

The second proposal concerns the installation of “smart boards” at regular intervals. Such boards are characterized as smart, in that they have a dual role: They function as common information boards providing data about the surroundings, special places in a walking 5 to15-minute distance, activities and/or events. In cases of emergency the smart boards will provide information about the nearest "temporary shelter areas” as well as directions to them. Information regarding nearby hospitals and other health centers will also be presented. Such an action could improve the accessibility of the area along with its economic development since it can be associated with the promotion of the neighboring businesses acting as an Open Mall (Bakogiannis et al., 2016), within a cluster of commerce and recreation uses. Figure 7 shows the results of a similar methodological approach to locate the nearest hospitals and health centers.

Several streets due to their geometrical characteristics and/or on-street parking prevent emergency vehicles from moving freely within the area. Information signage should be placed

Figure 8: How the Study Area will be more Resillient?
Source: Own Elaboration.

in these road sections providing drivers with information about the road width, prohibited vehicle types, etc. It is necessary to exploit the open spaces. Removal of some of the current parking spaces, as Hamburg and Zurich, is an action that has to do with the creation of new community areas that will strengthen the bonds among citizens (Steckers, 2011). Simultaneously this action will force citizens to consider alternatives to approach the various places in this area, like public transport. Of course, for such interventions land expropriation may be necessary; this is not usually an affordable solution however.

Along with the above actions, specific parking measures should be added in order to ease the movement of pedestrians and vehicles both in normal use and in emergency situations. Lastly the consolidation of the various archaeological sites in Athens (within the Commercial Triangle) may also act as a complementary action to the above while the pedestrianized streets (that will provide for the consolidation of those sites) may serve as "temporary shelter areas".

3. CONCLUSIONS-DISCUSSION

From the findings of the study and all presented above, the following conclusions may be derived:

- The city is a complex living and evolving organism which is difficult to fully protect from the abundance of risks it may face. Its characterization, however, as a "living organism" is the one that allows the reference to the concept of resilience, meaning the ability of the city to react quickly, almost instinctively, to protect itself from natural or artificial shocks and to function smoothly.
- A resilient city is a model which is combined with models of sustainable, economic and social cities. The parameters taken into account are both spatial and social in nature.
- The "urban resilience" varies and is applied differently depending on each case. However, problems related to disasters are matters on which modern cities must focus and require specific spatial data infrastructure to be prepared.
- Athens is a city that is lacking in infrastructure (physical systems) to some extent, therefore, it cannot function well as a "resilient city". The problems identified are largely related to narrow width of the roads in the city center, extensive vehicular traffic, roadside parking and the absence of signage. On the other hand, it is important that there are many open spaces that could be used in a case of emergency as "temporary shelter areas".
- The presented initial proposals achieve a double objective: the emergence of the center of Athens as a resilient urban core as well as a more sustainable and compact area. Focusing on improvements concerning pedestrian conditions and marking it is possible to promote sustainable mobility and social interaction.
- Research should be continued and expanded to provide the necessary spatial data infrastructure, identify the most appropriate and affordable measures that would function well in the various types of disasters, and investigate the potential use of social media.

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