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42 ASSESSING SPATIAL INEQUALITIES IN URBAN QUALITY OF LIFE - EMPIRICAL EVIDENCES FROM ANALYSIS IN ATHENS, GREECE

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Abstract: In the era of continuous urbanization and under the pressure of environmental degradation, the quality of life (QoL) in cities constantly attracts the interest of researchers from various scientific fields. The evaluation of the urban context, in terms of quality of life, is not limited just to assessing built and natural features, but is also related to socioeconomic and housing conditions, as well as the available amenities. This study aims to evaluate and map the urban quality of life in Athens' greater area, Greece, by implementing a GIS-based multicriteria analysis. The study area is one of the most extended urban areas in Southern Europe, characterized by significant spatial inequalities in population composition and both physical and social environment. Recent socioeconomic, and health crises seem to enhance these inequalities. The urban quality of life was assessed by criteria related to the built and natural environment, the socioeconomic environment, housing conditions, infrastructure and services, and cultural and recreational facilities. After the synthesis of all these estimators the urban QoL map of the study area was created. Spatial autocorrelation analysis of the output map revealed significant spatial clustering of low levels of QoL in the western parts of the study area, affecting almost 1/3 of the population in the study area. These results were validated after recording the residents' perception on the quality of life in Athens. The advantages, assumptions and limitations of the proposed approach are also discussed, providing the background to enrich the existing literature on urban QoL research. The findings of the research could lead to more effective decision-making in urban planning and setting targets to improve the urban quality of life in underprivileged areas.

Keywords: Athens, GIS, Greece, multicriteria analysis, quality of life.

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1. INTRODUCTION

Quality of Life (QoL), as an estimator of well-being, is a concept that has been studied by various researched areas such as social science, psychology, environment, geography etc. (Farquhar, 1995; Schalock, 2000). In recent decades, a lot of research has been conducted to assess QoL, focusing in QoL of urban areas (Rinner, 2007; Das, 2008; Psatha et al., 2011; Cabello Eras et al., 2014; Najafpour et al., 2014; Feneri et al., 2015; Peach & Petach, 2016; Biagi et al., 2018; Garau & Pavan, 2018).

Modern cities have an important role in the economic and regional development as they concentrate high population, are centers of innovation and technology, offer jobs and higher education services, etc. At the same time, urban areas face problems such as social inequalities, environmental degradation, crime, etc. (European Commission, 2016). Hence, assessment of Urban QoL (UQoL) bargains applications in various fields of intervention, such as urban geography and urban planning, paying attention to the spatial aspect of QoL and on issues related to crime, poverty, socioeconomic inequalities, built and natural environment degradation, etc. (Najafpour et al., 2014; Murgaš & Klobučník, 2016; Peach & Petach, 2016; Weziak-Białowolska, 2016; Kazemzadeh-Zow et al., 2018; Vukmirovic et al., 2019).

UQoL assessment can evaluate the spatial inequalities that exist in many cities worldwide (Martinez, 2009) presupposing the use of a variety of indicators and data evaluation (Moro, 2008; Faka, 2020). Many researchers have evaluated UQoL by exploring the differences between social indicators (Kladivo & Halas, 2012; Faka, 2020). The measurement of QoL in the urban environment cooperates a set of factors that compose the living environment, including all aspects of the physical environment, as well as the socioeconomic conditions (Sirgy & Cornwell, 2002; Witten et al., 2003; Cramer et al., 2004; Apparicio et al., 2008; Rose et al., 2009; Najafpour et al., 2014; Linares et al., 2016; Weziak-Bialowolska, 2016; Winters & Li, 2017; Eurofound, 2017).

Geospatial analysis of QoL has a significant role in geography and urban planning.spatial metrics and spatial analysis have been used for identifying homogeneities/heterogeneities of QoL in space. In Germany an exploratory spatial data analysis was contacted for West German labo rmarkets to achieve a description of the spatial distribution of QoL across the study area, discover spatial clusters and various spatial regimes, and identify outliers. (Rusche, 2009). Exploratory spatial data analysis was used also to measure the spatiotemporal dynamic of QoL of residents in Northeast China, providing measures of both local and global autocorrelation to characterize the spatial distribution of a set of values (Cheng et al., 2016). Such tools have been provided by Anselin (Anselin, 1988; Anselin, 1995; Anselin, 1996; Anselin, 1999; Anselin, 2005) and Anselin and Getis (1992).

Nevertheless, in Greece the research on the geography of QoL is limited (Feneri et al., 2015; Faka, 2020). This study aims to evaluate and map UQoL in Athens greater area, Greece, implementing a GIS-based spatial multicriteria analysis. UQoL was assessed by composite criteria related to the built and natural environment, the socio-economic environment, the housing conditions, the infrastructure and services, and the cultural and recreational facilities. Each criterion is composed of a set of variables that are estimators for the specific criterion. Corresponding criteria and indicators have occasionally been proposed and implemented to evaluate UQoL in various cities around the world (Mizgajski et al., 2014; Ivaldi et al., 2014; Feneri et al., 2015; Linares et al., 2016; Peach & Petach, 2016). To better understand the spatial dimension of UQoL, an exploratory analysis was conducted by applying spatial autocorrelation index (Anselin, 1995) and identifying spatial clusters and outliers. The validation of the results was based on the residents' perception of the UQoL in each municipality.

2. MATERIALS AND METHODS

UQoL was evaluated using GIS and combining spatial and statistical data. Overall UQoL was assessed by six composite criteria and each criterion was evaluated by a set of variables (Figures 1, 2 and 3). The criteria were based on the six basic domains of UQoL, including natural and built environment, socioeconomic environment, housing conditions, access to public services infrastructures, and access to cultural and recreational facilities.

Socioeconomic status, directly linked to QoL (Eurofound, 2013), was estimated by unemployment rate, higher educated population (International Standard Classification of Education - ISCED level 5 to 8, according to UNESCO's classification standard for educational level (UNESCO, 2012), illiterate population (ISCED level 0), and mean income (Figure 1). All variables are associated with conditions affecting directly QoL such as increased material deprivation, difficulties in satisfying basic needs and making ends meet (Rose et al., 2009; UNESCO, 2012; Eurofound, 2013; OECD, 2013, 2017).

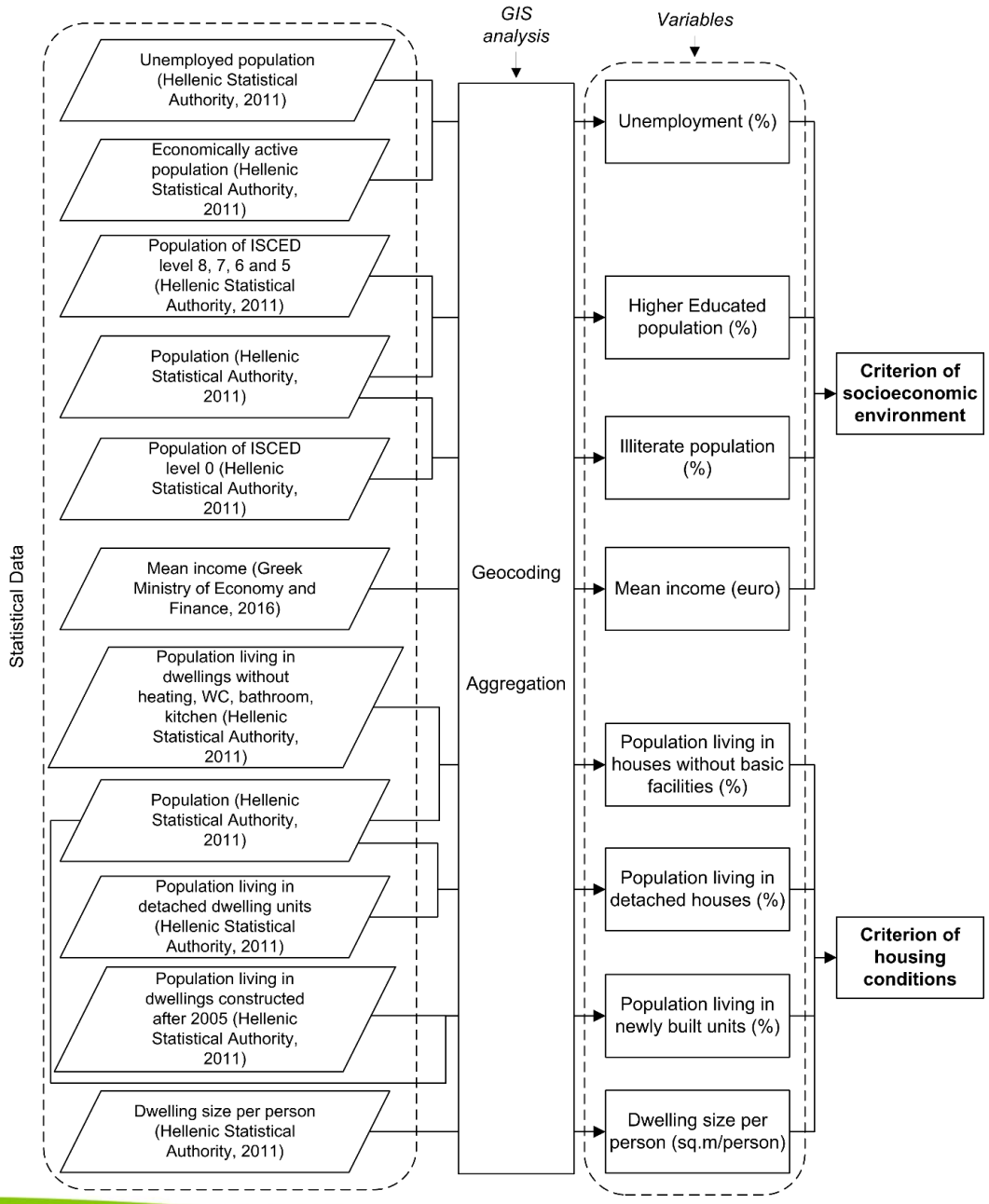

Figure 1: Flowchart of evaluating the criteria of socioeconomic environment and housing conditions

The criterion of housing conditions was evaluated by factors that have great impact on individual's everyday life and are related to the quality of the building and the sufficient housing space (Najafpour et al., 2014; Eurofound, 2017; Linares et al., 2016). Thus, population living in houses without basic facilities (heating, WC, bathroom, kitchen), in detached houses, in newly built units (during the last five years) and housing space (m^2) per person were used to estimate the criterion of housing conditions (Figure 1). All these variables were related to statistical data that were geocoded and aggregated at municipality level (Figure 1).

Built and natural environment have a great impact on both physical and mental health (European Environment Agency, 2009; Pukeliene & Starkauskiene, 2011). Population density and percentage of open spaces, were used to evaluate the characteristics of built environment, as long as QoL tends to be higher in less densely populated areas combined with open spaces (Cramer et al., 2004; Winters & Li, 2017).

The criterion of natural environment was estimated based on sources of noise and air pollution, two major problems in urban environments (Science for Environment Policy, 2018), using the mean distance to industrial units (Euclidean distance), the density of high-traffic roads and highways, and the percentage of green urban areas (Figure 2).

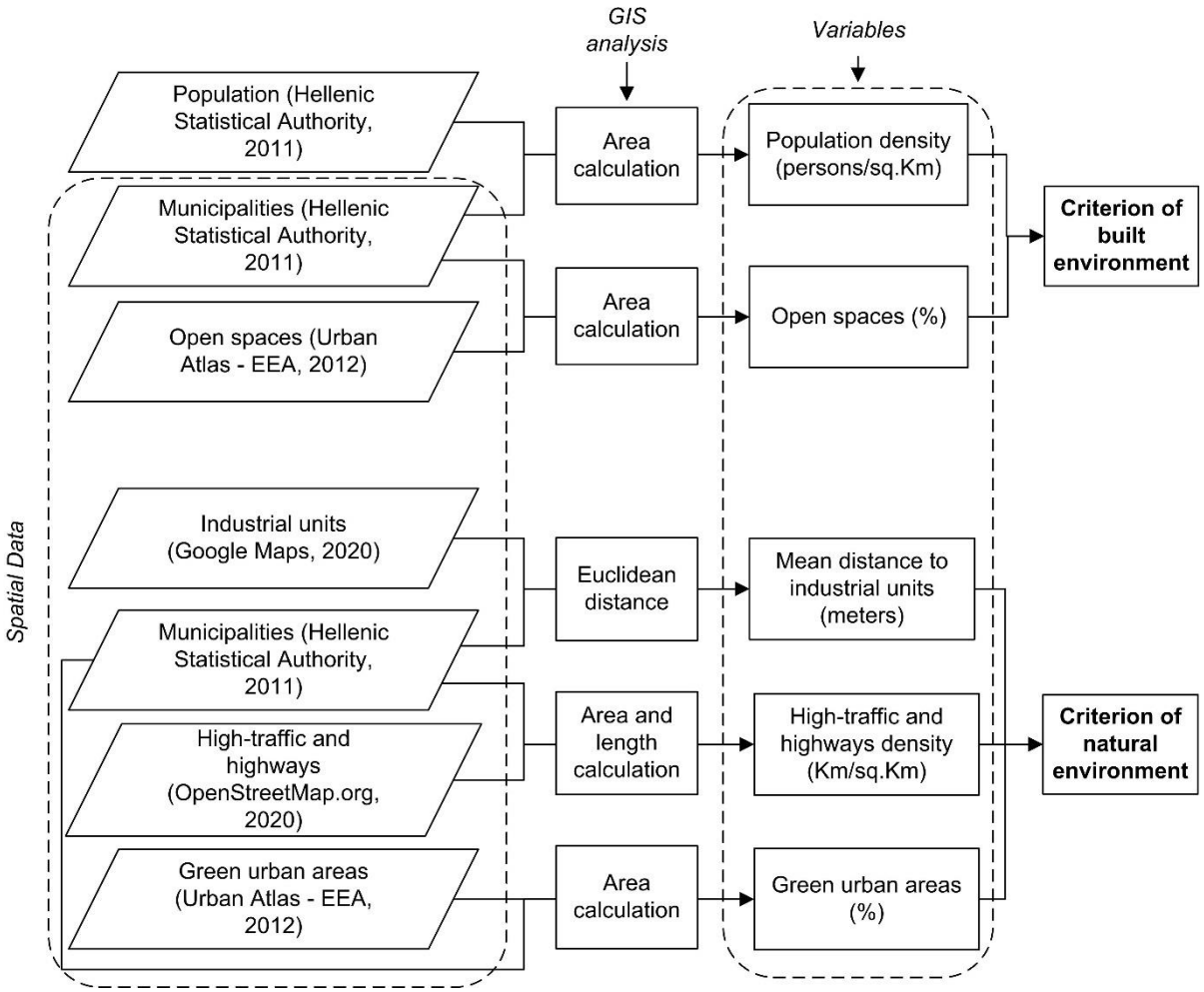

Figure 2: Flowchart of evaluating the criteria of built and natural environment

The criterion of public services and facilities was evaluated by the mean time to access hospitals and sports facilities, as well as the index of schools per 10,000 population (Figure 3). Accessibility to such essential facilities and public services is a strong predictor of QoL, affecting health, economic prosperity and finally overall QoL (Sirgy & Cornwell, 2002; Witten et al., 2003; Apparicio et al., 2008; Weziak-Bialowolska, 2016; Eurofound, 2017). In the same way, access to social meeting places, such as recreational and cultural facilities, affect positively individuals' well-being, contributing to balanced mental health (Oldenburg, 1997; Lloyd & Auld, 2002; Beggs & Elkins, 2010; Marans & Kweon, 2011; Terzi et al., 2015). To evaluate average time access to hospitals, sports facilities and recreational and cultural facilities, including theaters, cinemas, archaeological sites, museums, and libraries etc., cost distance analysis was performed (https://resources.arcgis.com/en/help). In cost distance analysis, the least accumulative time cost for each point of interest was calculated, based on the mean speed a vehicle travel in the urban road network (60 km/h) for the hospitals, and the mean pedestrian speed (4 km/h) for all other points of interest. Finally, the mean access time to public services and infrastructures, and to cultural and recreational facilities, was calculated for every municipality (Figure 3).

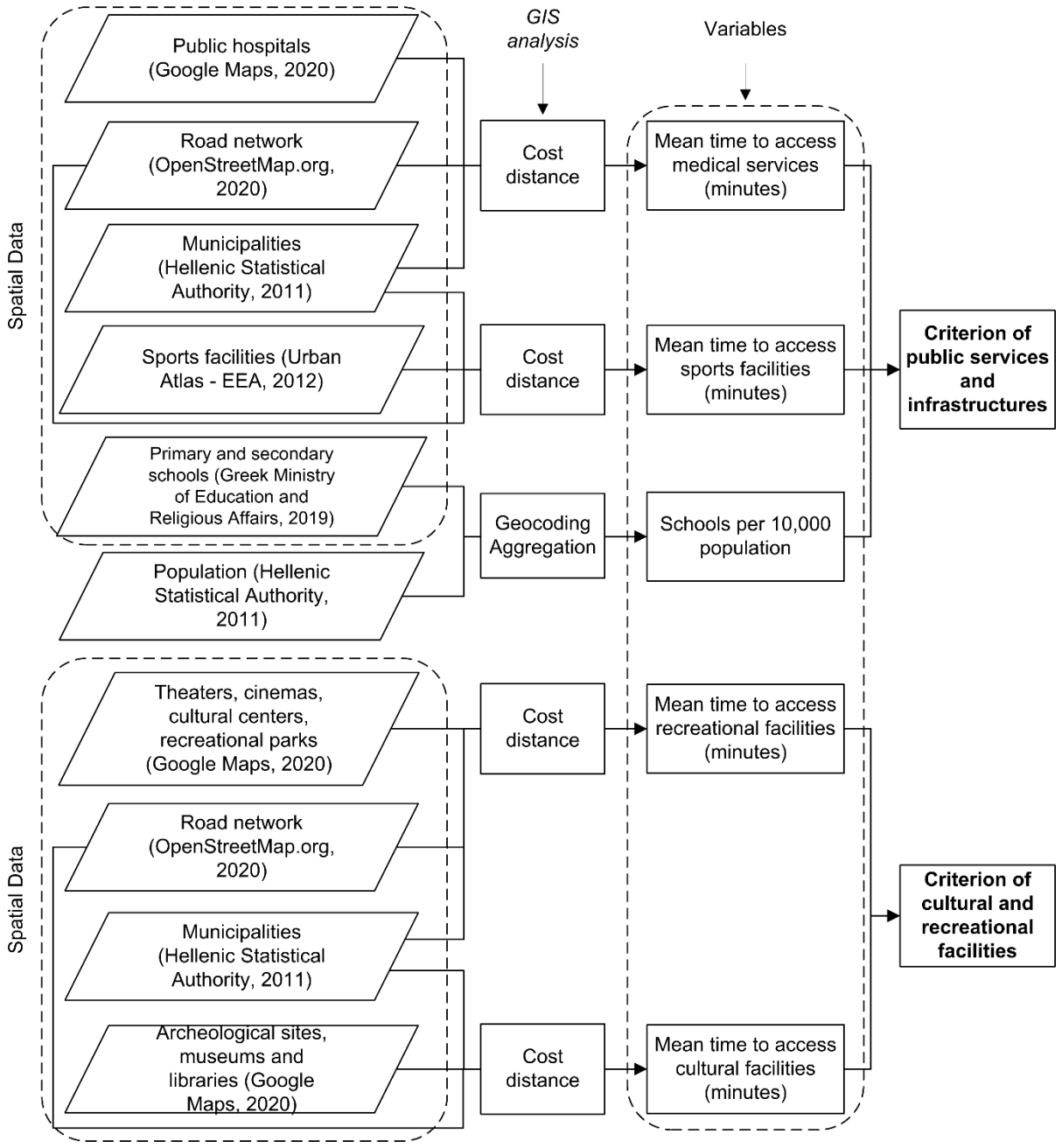

Figure 3: Flowchart of evaluating the criteria of public services and infrastructures, and cultural and recreational facilities

The values of all variables were reclassified to a common ordinal scale of five categories using Natural Breaks method (Jenks, 1977), according to which UQoL ranks from very low (category 1) to very high level (category 5). Each composite criterion was defined by the mean of the variables that compose it, and overall UQoL defined by the mean of the composite criteria (Figure 4).

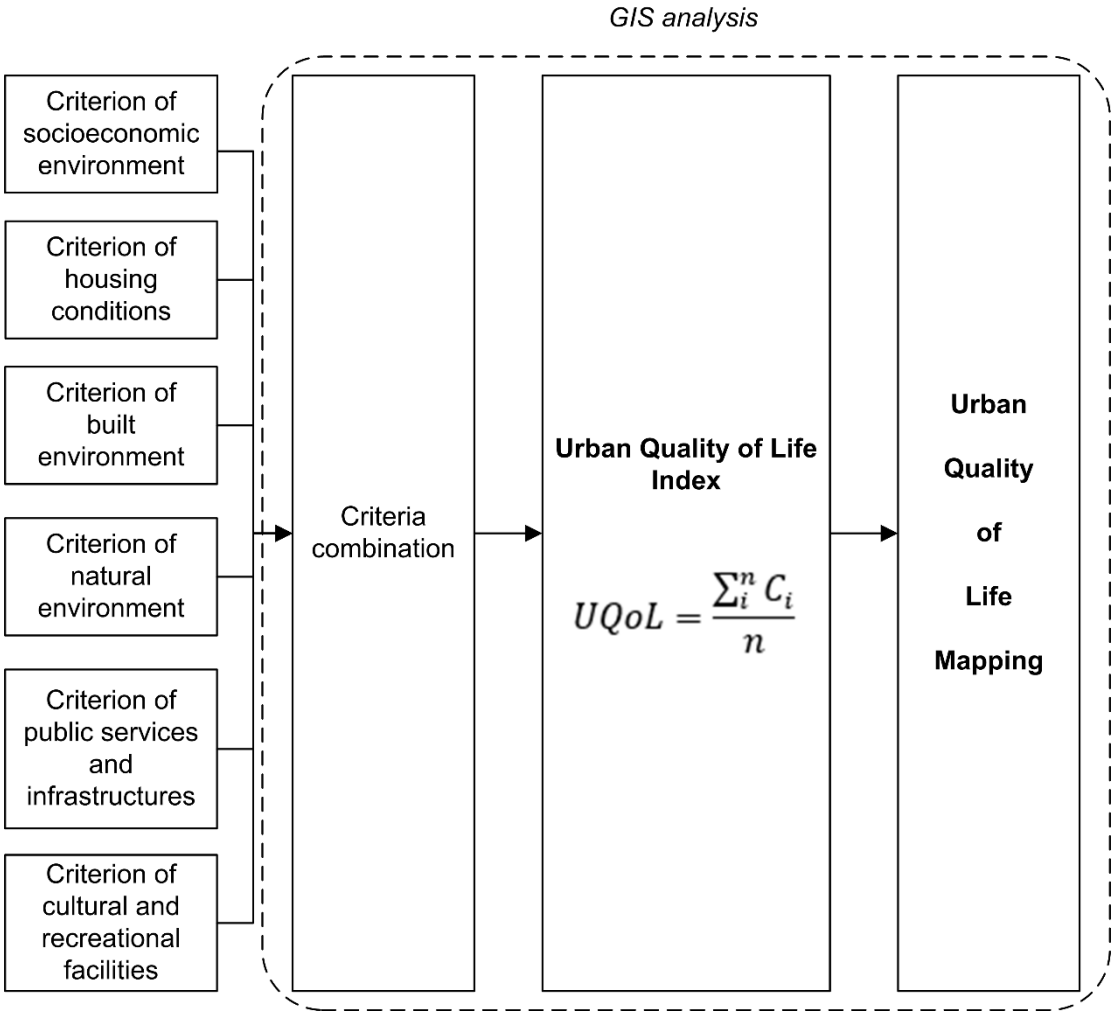

Figure 4: Flowchart of evaluating and mapping overall UQoL

Spatial autocorrelation was performed implementing local Moran's I index (Anselin, 1995) to identify local clusters and local spatial outliers. Local Moran's I evaluates the local spatial autocorrelation between neighboring spatial units, providing a cluster map where geographical units with similar values cluster spatially, and a significance map revealing the statistical significance of the se autocorrelation values (https://geodacenter.github.io/workbook/6a_local_auto/lab6a.html). The local spatial autocorrelation types can be distinguished at High-High (high-value unit surrounded by units with similarly high value) and Low-Low (low-value unit surrounded by units with similarly low value) spatial clusters, and High-Low (high-value surrounded mainly by low values) and Low-High (low value is surrounded mainly by high values) spatial outliers.

The validation of the results was based on the residents' perception of the UQoL in each municipality. Using questionnaires, residents were asked to rate from 1 (very low) to 5 (very high) the geographical environment and UQoL of their residence area. The questionnaire contained closed-ended questions regarding the score of QoL criteria, the factors valuing them, as well as overall UQoL. The mean value of overall UQoL scored in each municipality was mapped to validate the results of the proposed methodology.

Mapping all criteria and overall UQoL demonstrated UQoL levels among municipalities of Athens greater area. Spatial analysis and mapping were performed using the ArcGIS version 10.2 (ESRI Inc., Redlands, California, USA) software. Spatial autocorrelation was performed using GeoDa 1.16.0.12.

3. RESULTS

Figure 5 illustrates the results for each composite criterion and the final map of overall UQoL.

For the built environment, high levels of UQoL are revealed in the perimeter of the study area, whereas in natural environment there is no clear spatial pattern. The socioeconomic environment reveals a conceivable line that separates the study area into two major clusters. The west sector, characterized by degraded socioeconomic environment and the north-eastern and southern sector with high/very high socioeconomic conditions. The housing conditions are particularly degraded in municipalities around the center of the greater Athens area and are gradually improving as we move to the suburbs. The criteria of public services and infrastructures, and cultural and recreational facilities indicate higher levels of UQoL around the center of the study area as most of the services and cultural facilities are located in the Municipality of Athens (center of the study area).

Overall UQoL, indicates the division of the study area by an axis with northeast-southwest direction. On the one side of this axis, the northern, eastern and southern regions, present mainly high/very high levels of UQoL, while the western part of Athens greater area low/very low levels prevail.

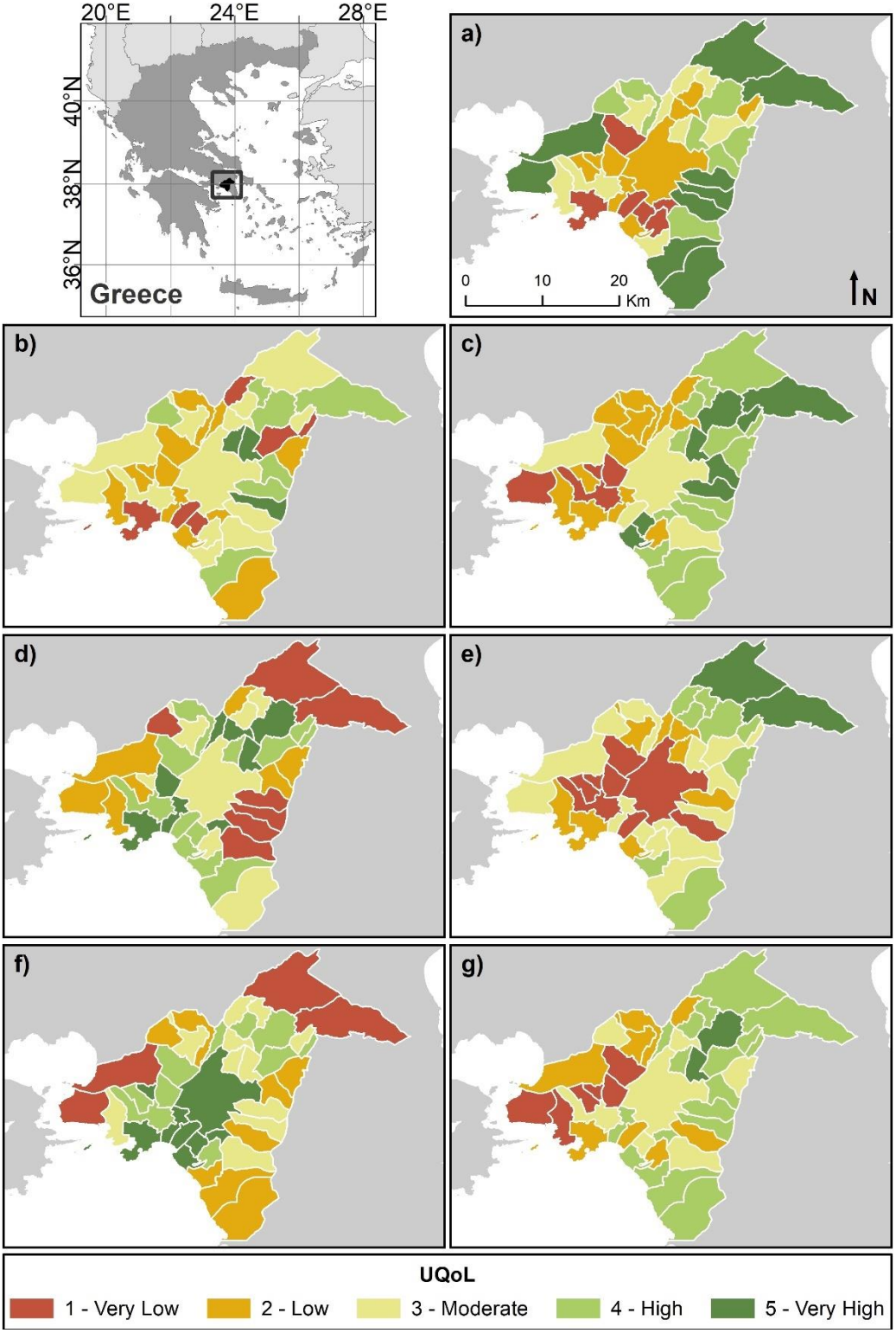

Figure 5: Mapping the composite criteria of (a) built environment, (b) natural environment, (c) socioeconomic environment, (d) public services and infrastructures, (e) housing conditions, (f) cultural and recreational facilities, and (g) overall UQoL in Athens greater area municipalities

The final output of the proposed methodology was validated based on the residents' perception on overall UQoL (Figure 6a), revealing the division of the study area by a northeast-southwest axis as well. Comparing the estimated UQoL levels across municipalities of Athens greater area to the final score the residents attributed to each municipality (Figure 6b), most of the spatial units have been rated at the same QoL level, except of a limited number that are classified to the right higher or lower category, whereas only one municipality seems to have more than one category difference.

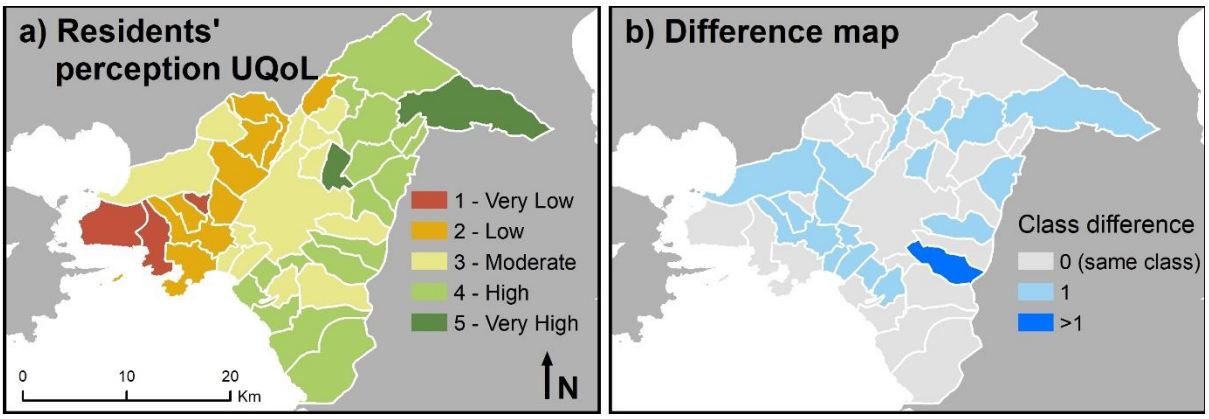

Figure 6: (a) Score of overall UQoL across the municipalities of Athens greater area, according to the residents' perception, (b) difference map between the UQoL of the proposed methodology and the UQoL of the residents' perception

Spatial autocorrelation outputs are presented in Figure 7, revealing a typical example of spatial clustering (Figure 7a). Almost 25% of the municipalities belong to the Low-Low type and another 20% of the municipalities belong to the High-High type. Analyzing this pattern, the Low-Low cluster is located in the western part of Athens greater area, which are the most degraded municipalities in the area, while the High-High cluster is located in the northern-eastern part of the Athens greater area. These municipalities are the most privileged, as far as living standards are concerned.

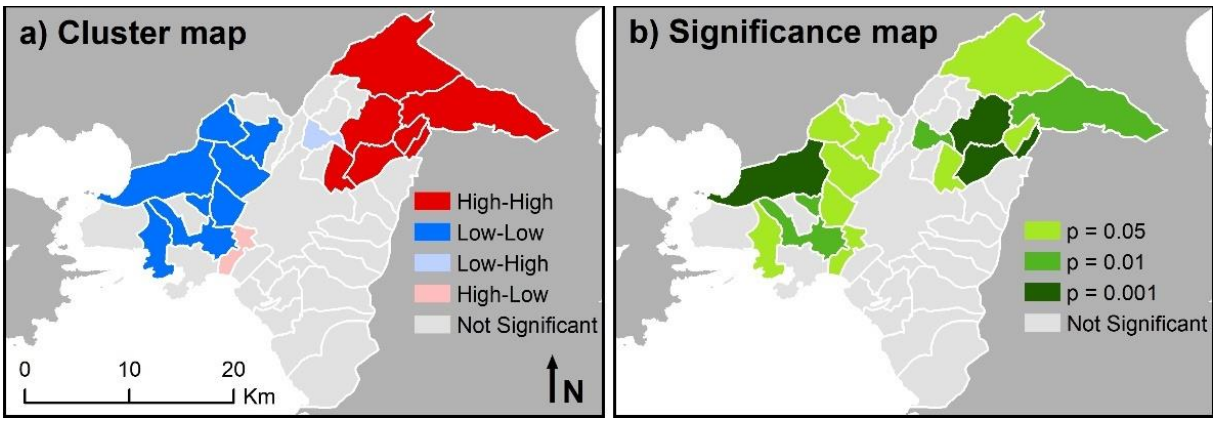

Figure 7: Spatial autocorrelation results implementing Local Moran's I (a) cluster map, (b) significance map

4. DISCUSSION - CONCLUSIONS

UQoL mapping revealed different zones among the municipalities of Athens greater area that seems to attribute various socioeconomic factors. In the western study area, where the disadvantageous municipalities in terms of QoL are located, lower socioeconomic strata are highly concentrated. On the other hand, the residents in north-eastern and south-eastern study area, in municipalities governed by higher overall UQoL, are characterized by higher educational and economic level (Chalkias et al., 2013). These clusters were also identified by the exploratory analysis, verifying the first law of Geography "*everything is related to everything else, but near things are more related than distant things*" (Tobler, 1970).

The north-eastern vs south-western spatial division of the study area is also evident in the housing conditions criterion. The living conditions of underprivileged people are associated with factors linked to lower levels of QoL, such as poorer housing quality and insufficient space (Sirgy & Cornwell, 2002; Linares et al., 2016; Eurofound, 2017). Geographers, social researchers and urban planners have analyzed the identified geographical inequalities in Athens greater area (Emmanuel, 2004; Maloutas, 2004). The urban development model of the area was based on simultaneous expansion and intensification (Arapoglou et al., 2021), as part of the Greek post-war model of economic accumulation. This model lacked of long-term development strategy, leading to the prevalence of short-term economic growth criteria, which in turn undermined socially rational and at the same time sustainable urban development (Karadimitriou et al., 2021).

Another geographical division is noticed between the central municipalities of Athens greater area and the more distant ones, regarding the built and natural environment criteria and the public services and recreational facilities. Low population density, extended open spaces and green urban areas, prevail in the more distant municipalities, characterized though by limited proximity to hospitals and sports facilities which are significant predictors of QoL (Apparicio et al., 2008; Kazemzadeh-Zow et al., 2018). On the contrary, central municipalities benefit from direct access to various infrastructures (Lloyd & Auld, 2002; Eurofound, 2013; Weziak-Bialowolska 2016; Kazemzadeh-Zow et al., 2018), whereas high population density, proximity to industrial units and high density of high-traffic roads cost to overall UQoL.

The results of this study could contribute to better decision making on developing targeted actions to upgrade UQoL, based on each municipality's drawbacks on the QoL-related criteria. Specifically, financial resources could be available to dwelling repair or renovation programs in municipalities where housing buildings of low quality are concentrated, and urban planning interventions could take place in areas with poor built and natural environment. Regarding the western municipalities characterized by low socioeconomic environment, social and long-term economic policies could be prioritized, while the enhancement of public services and recreational facilities at the most distant municipalities seem necessary to improve overall UQoL.

Beyond exploiting the findings of this study, the proposed methodology integrates a set of strong points related to the design and the implementation. The GIS-based assessment of UQoL enabled the construction of secondary variables through spatial data; an asset for local- level analysis that statistical data are not always available. In this way, the methodology implementation difficulties in other case studies with limited available data, could be overcome by replacing or constructing other UQoL-related indicators. GIS also allowed the criteria and overall UQoL mapping (Shyy et al., 2007; Ram Mohan Rao et al., 2012; Faka, 2020), demonstrating the benefits and drawbacks of the spatial units in each criterion and facilitating the identification of UQoL hot or cold spots (Martinez, 2009). The Natural Breaks method highlighted these inequalities among the spatial units. However, the classes thresholds were based on the values variance (Jenks, 1977) of the specific study area. Therefore, the values classification defined by this method vary from case study to case study.

The validation of the results, according to the residents' perception on overall UQoL, revealed that the proposed methodology can provide an acceptable QoL assessment at the urban environment. However, differences on a limited number of municipalities and the moderate level in which several spatial units are classified, highlight the need to explore UQoL inequalities within municipalities by implementing more exhaustive datasets and detailed information. Furthermore,

To conclude, mapping UQoL is a functional tool for the stakeholders to develop future strategies and design general objectives, focusing at the improvement of UQoL. In future work, the methodology can be implemented at neighborhood level to identify spatial inequalities within municipalities, and overtime periods to identify UQoL trends.

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