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Identifying equality and accessibility to health centers via Spatial Information Science

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ABSTRACT

Citizens living in mega cities need easy and fast access to health services and hospitals. In situations such as natural disasters or pandemics, it is critical to reaching such services rapidly to prevent losses and reduce health damages. Furthermore, ensuring equality in accessibility for such services is a vital responsibility for the governments. Quantifying accessibility and serving equality among the population is a significant challenge, where Geographical Information Systems (GIS) environment could provide solutions. In this paper, adequacy of the existing health services for the European side of Istanbul is analyzed spatially and quantitatively via open data sources. Then, the proportion of both rural and urban population that has access to the health services within walking distance is determined. Within this context, Urban and Rural Health Accessibility Indexes are proposed to generalize developed concepts. According to the achieved results, ~93% of the total population has access to a health service. Furthermore, the achieved results also represent the spatial distribution of the citizens having access to health services which is not previously provided via former studies in the region. The proposed concept is applicable for every city either in Turkey or in the world to help decision-makers prioritizing of their actions.

1. INTRODUCTION

Easy access to health centers and/or hospitals is a vital indicator for the public since every person has the right to get health care. Health investments should be prioritized and monitored by using quantified indicators to assure this condition. Relevant data, analysis and visualizations aid decision-makers and the public to understand the infrastructure performance against health cases (Krizek, 2010). Within the current pandemic conditions, accessibility to health services in equality is one of the top priorities of policy makers. Hence, informed decisions are highly appreciated.

This highly important aspect is monitored via local/national/international organizations, where quantitative Key Performance Indicators (KPI) for each spatial granularity are required. Accessibility to health services and access equality are also indicated in the United Nations' (UN) Sustainable Development Goals (SDG) that are international indicators described as the blueprint for peace and prosperity for people and the environment (SDKP, 2015). Goal nine of SDG is about the industry, innovation and infrastructure and several indicators/measures are presented within this goal to ensure the access equality.

In this study, two new indicators named Urban and Rural Health Accessibility Index are proposed that are applicable at the local level to identify the accessibility ratio and the spatial distribution of population towards health services. Quantifying accessibility is a spatial information science problem therefore it should be evaluated in a Geographical Information Systems (GIS) environment. Developed indicators are aimed to be useful for decision-makers and researchers to analyze the problem spatially to find quantitative and spatial insights about the situation. All data used are obtained from the open database, thus the methodology is applicable for all, where data is available.

Further sections are organized as follows: Study area, data and methodology are described in the following section. In section 3, results in both quantitative and spatial ways are presented and findings are interpreted. Finally, the subject is concluded in the last section.

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2. METHOD

2.1. Study Area and Data

Istanbul is Turkey's most crowded metropolitan city and its urban pattern is continuously changing due to the rapid population growth. The distribution, service capacities and accessibility conditions of the health services are vital. The challenge is significant in the case of natural/human-made disasters and/or pandemics. In this study, the European side of Istanbul where the population concentration is high and dense was examined in a GIS environment to analyze the access equality towards these health services.

To perform the analyses, location of current health services, road network and population information of Istanbul are needed. In the study, all data used for the analyses were obtained from open data portals and databases. Aforementioned required data were obtained from Istanbul Metropolitan Municipality (IBB) Open data portal, OpenStreetMap (OSM) and Turkish Statistical Institute (TUIK) respectively. For this high-resolution spatial analyses, the spatial resolution of the TUIK population data that is at district-scale should be increased. To solve the problem, 1km*1km grid-based population data was created from district-scaled data. For this preprocessing step, land cover/use information of Istanbul was used to distribute the population information into 1km*1km grids more precisely. The necessary land cover use data was obtained from the EU Copernicus Land Monitoring Service's open-source Corine Land Cover (CLC) database for the year 2018. The spatial resolution of land cover/use data is 100m * 100m. Urban class of land cover/use was used to identify the concentration of population; thus, the distribution was done in parallel with this information. All input data then were stored in a spatial database to later connect it to GIS environment. Turkish National Reference Frame (TUREF) TM 30 projected coordinate system was selected to represent the European side of Istanbul on the spatial database. Study area and data are shown in Fig. 1.

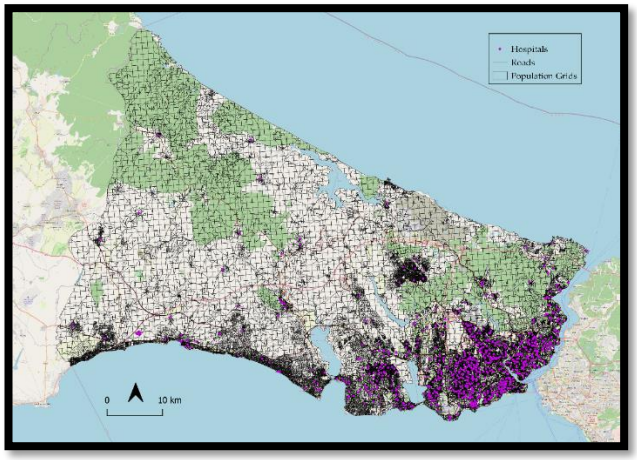

Figure 1. Study area and used data

2.2. Methodology

Within the scope of the study, the urban and rural population were evaluated separately to analyze access equality among citizens towards health services. So before starting the analysis, a consistent and reliable urban/rural definition is needed to separate the population characteristics. To ensure this, European Commission's urban-rural typology definition: "Rural areas are all areas outside urban clusters which are clusters of grid cells of 1km by 1km with a density of at least 300 inhabitants per km^2" was used (Eurostat, 2016).

According to the definition above, urban and rural grids were separated. 1km*1km grids having population value over 300 were selected as urban grids and rest as rural grids. Also, grids having population value under 20 were extracted from the rural grids since those grids represent water areas and barren lands. Resulted grids are shown in Fig. 2.

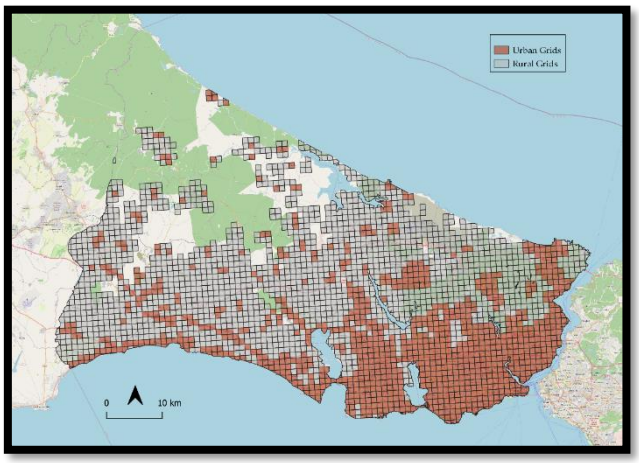

Figure 2. Urban and rural grids

To analyze the transport equality among different groups of citizens, walking distance accessibility condition for critical services was used as approximately 2 kilometers according to the definition of the United Nation's Sustainable Development Goals definitions (UN, 2018). To achieve this, hospitals' service area over the network was found by using the locations of the hospitals and the road network of Istanbul. Hospital locations were used to generate accessibility polygons toward them having 2 km radius over the network.

After this step, rural grids and urban grids were overlayered with resulted polygons to find the total population having access to hospitals in 2km walking distance. In this context, Urban and Rural Health Accessibility Indexes were proposed within this study. Equation of the proposed indexes is the following:

$$UHAI\ (RHAI) = \frac{Urban\ (Rural)\ Population\ Having\ Access\ to\ Hospitals}{Total\ Urban\ (Rural)\ Population}$$

Limitations within the study are listed as; (a) As health services, only IBB's open data was used. Services such as public hospitals, city hospitals, medical centers, family health centers, polyclinics and diagnosis centers exist in the data. (b) Road network quality depends on the OSM database that is a collaborative mapping project that provides a free and editable map of the world (Corcoran et al., 2013). It is one of the greatest resources for acquiring spatial data and its data quality is generally quite high (Haklay, 2010).

3. RESULTS & DISCUSSION

Resulted accessibility polygons in the 2km service area of the hospitals are shown in Fig. 3. Accessibility polygons then were intersected with urban and rural grids separately to show the distribution of relevant population having access to health services. Resulted maps are shown in Fig. 4 and Fig. 5.

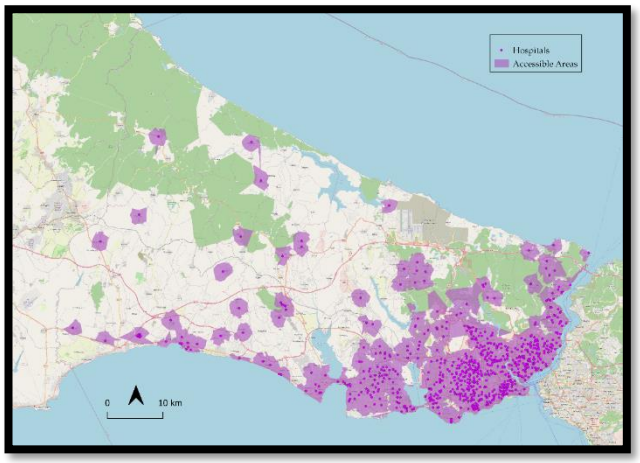

Figure 3. Areas accessible to hospitals in 2km walking distance

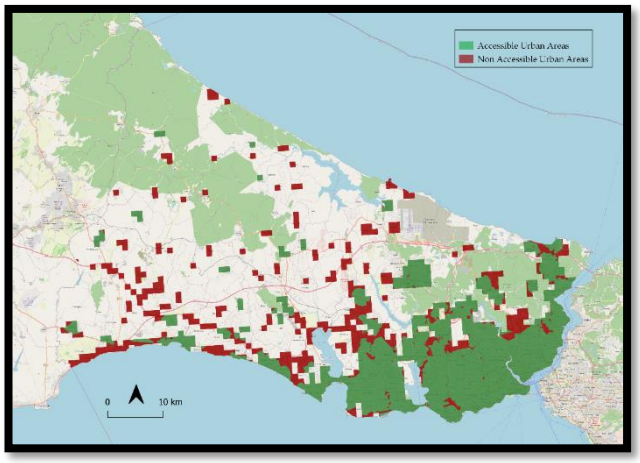

Figure 4. Urban areas accessible to hospitals

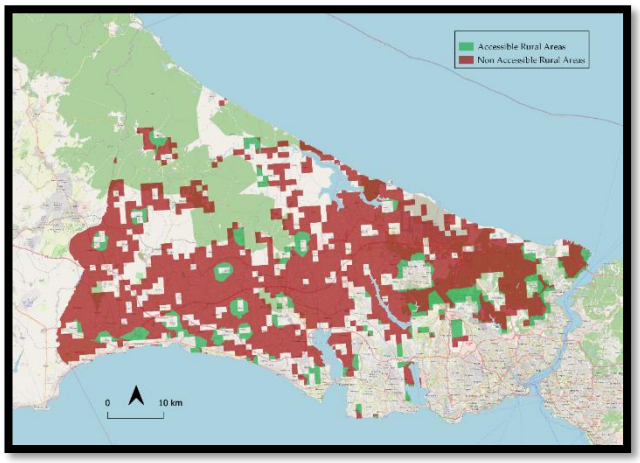

Figure 5. Rural areas accessible to hospitals

When accessibility maps are examined, it could be seen that most of the urban areas have access to hospitals spatially. However, the same could not be said for the rural areas. After interpreting the maps, the proportions of the population were quantified to get the quantitative results. Results of the proposed indexes are given in Table 1.

Table 1. Urban and Rural Health Accessibility Indexes (UHAI/RHAI)

Population	Urban Population	Rural Population	UHAI	RHAI
Having Access	8.430.474	40.814	93,5%	29,7%
Total	9.016.550	137.408		

92.5% of the total population have access to health services. While the urban population constitutes 99% of the total population of the European side of Istanbul, the rural population constitutes 1%. Results showed ~94% of the urban population has a health service where is accessible in 2km walking distance. However, in rural areas, this ratio is decreased to ~30%.

For the urban population, it is seen that current road structures are sufficient but it is hard to say the same thing for rural areas. It is an interesting finding for the health sector and also for governments to inspect the infrastructures or investments' impact on public accessibility. However, as mentioned in the assumptions section, used data quality depends solely on the open-source database. By using more detailed data, these concepts could be improved to get more realistic outputs. For example, bed capacities, intensive care capacities or unit-specific weights can be given as attributes to the hospital data to improve the methodology.

4. CONCLUSION

Health accessibility indicators are important to control the public's health accessibility conditions and to analyze the performance of health services. Also, urban and rural separation is a critical indicator for ensuring access equality among citizens. In this paper, open-source data and environments are used for each step of implementation of the proposed indicators. The methodology is applicable for every city either in Turkey or in the world to help decision-makers prioritize their actions. With simulated data, the methodology can be applied for future years to analyze the effects of taken decisions. Furthermore, support of decision-makers on open spatial thinking and adaptation of distribution policies are utmost importance, since without such data it would be very difficult or impossible to perform such analyses.

REFERENCES

Krizek K (2010). Measuring Accessibility: Prescriptions for Performance Measures of the Creative and Sustainable City. International Journal of Sustainable Design, 13, 149-160.

Sustainable Development Knowledge Platform. (2015). The 2030 Agenda for Sustainable Development. Available: http://sustainabledevelopment.un.org/post2015/transformingourworld, Accessed: 14.10.2020.

United Nations. (2018), Metadata for Indicator 9.1.1. Available: https://unstats.un.org/sdgs/metadata/files/Metadata-09-01-01.pdf, Accessed: 14.06.2020.

Corcoran P, Mooney P & Bertolotto M (2013). Analyzing the growth of OpenStreetMap networks. Spatial Statistics, 3:21 – 32.

Haklay M (2010). How good is volunteered geographical information? A comparative study of OpenStreetMap and Ordnance Survey datasets. Environment and Planning B: Planning and Design, 37(4), 682–703.

Eurostat (2016). Urban-Rural Typology, Available: https://ec.europa.eu/eurostat/web/rural-development/methodology, Accessed: 14.06.2020.