Evaluating Public Space Pedestrian Accessibility: A GIS Approach*

TUDOR MORAR, LUCA BERTOLINI, RADU RADOSLAV

1. Introduction

1.1. The importance of public space

THE MANY factors operating in the city make it a complex study environment, but these many, sometimes unrelated factors, also contribute to its beauty and functionality. Unwin (1909, 10) argued that since towns are more than a mere aggregation of people, it should be the planner's work "to transform these same aggregations into consciously organized communities," meaning that planners have the task to find inter-related factors and to come up with measures that fulfill the city's needs.

One of these needs is well functioning public spaces. Even though society has an ever-growing mobility, and is no longer solely dependent on the functions provided by the town square, "good urban public space is required for the social and psychological health of modern communities" (Mehta 2007a, 165). It facilitates dialogue, fosters social awareness and encourages ethical conduct (Mehta 2007b). It also acts as source of quality of life and sustainability (Chiesura 2004; Neamţu et al. 2009).

Public space has been extensively studied both from a sociological (Mitchell 2003; Neacşu, 2009; Worpole and Knox 2008) and a planning point of view (Asensio and Webb 1997; Carmona 2003; Cybriwsky 1999; Marcus and Francis 1997). Given the amount of 'ingredients' that make a public space successful, many studies try to create an overview of the whole array of measures of improvement (Pasaogullari and Doratli 2004). These measures can be looked at from two perspectives: one that looks at the public space and one that looks at its users. Most studies take the first perspective. Taking for example livability, they say a public space can be considered livable if at any moment it has a certain number of people using it, in proportion to its surface (Alexander et al. 1977). Others state for instance that: "A good plaza begins at the street corner" (Whyte 1980, 54), where there is natural flow of foot traffic. This paper takes instead a user

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perspective, and looks in particular at user accessibility, namely how many and who are the people able to use the public space in an acceptable walking time from their homes, i.e., how many and who are the potential generators of the foot traffic.

This is important for both the quality of life of people as well as the quality of public spaces themselves. Low and Smith (2006) discuss the drawbacks of the enclosure of the urban world through such amenities as 'theme park development', shopping malls, condominiums and gated communities, all subject to technologies of surveillance and private ownership. Tonnelat (2010, 5) argues that "if the diversity that people learn to interact with is controlled, "sanitized" and devoid of any risk of unsettling encounters, the learning and civility that is produced is necessarily contained within a restricted definition of who the members of society are." So it is important that in a city there are enough public spaces that offer unrestricted access to all citizens.

We could identify as examples of unrestricted access public spaces: the square, the promenade, the cluster of coffee shops, the pedestrian street, or the park. Streets are also public places, but they are "primarily places of transit, in contrast to public squares, which despite embodying a certain degree of pedestrian through movement are fundamentally places of destination for static activities" (Campos 2000, 1).

In particular, this study takes into consideration accessibility to public squares that were planned as community centers, public markets or urban plazas. We consider walking the main access mode, since it is the one having the capacity to maintain the most direct relationship with the environment of the city, and the one bringing most benefits to human interaction (Talav Era 2012). Walkable neighborhoods have also been found to encourage the development of social capital (Leyden 2003).

In her 1997 paper, Handy was stating that "the concept of accessibility has rarely been translated into performance measures by which policies are evaluated, despite a substantial literature on the concept" (S. L. Handy and Niemeier 1997, 1175). Since then other scholars, besides Handy have shed light upon accessibility measures—see e.g. review in Curtis and Scheurer (2010), yet, because of their theoretical sophistication, such measures "require more analytical skills from the participants, so it is more difficult to use such measures in practice" (Straatemeier and Bertolini 2008, 2). Besides these interpretability issues, the data required for input often comes from open access governmental sources and national census bureau servers, which in many European countries are not yet publicly available because of legislation that is only currently taking shape (European Comission 2011). Actual costs of producing data (Schellong and Stepanets 2011) also delay its availability, although efforts are being currently undertaken in this direction through national and European projects (Vandenbroucke and Biliouris 2010). So most of these measures remain hardly available for professionals or municipalities in countries where knowledge and data is scarce. It was our aim to develop an accessibility measure that is easy to interpret and does not have high data requirements.

We define accessibility as ease of access to the activities that people need or want to participate in (Susan Handy 2002). Accessibility analysis regarding pedestrians mostly uses tools like space syntax and walkability inquiries, such as the ones funded by Acting Living Research (2012). Most accessibility instruments consider land-use, street pattern and population density as main factors (De Meester et al. 2012). Street design, in terms of sidewalk width and condition, crossings, shaded walkways (Bach and Pressman 1992), and so on, is also a contributing factor to accessibility. In this paper we will focus on the more macro-factors, like street network and density.

High density is often associated with the compact city and its specific characteristics that improve quality of life: reducing the need to travel, promoting public health through walkability (Ioncică et al. 2012), providing good pedestrian access to facilities (Inoue et al. 2009) and social interaction in terms of opportunities for social contact (Mansavi 2000). Next to density network design is a key determinant of access (Ewing and Cervero 2010). Having density and street network as main parameters, this paper focuses on three areas: theory of public space accessibility, description and improvements brought by the GIS method used for the analysis, and conclusions that can be drawn from a case study. The case study consists of three phases of the development of Timişoara city, Romania, namely a 1941 historical phase, the 2012 situation, and a proposal realized by the Planning Master classes of the Polytechnic University of Timişoara.

The following section will present the historic and current state of public spaces in Timişoara, along with criteria of public space functionality. Then, a methodology section will present the data sources, and functioning of the GIS model. After this, the three city development phases are described and analyzed followed by a discussion of the results. Finally, the conclusions present the main findings of the paper from both a methodological and planning point of view and show further research directions.

1.2. Case Study Timişoara

In Timişoara and other Romanian cities, planning has changed after the 1990's. If between the 1950's and the 1990's city planning was regulated by the socialist state with investments in apartment building complexes as leading intervention (Maxim 2011), after the 1990's state housing corporations slowed down their activity only to be revived at a much lower pace after 1998 through the National Housing Agency (UNECE 2002). Furthermore, since planning in the socialist era was conducted by the state, it could be, and was integrated with public transportation. With the market economy, personal transportation began to grow, clogging the streets with vehicles (EUROSTAT 2012). Furthermore, private investment in housing is leading and is mainly characterized by urban sprawl (Neam□u 2005), which is extending the city at low densities that cannot sustain public transport nor walking or cycling and create a high degree of car dependency (Newman and Kenworthy 2006). The situation in many European countries is actually not so different in terms of rise of private vehicles (World Bank 2011) and urban sprawl (European Environmental Agency 2006). This is why we could consider the case study representative for other European cities with a similar planning evolution which should be able to have an assessment of the accessibility levels of their public spaces, and what factors influence these levels.

Timişoara has long been characterized as a multi-cultural city which owed its development to the good cohabitation of its citizens. The historical neighborhoods built around the fortified center in the 18th and 19th centuries were centered on urban plazas that served multi-functional purposes like commerce, religion and social life. As the city grew after the 1960's, the availability of public transportation made the planning of these spaces less important, increasing access to more distant workplaces being seen as the main objective. In turn, this led to a loss of identity of many built areas, which were merely characterized by current architectural fashions and available building materials, financial status of the investors (which led to similar building volumes), and road profiles. The most symbolic public spaces still remained those in the historical centers (Blinkova & Pavlenko, 2005), with the central Unirii Square as highlight. In recent years, funding has been attracted mainly by central public spaces, leaving lower-level centers on a path to under usage. This path has its roots in the migration of services and production to office buildings and industrial complexes, which led to society's basic needs (like shopping and jobs) finding their way elsewhere, and ends with the deterioration of their physical qualities like street furniture and architecture. So, if not properly maintained, lower-level centers risk not functioning at full potential and not fulfilling their role towards the community.

Given this state of facts, we focus on the neighborhood public space, and find in the literature that it needs to meet certain criteria in order to function: it should be integrated into the urban structure (AFSSDS 2006), it should have an identity (AFNEKS 2007), a historical background (Southworth 1990), it should be secure and offer opportunities for socialization (Ţurlea 2008). Furthermore, Lynch argues that public space performance is related to access, meaning "the ability to reach other persons, activities, resources" (Lynch 1981, 118). All these being part of the public space, we argue that it is important to see which neighborhood public spaces have (or could have) the most potential in terms of accessibility, to be able to start formulating plans for their maintenance or development.

2. Methodology

Overview and selection of methods

THE PURPOSE of the method is investigating two topics. The first topic is showing how many and which people can reach a public space and the second one, to give insight on which factors influence the results. Kwan (1998) has shown that accessibility is generally measured in three steps: by choosing a reference location (in our case households), specifying a set of destinations (here, neighborhood public squares) and deciding the physical separation model (the pedestrian street network). To do this one needs to make use of geographical datasets, meaning maps associated with tabular data. The resources requested would be: the density map of the city and cadastral plan (for computing household locations and population), the shape and location of public squares (destinations) and a street network dataset (ESRI 2012) with routing functionality.

An overview of accessibility measures used in urban and transportation planning has been done by Lotfi and Koohsari (2009), and it identifies the following methods:

- container (number of facilities within defined limits);
- coverage (number of destinations within a distance);
- minimum distance (distance to closest facility);
- travel cost (average time, time distance, or cost measurements);
- gravity (all facilities divided by distance).

Out of these we will use the coverage method, by looking at number of people reachable by walking within a certain timeframe from a public square. This timeframe has been set to 10 min. since it is a generally accepted walking time to daily-needs facilities (Cervero and Kockelman 1997; Cervero et al. 2004), and also particularly specific, as "public space in a neighborhood should be reached in a maximum of 10 min. of travel time" (Sevtsuk and Mekonnen 2011, 232).

Next, we have computed accessibility by means of the shortest network path method. Since this method connects origins and destinations, their number and location becomes extremely important. With a fixed number of destinations (i.e. public squares), the accuracy of the origins becomes decisive. Quality of origins refers to generalization level, like: census tract level (Gregory 2002; Talen and Anselin 1998), parcel level (Biba et al. 2010), or apartment parcel centroids (Tribby and Zandbergen 2012). We have chosen to construct a model at household level, with households showing number of residents living at each point. We will show how this approach eliminates uniformity constrains of density data, allowing the use of GIS for small-scale accessibility analysis.

2.2. Data Sources

The data sources used in the model are listed in

ID	Data	Type	Source
1.	Timişoara's street network	Line	OSM (2012)
2.	Timişoara's network dataset	Dataset	OSM2NetworkDataset (Peters 2011)
3.	Timişoara's density map	Polygon	SC Plancontrol SRL, as part of the Study for densification of the urban tissue of Timişoara
4.	Public squares 1941	Polygon	Timişoara City Plan 1941
5.	Public squares 2012 & proposals	Polygon	Imported from CAD from the studies of the Urban Planning Master classes of the Architecture Faculty in Timişoara 2010

The data used in the study is publicly available, the only software requirement being the Network Analyst extension of ArcGis. Three development phases are taken into consideration, namely the 1941 urban development, the current 2012 one, and a possible development based on the studies realized by the Planning Master classes of the Polytechnic University of Timişoara, led by As. Prof. Ph.D. Arch. Radu Radoslav.

2.3. Model Description and Conceptual Explanation of its Functionality

We started out building the GIS model by extracting the road data from OpenStreetMap, and turning it into a network dataset with the help of OSM2NetworkDataset application, designed by Peters (2011), which assigns travel times to each road segment at a constant speed. Studies have found that pedestrian walking speed ranges from 4.51 km/h to 4.75 km/h for older individuals to 5.32 km/h to 5.43 km/h for younger individuals (Knoblauch et al. 1996). Thus, the average walking speed used in the network is 4.8km/h as a medium value of the above mentioned, and confirmed by common routing applications like Google Maps and Bing Maps. Taking account of the 10 minute timeframe mentioned above this means roughly 800m, and this distance is computed through the shortest network path method, the same method used in most studies using the Network Analyst extension of ArcGis (Sevtsuk and Mekonnen 2011).

In terms of calculating density, many scholars turn to census data. A commonly used measurement method is buffer containment, namely superimposing a buffer over a location and intersecting its surface with census tract data (Mennis 2002). The main disadvantage of the census data is that it standardizes units of analysis. This procedure thus lacks the ability of capturing real urban population densities because it may overestimate homogeneity within small areas (Harris and Longley 2000). Our methodology seeks to improve this procedure by offering a way to compute actual household reach, since "house-level distribution enables a more sensitive and accurate assessment of differences between urban areas" (Omer 2006, 261).

The density data is the one used for the Densification Study (CCDDT 2009) commissioned by Timişoara's urban planning committee in 2009. The map was checked to verify if the population/ha × total ha was corresponding to the total population, and the error was less than 5% (311,927 as compared to the existing 303,708 in the preliminary reports of the 2012 Census). An additional reason why this specific density area map is used is because official data is still in a preliminary phase (official release being scheduled for 2013), and does not come in a census-tract form. Finally, even if census data was available, our method deals better with the small area homogeneity problem, as discussed above.

We have constructed the housing units through shape recognition based on Timişoara's cadastral plan (Planwerk SRL and Vitamin Architects SRL 2011) and aerial imagery base map. Only houses were selected, excepting annexes, industry or any other type of construction. An extensive description of this process was done by Ural et al. (2011) who used a similar technique in combination with color infrared aerial photography. Not being able to make use of such images, we state that such a process can also be done based on detailed city-block studies (CCDDT 2009) or a proper database regarding building usage (Callies 2003, 526). We consider it to be extremely helpful when detailed postal addresses are not available.

House footprints formed a polygon feature class, with the total number of houses constituting the model at 24.200. The 2012 Census Report stated 24,311 buildings with living units (Romanian National Statistics Bureau 2012). Population was then attributed to each house according to its area ratio of the total built surface for housing, within a density zone. Fig. 1 illustrates the conceptual building of the model.

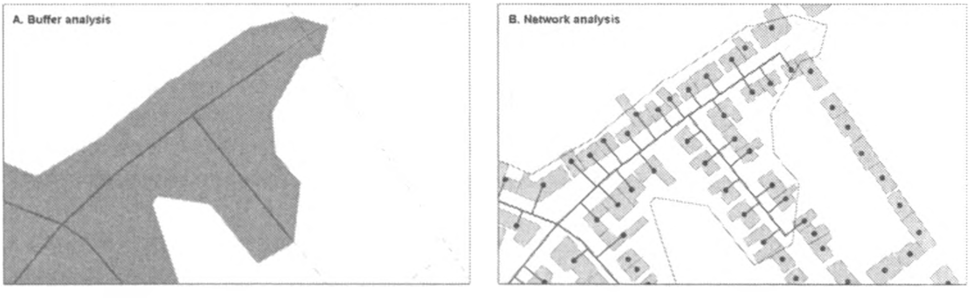
Fig. 1A. shows a city block that is similar to a density area, but on a smaller scale, to have a more detailed view on buildings and network construction. The shape of the buildings was realized with closed polygon recognition in CAD software, and the results

FIG. 1. Conceptual model

SOURCE: Original work

transposed into ArcGIS. So, if considered a density parameter of 50 inhabitants/ha, and a surface of 1ha, it would result in a total population of 50 persons. Fig. 1B shows how this population is redistributed to each building according to its footprint size, gray intensity showing more people. Fig. 1C shows centroids retaining the population numbers and being connected to the street centerline to allow network analysis.

FIG. 2. Shortest network path density assessment. A—Percentage of buffer surface in total surface. B—People in households reached by network.



SOURCE: Original work

The assessment method of shortest network path may work in two ways, namely through buffer analysis (an area of fixed width along the road centerline that would include all housing units), and network analysis (connecting each house to the road centerline). For a more detailed overview on these methods see Achuthan et al. (2007). The buffer analysis method extracts demographic characteristics, by calculating the proportion of the area of the density zone within the generated buffer, as seen in Pulugurtha and Sambhara (2011). Before the possibility of distributing population from density area to houses, the buffer analysis method was the only available one. We see that after, network analysis becomes possible, with its advantages recognized in a number of papers, namely realistically assessing individual accessibility in urban areas (Tribby and Zandbergen 2012), offering more realistic insight than buffer analysis (Comber et al. 2008), and measuring exact numbers of destinations along footways (Achuthan et al. 2007). In light of these advantages we also adopted the network analysis approach.

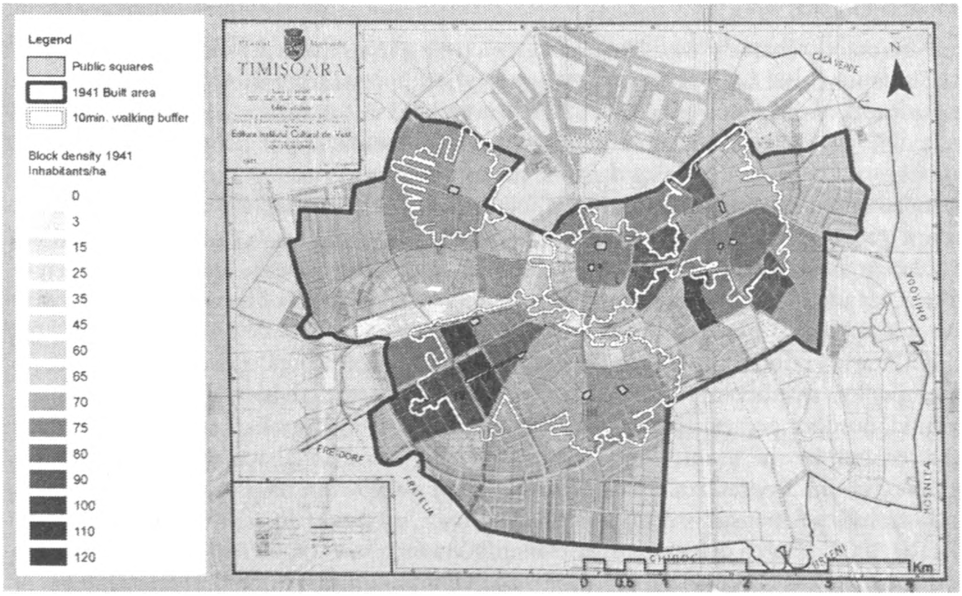
3. The 1941, 2012 and Proposed Timişoara Urban Squares Datasets

For constructing the historical square dataset seen in Fig. 3, we imported into ArcMap the 1941 City Plan and georeferenced it. The built area limits were constructed with a resulting surface of 2,190 ha, and a total road length of 292 km, which is close to the 312 km reported for the year 1943 (Timi_oara City Hall 2000). Density data was then distributed to blocks derived from the street network using the 'Feature to polygon tool.' The distribution of population was realized in two steps. One was assigning current density to historical areas which did not suffer changes until present. The other was decreasing density of areas occupied today by apartment buildings to zero where the historical map showed undeveloped land, or to low one-story housing density where new constructions have been inserted next to old ones. The total population of the historical model resulted in 120148 inhabitants leading to a gross density of 54.8 inhabitants/ha.

The map shows to the north a built area outside the red limit, this representing the planned extensions of the city to accommodate its growing population from 102,390 in 1930 to 125,052 in 1941 (Varga 2002). These areas were not included in calculations since they were not yet built in 1941.

The 2012 current situation (Fig. 4) shows that excepting the central main city squares, other public squares can be divided into three groups: 'historical,' 'socialist,' and 'utilitarian.' Historical public squares are the ones with a life span of more than 100 years,

Fig. 3. 1941 public squares with 10 min. walking buffer



Source: Original work. Background plan after Timisoara's city plan of 1941.

FIG. 4. 2012 public squares with 10 min. walking buffer

SOURCE: Original work

and are mainly characterized by some restructuring in terms of surface and functionality. Three new socialist public squares appear, occupying the centre of dense apartment complexes built between 1962 and 1989. As opposed to central socialist plazas, designed for public demonstrations, control and supervision of the life of people, the residential complex centres were gathering daily life functions like pharmacy, grocery or postal office, grouped in one or more multi-purpose buildings (Engel 2006). Their open space did not have a particular design apart from the sidewalk that could reach 5m in depth and the placement facing one or two quiet streets. However, their central location in the neighbourhood and their quiet surroundings offer them the potential of becoming more attractive with proper rehabilitation.

Utilitarian public squares are the ones that took shape around existing green squares or empty lots that became community ground for different activities (e.g. children's playground, outdoor games) and gradually attracted other functions like small stores. Others were created by the municipality to host open-air commercial activities and gradually became community centres. Their use could grow if they were to be supported by design and incentives for small investors.

The 2008 research question of the Planning Master classes of the Polytechnic University of Timişoara was defining the limits of the city's administrative units. The conclusion of the study was that Timişoara can be divided into over 100 territorial reference units, of which over 70 are characterized by a residential land-use. According to the "Master plan

FIG. 5. Existing and proposed public squares with 10min. walking buffer

SOURCE: Original work

for sports and recreational facilities in the city of Timişoara" (SC Plancontrol SRL 2009) each of these territorial reference units needs a kindergarten, a school, a small park, commercial facilities, and a public space as main functions. Density analysis has shown that not all can sustain these functions. This is why the 2009 Master Classes proposed public spaces in the ones more likely to support them. These proposals were based on an analysis methodology that is extensively defined in the "Organic Growth" monograph (Radoslav et al. 2010). In short, each student had to study one area of the city and identify the place with the highest potential to become a community centre, either by strengthening its existing characteristics or by attaining a new identity. As seen in Fig. 5, the result was a total of 29 proposals for building new or rethinking existing public squares.

4. Results

THE RESULTS help us recover the main ideas around public spaces raised in the introduction, namely planning for their accessibility, acknowledging the importance of city density and of integration into the urban structure.

As shown in Table 2 the analysis can answer three questions:

How many people have good access to public squares? [A, B, C]

How did public squares' surfaces and numbers change? [D, E, F]

How well are public squares integrated into to the city's structure? [G, H,I,J]

Table 2. Results

ID	Result	1941	2012	Proposal
A	Population in model	120,148	311,927	311,927
B	Population with access	47,260	121,243	210,972
C	Population with access of total population accessed (A/B)	39.3%	38.9%	67.6%
D	Public square total area in hectares	9.3	10.3	17.7
E	Mean public square area in hectares (D/F)	0.77	0.60	0.61
F	Number of public squares	12	17	29
G	Total area within 10 min. reach in hectares	1,190	1,520	3,670
H	Model city area in hectares	2,190	5,730	5,730
I	Percent of the city area within 10 min. reach (H/G)	54%	26%	64%
J	Medium density in the 10 min. buffer area in population/ha (B/G)	40	80	57

The first observation is related to total population numbers, which more than double from 1941. The increase of population is related to the strong industrialization and urbanization that took place between the 50's and the 90's. This increase of population was mainly dealt with by accommodating people into four to ten floors apartment buildings, placed on empty city lots. They can be visible in Fig. 6, spread all around the city centre, with three main concentrations, one to the north and two to the south. These complexes are the ones surrounding, or hosting the socialist public spaces identified in Fig. 4. They are the reason for the increase in density around a number of public squares that led to the mere difference of 0.4% population with good access to public squares between the historical and present timeframe. However, if the percentages are similar, absolute numbers show that in 1941 the 39.3% population with access referred to about 73,000 people, while in 2012 the 38.9% refers to 190,000. Conversely, in absolute terms, those without access rose from 72,888 to 190,684. On the contrary, the new proposal would mean a sharp increase in population accessed, both in relative and in absolute terms.

Planning implications of these findings are that designing dense housing complexes improved overall access not only to public spaces integrated into the design, but also to adjacent ones, raising the overall city average. This meant that from the accessibility point of view, coherently planned medium-rise residential surfaces can prove to be more successful in this respect than individual efforts resulting in fairly large one to two story housing areas. We have tested this hypothesis by looking into the density of the three socialist public squares and finding it to be of 175 persons/ha. This contrasts with the density around three proposals for public squares placed in individual housing areas, with an average of 95 persons/ha. Yet, the lack of initiative coming from the administration, and the support of the banking system trough credit for individual housing currently results in the city sprawling outside its current limits at a fluctuating pace.

Population that had good accessibility in 1941 was mostly formed by rich city estate owners living in the historical neighborhoods. Today it also consists of those liv-

FIG. 6. High density areas built between 1962 and 2009

SOURCE: Original work. Background plan from Open Street Map (Open Data Commons Open Database License)

ing in apartment building complexes, although the socialist public squares cannot be considered to be fully functional, as described in Section 3.

Outside medium-rise areas, uniform zoning at low density is preventing public squares to naturally form around clusters of neighborhood-scale retailers. The proposal's sharp increase in population with good access to public squares is due to placing new small squares where previously there were none, and thus extending the overall served area. It would mean that also a part of the population living in individual houses may have good access to public squares.

The second group of observations relates to surface and number of squares (D, E, F in Table 2). Historical public squares were generally characterized by large dimensions since they were planned by the Austro-Hungarian administration for trading activities. This explains the mean public space area of 1941 being highest. The ones constructed in the last 70 years didn't require large surfaces since they fulfilled functions like exposing a main building (like the railway station, or a cultural centre), offering access to a group of buildings in socialist neighborhoods, or simply connecting two points of access. This is shown by the mere one hectare increase in total public square space. This is contrasted by the large surface increase in the proposal. This increase in total area is explained by the much higher number of public squares.

The last part of observations is related to integration into the city structure (G, H, I, J in Table 2). We see the urban surface within reach of public squares increasing from 1941 until today, due to the insertion of the new squares. However, due to the large increase in city surface, the percentage of accessed surface has declined sharply from 1941 to 2012. The new proposals would correct that as they would rise the percentage of surface within reach to more than twice the size of todays. Furthermore, we see the density in 2012 rising around public squares because of the apartment building complexes, and decreasing in the proposal because of the public squares placed in more low-density parts of the city. Since "the optimum density for sustainable development is generally in the range of 150-180 bed-spaces per hectare" (Arbury 2005, 47), we can conclude that overall city density should grow, to allow efficient use of public squares.

5. Summary of Main Findings and Further Research

CONCLUSIONS CAN be grouped into two sections, namely conclusions regarding the method and conclusions regarding the case study. The GIS method has shown how publicly available data and simple software was used to get a comprehensive overview on the city's accessibility to neighborhood public spaces. It improved the use of density data by concentrating it into households and then used this household density together with network analysis showing that macro-scale data can be adapted and used for micro-scale research.

The construction of density which was assigned to centroids that became geo-referenced addresses may be further developed in three steps. The first step would be information about building height, as in Ural et al. (2011). This would result in a more accurate distribution of population. The second step would be on-site visit by evaluators that would mark the number of apartments in each building. And the third step would be apartment population data from the National Population Census Survey.

In our application, even though height information was not available, higher density areas represent taller apartment buildings, and their footprints show these higher densities. This is why errors may have only occurred where one area was substantially varying in building typology, turning the discussion into a question of data quality, namely the smaller the density areas are, the more accurate the results from the analysis.

As stated in previous studies, one of the key barriers to accessibility planning is the lack of a "common language" between urban and transport planners (te Brommelstroet and Bertolini 2008). GIS based accessibility indicators can provide such a language (Straatemeier and Bertolini 2008). This study suggests how urban planners, through means of regulating density around key locations, can start improving accessibility to public spaces. The model can also offer a means to transport planners for assessing implications for pedestrian access when designing or modifying street networks. In this last respect, the model could be improved by including the barrier effects of street crossings. This results into yet another further research direction, namely modeling delays at crossing facilities according to either traffic light time or street traffic intensity, based on a field study.

With the help of this information, public authorities may check if requests for building developments or street layout re-design would aid or misbalance the city's current quality of access to public squares. This would mean that they could gradually and objectively measure the density and street network coherence growth of the city and properly evaluate neighborhood potential, in this case with respect to its impact on people's access to public squares.

Limitations of the methodology are in data availability, a minimal requirement being the density map. While open-source data allows a good overview, official data would result in a more precise report.

Furthermore, as this model adopts a simple accessibility measure (measured in distance and time) it may misrepresent actual accessibility because of neglecting qualitative factors like street design and number of services at destination. That is why it needs to be complemented by other measures like: spatial configuration, attraction of opportunities, and pedestrian comfort (Talav Era 2012). This would mean introducing other types of parameters into the methodology, but also requiring more programming and data.

Having as goal promoting sustainable accessibility and reducing car dependency, another direction of further research would be studying differences in access to city-scale public spaces, which cannot just rely on access by walking and, in order to reduce car dependency should be also accessible by bicycle and public transportation. This would require building a multimodal transport network model.

In terms of planning, Timişoara is one of Romania's cities that inherited a large surface of historical neighborhoods, thanks to the role it played under the Austro-Hungarian rule as capital of the Banat region, and its 18th century development. It remains today one of Romania's largest cities. Most other cities in Romania grew only after the middle of the last century, either through private or state-built housing when public space did not longer play such an important role because of, among other, the growth of public transportation and out of the neighborhood destinations. However, even in Timişoara's case, 60% of the current population still does not benefit from good access, representing an increase in absolute numbers from the 1941 analyzed state. We were able to show how well placed new public squares could improve this situation, by adding almost another 30% of people with good access and still achieving reasonable densities of public square use.

So, suggestions to improve public space accessibility following the analysis would be firstly placing new ones, mainly in residential areas with individual houses that didn't benefit from integrated planning. Second, improving accessibility to existing public squares may be realized by reusing and opening up non functional industrial land, and creating pedestrian connections like bridges over main city barriers (e.g. the Bega water channel and the railroad bordering the city centre). Furthermore, 'socialist' public squares placed in high density areas show to have the most potential in usability, and may represent priorities in a general redevelopment plan.

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References

Achuthan, K., H. Titheridge, and R. Mackett. 2007. Measuring pedestrian accessibility. In *Geographical Information Science Research UK (GISRUK)*, 264–69. Maynooth, Ireland: National Centre for Geocomputation, National University of Ireland.

Acting Living Research. 2012. Environmental assessments.

AFNEKS. 2007. Charta für den öffentlichen raum. Ed. Arbeitsgruppe des Forums Nachhaltige Entwicklung für Kantone und Städte. Lübeck: Perspektivenwerkstatt.

AFSSDS. 2006. Strategien für den öffentlichen Raum. In *Arbeitsgruppe der Fachkommissionen Stadtentwicklungsplanung und Stadtplanung des Deutschen Städtetages*. Cologne–Berlin: Deutscher Städtetag.

Alexander, C., S. Ishikawa, and M. Silverstein. 1977. *A pattern language: Towns, buildings, construction*. New York: Oxford University Press.

Arbury, J. 2005. From urban sprawl to compact city—an analysis of urban growth management in Auckland. Auckland University.

Asensio, C. F. and M. Webb. 1997. *Redesigning city squares and plazas*. New York, NY: Arco for Hearst Books International; distributed in the U.S. and Canada by Watson-Guptill Publications.

Bach, B. and N. Pressman. 1992. *Climate-sensitive urban space: Concepts and tools for humanizing cities*. Delft, Netherlands: Publicatieburo.

Biba, S., K. M. Curtin and G. Manca. 2010. A new method for determining the population with walking access to transit. *International Journal of Geographical Information Science* 24, 3: 347–64.

Blinkova, O. and A. Pavlenko. 2005. Sistemul Informa□ional Geographic al punctelor de reper turistice ale oraşului – folosirea lui în scop turistic şi de conservare. *Amfiteatru Economic* 18: 121–124.

Callies, C. 2003. Kommunale Einzelhandelszentrenkonzepte und ihre anwendung als Steuerungsinstrument der städtischen Einzelhandelsentwicklung – Ziele, Ansätze, Wirkungsweise und Erfahrungen aus der Praxis. University of Dortmund.

Campos, A. 2000. Urban public spaces: A study of the relation between spatial configuration and use patterns. Doctoral, University of London.

Carmona, M. 2003. *Public places, urban spaces: The dimensions of urban design*. Oxford–Boston: Architectural Press.

Centrul de Cercetare şi Dezvoltare Durabilă Timişoara (CCDDT). 2009. Studii directoare privind densificarea □esutului urban in municipiul timisoara. Timişoara: Facultatea de Arhitectură Timişoara.

Cervero, R. and K. Kockelman. 1997. Travel demand and the 3ds: Density, diversity, and design. Transportation Research Part D: Transport and Environment 2, no. 3: 199-219.

Cervero, R., S. Murphy, C. Ferrell, N. Goguts, and Y. Tsai. 2004. *Transit-oriented development in the United States: Experiences, challenges, and prospects*. Washington, D.C.: Transportation Research Board.

Chiesura, A. 2004. The role of urban parks for the sustainable city. *Landscape and Urban Planning* 68, 1: 129–38.

Comber, A., C. Brunsdon, and E. Green. 2008. Using a gis-based network analysis to determine urban greenspace accessibility for different ethnic and religious groups. *Landscape and Urban Planning* 86, 1: 103–14.

Curtis, C. and J. Scheurer. 2010. Planning for sustainable accessibility: Developing tools to aid discussion and decision-making. *Progress in Planning* 74, 2: 53–106.

Cybriwsky, R. 1999. Changing patterns of urban public space—observations and assessments from the Tokyo and New York metropolitan areas. *Cities* 16, 4: 223.

De Meester, F., D. Van Dyck, I. De Bourdeaudhuij, B. Deforche, J. Sallis, and G. Cardon. 2012. Active living neighborhoods: Is neighborhood walkability a key element for Belgian adolescents? *BMC Public Health* 12, 1: 1–12.

Engel, B. 2006. Public space in the blue cities in Russia. *Progress in Planning* 66, 3: 147–239.

ESRI. 2012. GIS dictionary.

European Comission. 2011. Open data an engine for innovation, growth and transparent governance.

European Environmental Agency. 2006. Urban sprawl in Europe—the ignored challenge. Ed. European Environmental Agency, Office for Official Publications of the European Communities.

EUROSTAT. 2012. Motorisation rate.

Ewing, R. and R. Cervero. 2010. Travel and the built environment. *Journal of the American Planning Association* 76, 3: 265–94.

Gregory, I. N. 2002. The accuracy of areal interpolation techniques: Standardising 19th and 20th century census data to allow long-term comparisons. *Computers, Environment and Urban Systems* 26, 4: 293–314.

Handy, S. 2002. *Accessibility- vs. Mobility-enhancing strategies for addressing automobile dependence in the U.S.* Davis, Calif.: Institute of Transportation Studies, University of California at Davis.

Handy, S. L. and D. A. Niemeier. 1997. Measuring accessibility: An exploration of issues and alternatives. *Environment and Planning* A 29, 7: 1175–94,

Harris, R. J. and P. A. Longley. 2000. New data and approaches for urban analysis: Modelling residential densities. *Transactions in GIS* 4, 3: 217–34.

Abstract

Evaluating Public Space Pedestrian Accessibility: A Gis Approach

Public spaces are sources of quality of life in neighborhoods. Seeking to help professionals and municipalities assess how well a public space can be used by the community it serves, this paper presents a GIS-based methodology for evaluating its pedestrian accessibility. The Romanian city of Timisoara is used as a case study, by comparing past, present and potential access to public spaces. The main contributions to the field in terms of methodology are establishing a procedure that can be used in cities where data is poor, and offering a more accurate interpretation of urban density, as opposed to traditional census data. The article's conclusions show that historical and present access to public spaces does not differ that much due to the 20th century densification of the urban structure. Yet, well-placed new public spaces could improve this situation significantly especially in low-density neighborhoods.

Keywords

Public space, Accessibility, GIS, Network Analyst, city evolution