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Identifying the Impacts of Land-Use Spatial Patterns on Street-Network Accessibility Using Geospatial Methods

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While the land use-street network nexus is well acknowledged, evidence for the one-way impacts of land-use patterns on street accessibility is still inadequate. The measurements of land-use patterns and street accessibility lack systematic knowledge. Their empirical correlations also lack geographical variability, constraining site-specific land-use practices. Therefore, this study overcame the aforementioned limitations by examining the two-level spatial models to formulate accessibility-oriented land plans, using a well-developed Chinese city as an example. Firstly, two landscape metrics – Euclidean Nearest-Neighbor Distance (ENN) and Similarity Index (SIMI) – were used to quantify the intra- and inter-land-use configurations, respectively. Both city-level and local accessibility were measured using spatial design network analysis. Performing both ordinary least squares (OLS) and geographically weighted regression (GWR) models, results identified the statistically significant effects of inter-land-use patterns on two-level street accessibility. An exception was that land-use configurations within residential and industrial regions were irrelevant to street accessibility. We also found GWR was a better-fitting model than OLS when estimating locally-varied accessibility, suggesting hierarchical multiscale land-use planning. Overall, locally heterogeneous evidence in this study can substantialize land use-street network interactions and support the decision-making and implementation of place-specific accessibility-oriented land use.

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Introduction

Land use and transport construction are both the outcomes of human activities in urbanization. Transport infrastructure directly influences urban facilities and land use patterns with changes in mobility (Morimoto, 2015) and, at the same time, street network layout is another legacy of human disturbances on land use and the resulting traffic demand (Lin et al., 2019). Therefore, it is well-recognized that land use and street network are interacted and jointly shape urban characters (Forsyth and Krizek, 2010; Zook et al., 2012; Chaudhuri and Clarke, 2015). It is necessary to decouple land use and street network dynamic quantitatively. Otherwise, this complex and uncertain system constrains effective decision-making in both urban planning and transport studies.

Accessibility is a widely-explored attribute of street networks since it indicates the extent to which humans have comparable socioeconomic opportunities while experiencing urban functions (Geurs and van Wee, 2004). Street-network accessibility is a well-accepted human need and accessible street networks enable people to move to the destinations they want and obtain urban services easily. Improving street accessibility through land-use rearrangements allows for better environmental quality (Li and Zhou, 2019), less energy use (Sharifi, 2019; Lee et al., 2020), and a better human traveling experience (Zacharias and Liu, 2022). That is why we consider an accessibility-oriented land use by demonstrating how land use patterns affect street accessibility.

In literature, various metrics of accessibility and land use have been developed. For example, Wang, Han, and De Vries (2022) adopted the minimum traveling time, the trip area, and the number of destinations to measure accessibility. The shortest distance between the origins and the destinations is the most conventional approach (Witten et al., 2008; Le Texier, Schiel, and Caruso, 2018). At the same time, land use patterns were typically characterized by satellite-based images mapping the land types and their sizes with different spatial resolutions (Liu et al., 2019; Ahmadzai, 2020). It means that only the compositional aspect of land use patterns has been investigated. A limitation of the above measures in common is lacking a systematic perspective. As a response, this article adopts the configurational idea in measurements which illustrates the degree of relationship between land areas and between street segments (Hillier, Hanson, and Graham, 1987; Rashid, 2019). Configurational properties of land use patterns are determined by their spatial positions, arrangements, and characters (McGarigal, 2006). Moreover, configurational property in street accessibility measures is reflected by its topological structure, which establishes the hierarchical arrangements of street segments and characterizes the role of each street segment in shaping the street network's behavior (Molinero, Murcio, and Arcaute, 2017). Hence, typological distance, that is, the number of directional changes, can quantify street accessibility more accurately than geographical distance (Borzacchiello, Nijkamp, and Scholten, 2009; Xiao, Orford, and Webster, 2015), due to the fact that in the real world, people may not always choose the shortest-distance paths when traveling, instead, the topologically shortest ways with the fewest directional changes are preferred (Dettlaff, 2014). We contend that configurational measures can provide additional system-level and relational understanding of land use patterns and street network accessibility.

Furthermore, the configurational properties of urban streets could be better understood from a multiscale perspective. Multiscale measurements could benefit the precise modeling of urban configurations (Xiao, Orford, and Webster, 2015) and hierarchical planning of street networks and land use (Sun et al., 2022). The scale's roles in accessibility measurement have also been discussed (Kwan and Weber, 2008). The overall accessibility level throughout a city has been a popular issue in land planning, meanwhile, street accessibility level within a neighboring scope is receiving increased attention, in response to the initiatives to improve community life quality. As a result, street accessibility measured at both local and municipal levels will be involved in this study.

Additionally, the configurational characteristics of land use and street accessibility are supposed to be heterogeneous in an urban system. We assume that the impacts of land use configurations on street accessibility will also differ by location. However, the existing empirical relationships lack geographical variability (Liu et al., 2015; Yin et al., 2018). Insufficient local information constraints context-dependent land-use planning. Therefore, geospatial methods are necessary, which are used in this study to examine the spatially-heterogeneous patterns of how the spatial layouts of different land-use types control street-network accessibility.

Using configurational metrics of land use and two-level street accessibility, as well as the spatial regression models, this research aims to develop a spatially-varying accessibility-oriented land use framework to answer the following research question:

- Whether and how local variations in urban functions in terms of two-level street accessibility are impacted by land-use configurations of urban patterns?

In detail, four research objectives are: (1) to measure city-level and local street accessibility based on configurational consideration by defining different radial distances from the streets in question; (2) to characterize land-use configurational patterns using landscape metrics; (3) to determine the model that can better fit the effects of land-use spatial analyses on two-level accessibility by comparing ordinary least squares (OLS) and geographically weighted regression (GWR) models; and (4) to provide evidence-based guides for formulating place-specific accessibility-oriented land use. In this way, the quantitative indicators of land-use structural configurations can be used to reflect and predict functional aspects of land-use planning, such as street accessibility. In Section 2, we elaborate on measurements of landscape metrics-based land configurations and two-level street-network accessibility. Both OLS and GWR models are also described. In Section 3, we present the multi-scale representations of city-level and local accessibility and illustrate spatially uniform and heterogeneous associations between land-use configurations and two-level accessibility. Furthermore, Section 4 discusses the implications of our findings for accessibility-oriented land-use plans, and Section 5 makes conclusions.

Data and methods

Data sources

To characterize land-use spatial patterns, raster data of land use with 10 m spatial resolution were used in this study, which are the outputs of the Finer Resolution Observation and Monitoring of Global Land Cover (FROM-GLC) project of Tsinghua University of China (http://data.ess.tsinghua.edu.cn/). This land dataset has an overall accuracy of more than 60% (Gong et al., 2020). This dataset classified the urban landscape into two levels. We used the Level I category here that includes a total of five types – residential, commercial, industrial, transportation, and public management and service. Moreover, to quantify the street-network accessibility, vector layers for urban street networks were derived from OpenStreetMap (OSM), which is a free and open-source dataset that uses local expertise to give timely and precise street information (Mann et al., 2021). The OSM is a popular dataset in spatial network studies, according to Brovelli et al. (2016) and Girres and Touya (2010), because of its high quality in comparison to authoritative datasets.

Analytical framework and study area

Using the aforementioned datasets, the street-network accessibility at the city and local levels as well as land-use spatial patterns can be quantified and characterized, and their empirical relationships also can be revealed (Fig. 1). Our analytical framework hypothesis is that land-use spatial patterns affect street-network accessibility and their associations differ across spaces. This assumption emphasizes the importance of considering locally heterogeneous land-use situations when developing land planning strategies to improve accessibility. Specifically, street-network accessibility at the city and local levels is illustrated using spatial design network analysis, and land-use spatial patterns are quantified by two patch-level landscape metrics in the FRAGSTATS tool. To capture the relationships between two-level accessibility and land-use spatial patterns, OLS and GWR models are established and compared in order to detect the better-fitting one. The main outputs of this study are (1) the spatially explicit measures of city and local accessibility; (2) the well-fitting models to explain accessibility from spatial patterns of land-use patches; and (3) an empirical approach to demonstrating space-varying effects of land-use configurations on two-level accessibility.

This analytical framework (Fig. 1) was examined using Dongguan as an example, a well-developed city in the Guangdong-Hong Kong-Macau Greater Bay Area (GBA) that is an emerging urban agglomeration in China (Fig. 2). With the rapid growth in the GBA, Dongguan performs great economic development as well and is expected to be one of the top cities in China. Moreover, Dongguan is regarded as an important node in the GBA since it is close to

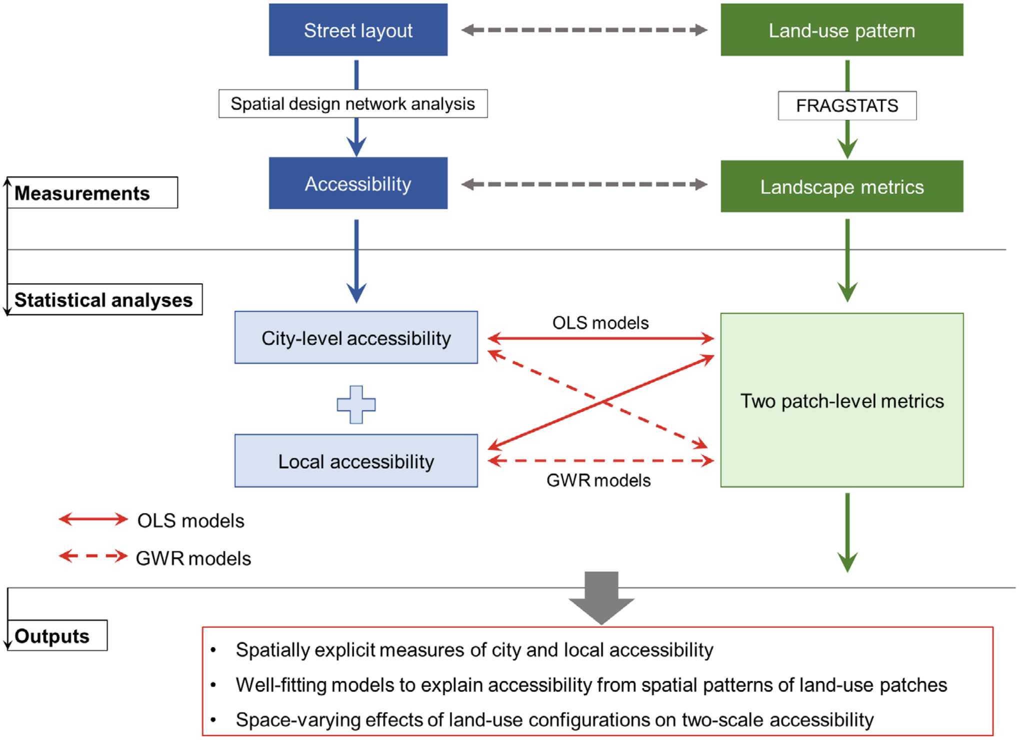


Figure 1. An analytical framework to model the relationships between two-level accessibility and land-use spatial patterns.

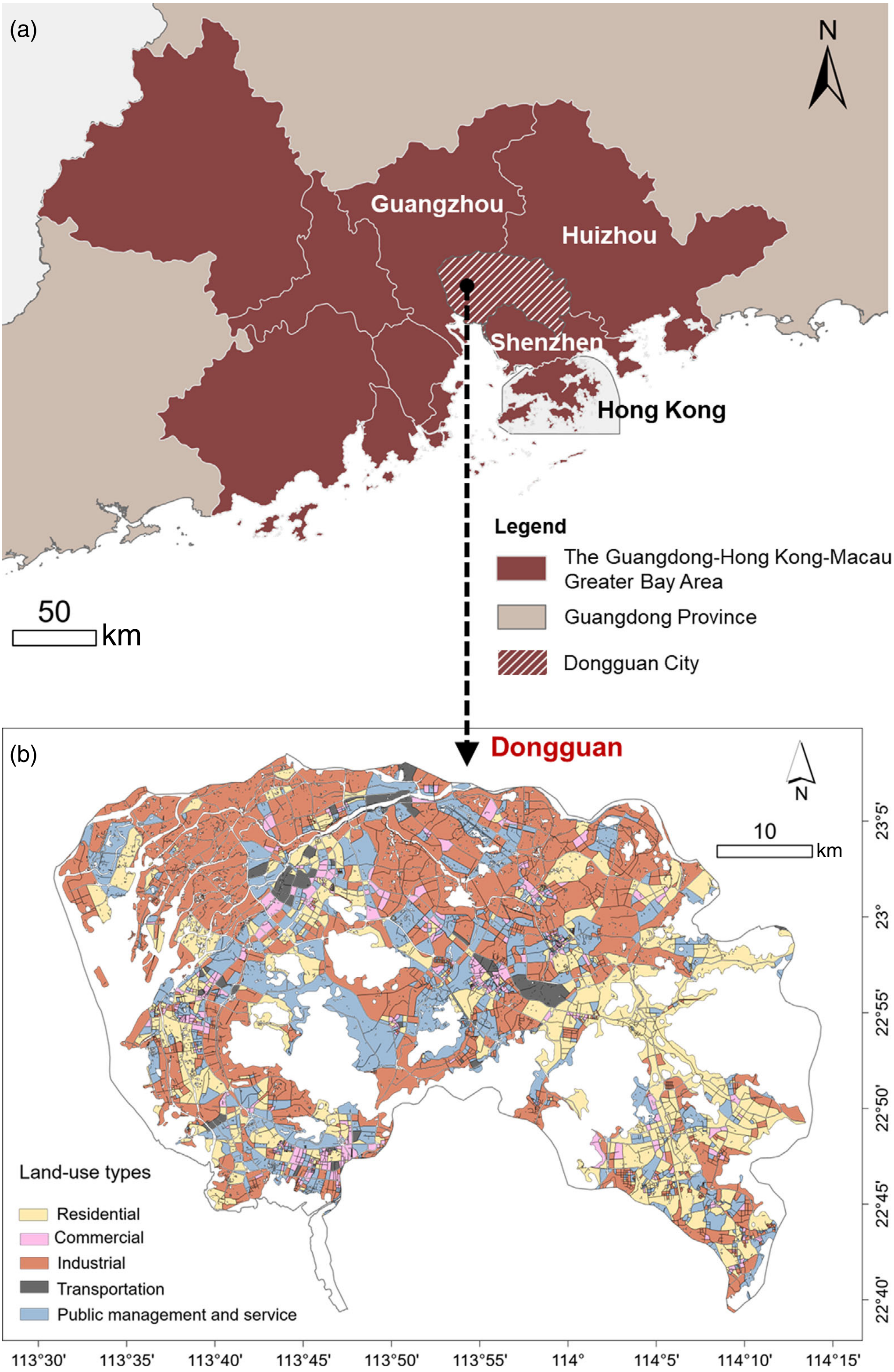


Figure 2. Dongguan's geographic location (a) and land-use map (b).

Guangzhou, Shenzhen, Huizhou, and Hong Kong, all of which are leading world-class cities. These geographical advantages in Dongguan facilitate the creation of highly-connected street networks. With further regional integration in the GBA, more intercity transportations, such as Guangzhou-Shenzhen Railway, are expected to travel through Dongguan, having considerable impacts on land-use spatial patterns. In the last three decades, the urban areas in Dongguan increased by almost 25 times (Yang et al., 2019), and about 19% of the total areas of forests are converted into urban areas in Dongguan that are the highest among all cities in the GBA (Yang et al., 2021). Land-use variations are affecting the street-network structure. Therefore, there is a need to investigate how land-use distributions affect street-network accessibility for guiding accessibility-oriented land-use planning.

Measurements of land-use spatial patterns

The land-use spatial pattern was commonly measured using landscape metrics that are the scalar quantitative summary of the spatial structure of patterns within a geographic area (McGarigal, 2006). Landscape metrics have multiple scales and we focused on the patch level since it can show pretty fine-resolution land-use configurations. The patch is the smallest homogeneous area with different surface characteristics from its surroundings (Wiens, 1976). In a categorical land-use map, patch-level metrics indicate the spatial distributions of each land-use patch. Two patch-level landscape metrics, namely, Euclidean Nearest-Neighbor Distance (ENN) and Similarity Index (SIMI), were used to illustrate how the individual land-use patches were located in the spaces (McGarigal, 2006). ENN defines the smallest Euclidean distance between two neighboring patches of the same land-use type, which was used to quantify intra-land-use configuration. ENN increases as patch distributions become more dispersed. SIMI shows the similarity of land property between adjacent patches regardless of their land-use types, within a user-specific distance (e.g., 1200 m), referred as a proxy for inter-land-use configuration. A higher SIMI suggests more clustered land-use patterns of land use with similar property. For example, we consider that residential land is more comparable to commercial land than industrial regions.

Quantification of the landscape metrics was performed in an easy-to-use software – FRAGSTATS – with an almost automated program and mainly intuitive interpretations (McGarigal and Marks, 1995). Requiring few specialized techniques, FRAGSTATS has wide applications in spatial pattern analysis to guide urban planning practices (e.g., Feng et al., 2021).

Multiscale measurements of the street-network accessibility

Spatial design network analysis (sDNA; Cooper and Chiaradia, 2020) is a network modeling tool frequently applied in graph theory-based measurements (e.g., Sarkar et al., 2015). sDNA provides a metric – Network Quantity Penalized by Distance in Radius Angular (NQPDA) – to quantify the accessibility level of street networks. Higher NQPDA values indicate greater street-network accessibility. NQPDA is quantified using (Cooper, 2021):

$$NQPDA(n) = \sum_{y \in R_x} \frac{W(y)P(y)}{d_M(x, y)},$$

where n denotes the scope where the set of street segments will be used in the calculation. $W(y)$ is the weight of a street segment y in the radius from segment x (R_x). $P(y)$ is the proportion of street segment y within the radius. $d_M(x, y)$ is the topological distance between the origin segment x and the destination segment y.

NQPDA(n) is used to represent the quantitative city-level accessibility which is the average ease of access from the original street segment to all other connected streets throughout the city. Moreover, we also measured the local accessibility using the NQPDA values within the 1.2 km radial distance from each street segment (represented as NQPDA (1.2). The reason for defining 1.2 km as the local scale is that the average walking distance in 15 min at normal walking speed is around 1.2 km. Urban planners in China are encouraging 15-min walkable regions in response to the ‘15-min walkable neighborhoods’ initiative of ‘The standard for urban residential area planning and design (GB 50180–2018)’. Measuring local accessibility within 1.2 km (i.e., NQPDA(1.2) values) for relating to land-use spatial patterns is instrumental in providing empirical information for building 15-min walkable regions.

Ordinary least squares and GWR

OLS is a simple global fitting method which estimates the overall accessibility without considering the disparities in landscape metrics spatially. In comparison, the GWR is characterized by its spatial heterogeneity in modeling the relationships among spatially nonstationary variables (Fotheringham, Brunsdon, and Charlton, 2003), allowing its wide application in environmental management (e.g., Wu et al., 2020), and urban planning (e.g., Shen et al., 2020). Moreover, spatial autocorrelation was required to determine whether our land-use and street-network data was spatially nonstationary, by analyzing whether the variables are correlated in each observation (Getis, 2008). Our test showed that city-level accessibility measured by NQPDA(n) and the landscape metrics were spatially clustered (Fig. 3). It exemplified the spatial heterogeneity in our data and justified the application of GWR models here.

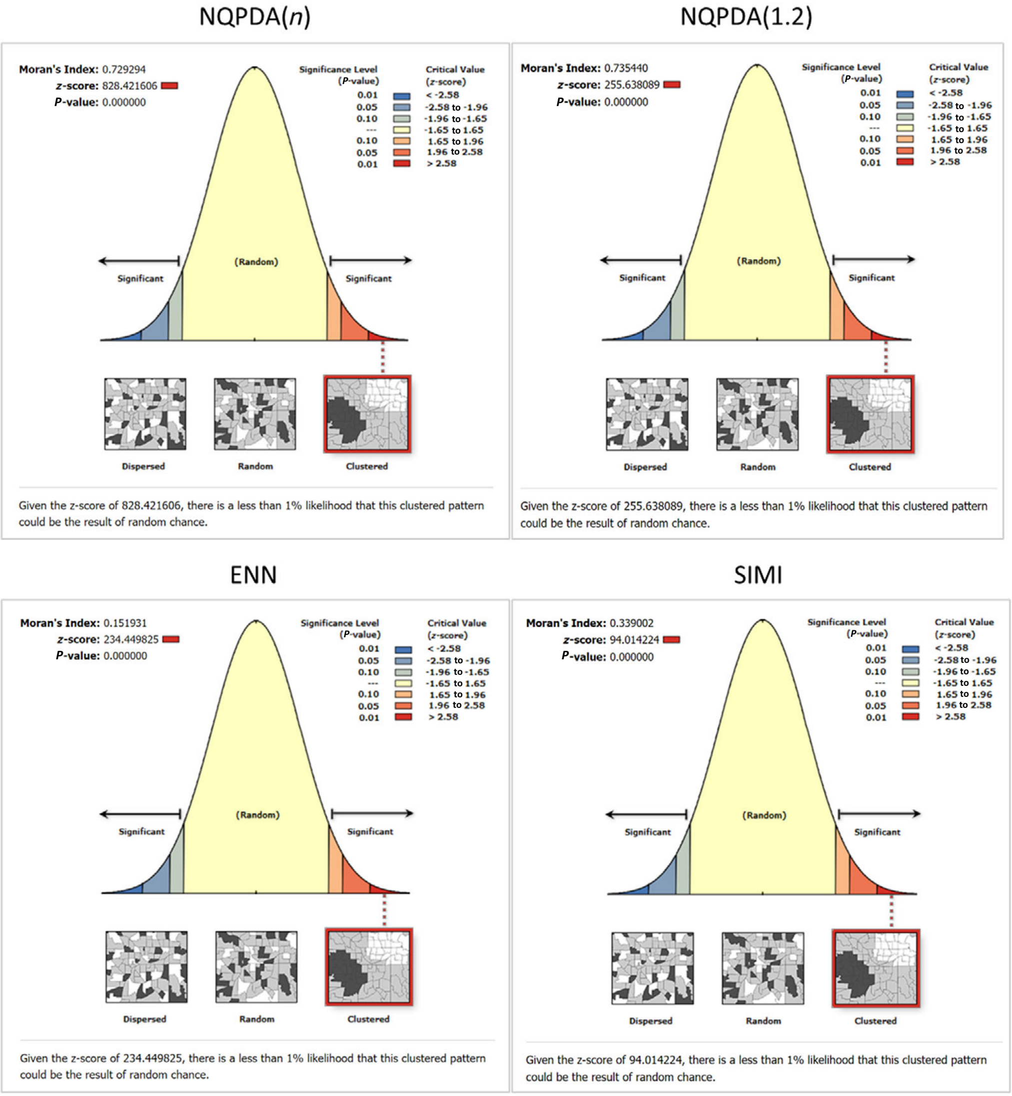
Also, allowing the local variations in relationships between accessibility and land use patterns, GWR is modeled as (Matthews and Yang, 2012):

$$y_i = a_0\left(\mu_i, v_i\right) + \sum_{k=1,m} a_k\left(\mu_i, v_i\right) x_{ik} + \varepsilon_i,$$

where y_i is the local estimation at the location i with the coordinates of $\left(\mu_i, v_i\right)$. a_0 is the intercept of local estimation at location i $\left(\mu_i, v_i\right)$. a_k represents the coefficient of variable k for observed data x_{ik} at location i.

The local estimation of $a_k\left(\mu_i, v_i\right)$ distinguishes GWR from the conventional regression models. The estimation of $a_k\left(\mu_i, v_i\right)$ varies over the space in the GWR models, by assigning the diverse weightings according to the distance between location i and other observations. The locations closer to i have stronger influences, resulting in greater weightings to estimate $a_k\left(\mu_i, v_i\right)$ in the GWR calibration.

Four parameters – adjusted R^2, Akaike’s Information Criterion (AIC), Residual Sum of Squares (RSS), and residual spatial autocorrelations – were used to compare the performance between OLS and GWR models (Koohsari et al., 2016). We used Moran’s Index of residual to quantify the spatial autocorrelation of GRW and OLS residuals. Lower Moran’s Index shows that the model explains the variance in spatial heterogeneity better. Moreover, lower RSS, Lower AIC values, and higher adjusted R^2 values are indications of better-fitting models. Comparing the performance of OLS and GWR models, we can demonstrate the roles of spatial heterogeneities of land use and street accessibility in land use planning.



NQPDA(*n*)

Moran's Index: 0.729294
z-score: 828.421606
P-value: 0.000000

Given the z-score of 828.421606, there is a less than 1% likelihood that this clustered pattern could be the result of random chance.

NQPDA(1.2)

Moran's Index: 0.735440
z-score: 255.638089
P-value: 0.000000

Given the z-score of 255.638089, there is a less than 1% likelihood that this clustered pattern could be the result of random chance.

ENN

Moran's Index: 0.151931
z-score: 234.449825
P-value: 0.000000

Given the z-score of 234.449825, there is a less than 1% likelihood that this clustered pattern could be the result of random chance.

SIMI

Moran's Index: 0.339002
z-score: 94.014224
P-value: 0.000000

Given the z-score of 94.014224, there is a less than 1% likelihood that this clustered pattern could be the result of random chance.

Figure 3. The spatial autocorrelation analysis of two-level accessibility and two landscape metrics.

Results

Two-level accessibility measurements of urban street networks

Fig. 4a illustrated the spatially explicit city-level accessibility in the entire city, based on NQPDA(*n*) values. The streets with high city-level accessibility were mainly concentrated in the north-middle areas. More accessible streets generally had stronger spatial associations with their surroundings. Moreover, the spatial characteristics of local accessibility based on NQPDA(1.2) values were presented in Fig. 4b. Streets having high-level local accessibility did not cluster in the city center but rather were scattered throughout the city. It means that, within 1.2 km radial distance (i.e., 15-min walking distance) from the streets, the city center was no longer the most accessible location at the local level, partly because of the emerging polycentric urban

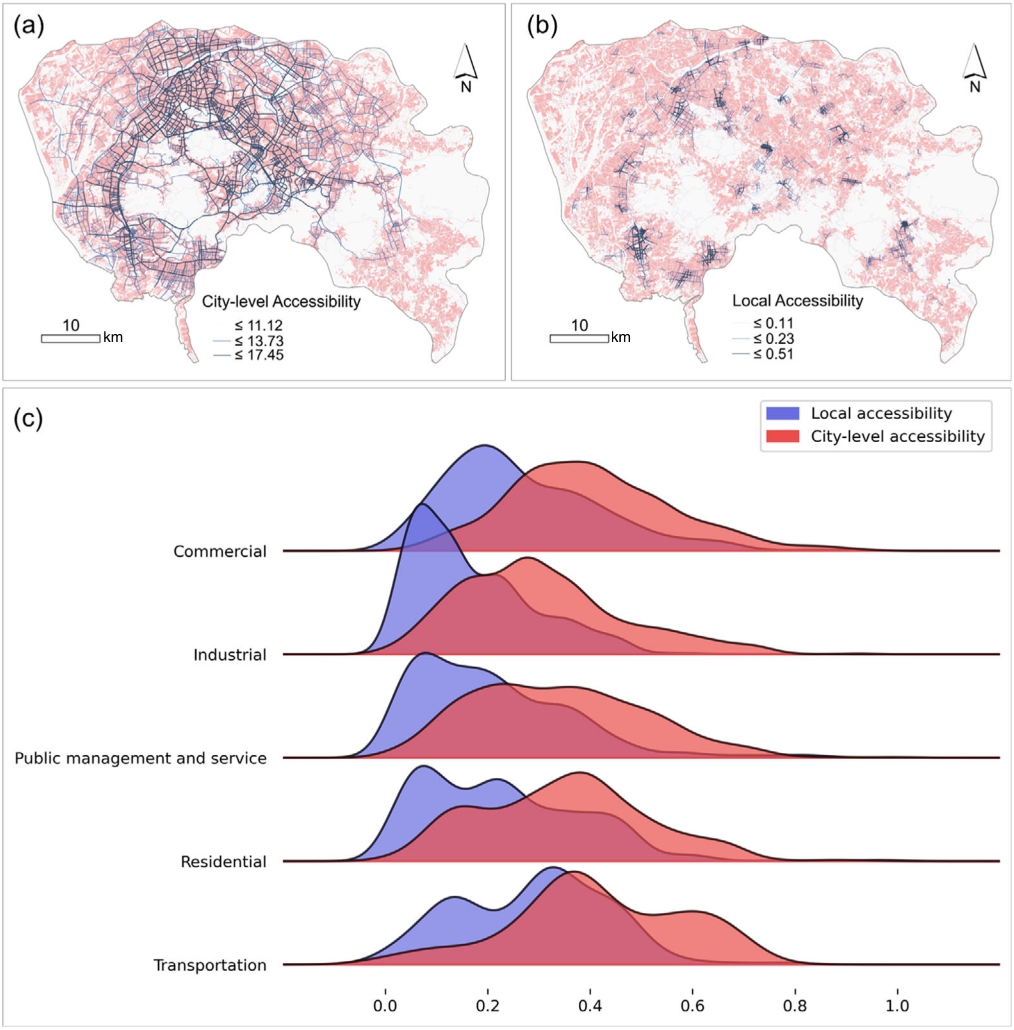


Figure 4. Spatial maps of city-level accessibility (a) and local accessibility (b). Lines with darker colors are the streets with greater city-level or local accessibility. The distributions of two-level accessibility are shown at (c).

development trend. Comparing city-level and local accessibility, local accessibility was much worse, which means that people may find it rather difficult to reach their destinations within their 1.2 km walking distance. More specifically, five land-use types showed different accessibility distributions at the local and municipal levels (Fig. 4c), suggesting potential effects of land use on street accessibility.

Associations between street accessibility and intra-land-use spatial patterns

To investigate how the patches distributions within a land-use type influence street-network accessibility, the OLS models are thus created between the landscape metric of ENN and accessibility measures of NQPDA in five land-use types – transportation, residential, public management and service, industrial, and commercial land types. According to the global regression results derived from the OLS models (Table 1), the ENN values of (1) public

Table 1. OLS and GWR Models for Both City-level and Local Accessibility and Intra-land-use Configuration (*P-value <0.02)

				OLS model				GWR model			
Dependent variable	Independent variable	Land-use type	P-value	Adjusted R^2	AIC	RSS	Moran's I of residual	Adjusted R^2	AIC	RSS	Moran's I of residual
City-level accessibility NQPDA(n)	Landscape metric of ENN	Transportation	0.000*	0.10	454	148	0.634	0.66	310	51	0.272
		Residential	0.851								
		Public management and service	0.012*	0.004	3769	1323	0.811	0.80	1778	243	0.112
		Industrial	0.934								
		Commercial	0.001*	0.02	1567	543	0.819	0.85	588	74	0.034
Local accessibility NQPDA(1.2)	Landscape metric of ENN	Transportation	0.132								
		Residential	0.832								
		Public management and service	0.013*	0.004	3769	1323	0.500	0.45	3106	655	0.159
		Industrial	0.361								
		Commercial	0.004*	0.013	1571	547	0.468	0.55	1198	222	0.100

*P-value < 0.02.

management and service and (2) commercial land-use types have statistically significant impacts on both city-level and local accessibility with *P*-value less than 0.02, while the ENN values of transportation land have only substantial effects on local accessibility. Contrarily, how land patches are located within residential and industrial land-use types are irrelevant to urban street accessibility. Overall, the OLS results specify the land-use types in which their shortest distance (measured by ENN) will affect street-network accessibility. Following OLS results, the GWR

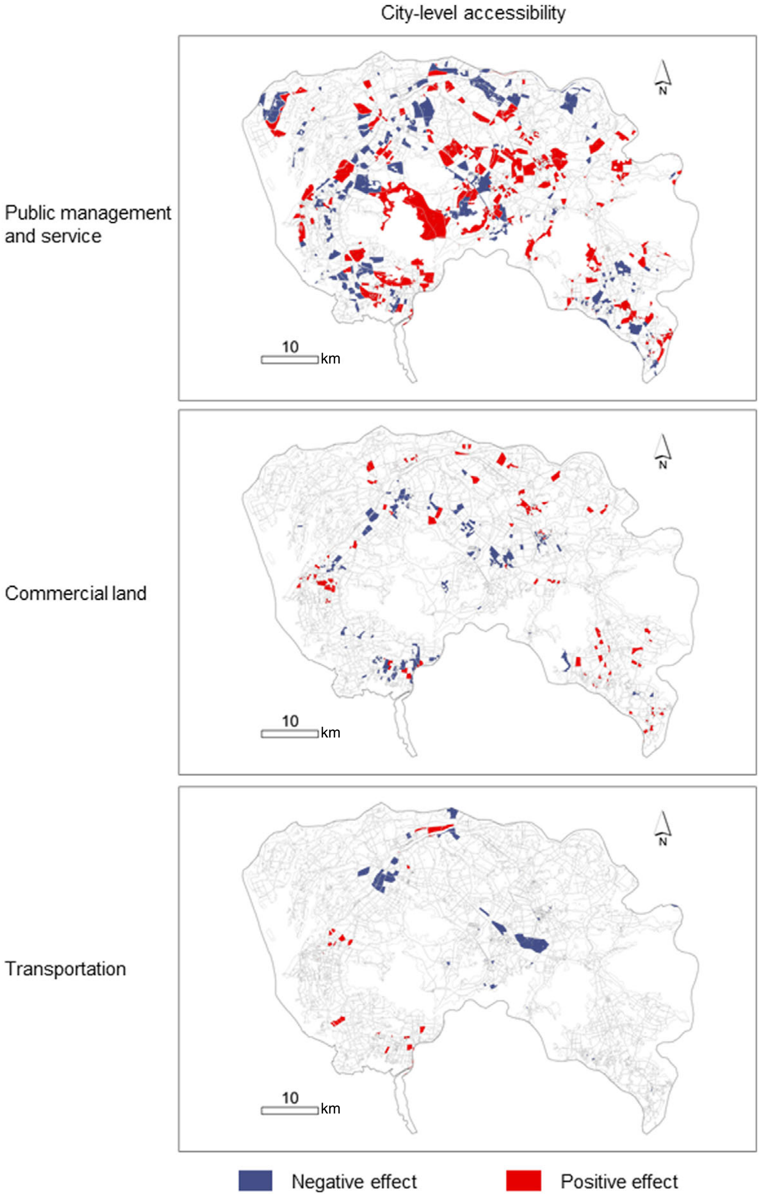


Figure 5. The GWR models illustrated the spatial-varying impacts of intra-land-use configurations on city-level accessibility.

models are performed, supporting the hypothesis that the impacts of patch configurations of intra-land-use on street accessibility vary across locations (Figs. 5 and 6), as a result of the GWR models' superior performance (higher R^2, lower AIC, lower RSS, and lower Moran's Index) (Table 1). In the patches demonstrating negative effects, the smaller the ENN values, the better street accessibility, indicating that more aggregated and spatially-adjacent land patches of the same land use type, such as residential neighborhoods, have the ability to improve street accessibility. Similarly, greater dispersed distributions of land patches support accessible streets in the patches showing positive effects. Another observation is the mild disagreement over the land patch adjustments needed to ensure city-level or local accessibility, which necessitates strategic design depending on the circumstances.

Associations between street accessibility and inter-land-use spatial patterns

Following experiments that show how patch distributions of the same land-use type relate to street accessibility, it is also postulated that relative spatial relationships between different land-use types influence street accessibility. Inter-land-use configurations arrangements (measured by SIMI) are seen as significant influences on street accessibility (Table 2). In comparison to OLS models, the GWR models can provide a better fit due to their greater R^2, lower AIC, lower RSS, and lower Moran's Index (Table 2). Within areas demonstrating positive effects, spatial

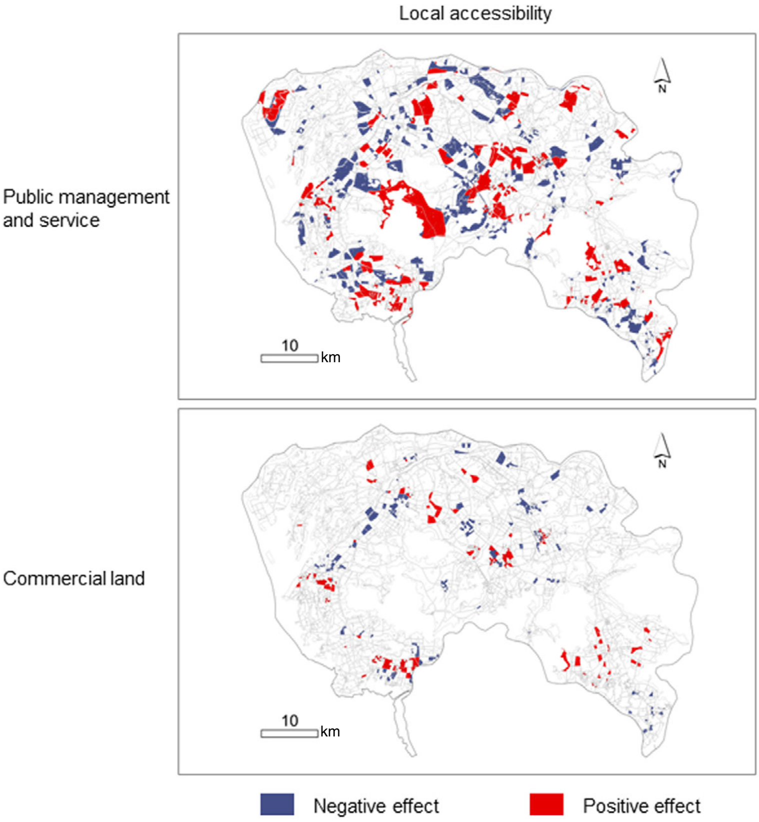


Figure 6. The GWR models illustrated the spatial-varying impacts of intra-land-use configurations on local accessibility.

Table 2. OLS and GWR Models for Both City-level and Local Accessibility and Inter-land-use Configurations (*P-value <0.02)

Independent variable	Dependent variable	P-value	OLS model Adjusted R^2	OLS model AIC	OLS model RSS	OLS model Moran's I of residual	GWR model Adjusted R^2	GWR model AIC	GWR model RSS	GWR model Moran's I of residual
Landscape metric of SIMI	City-level accessibility NQPDA(n)	0.000*	0.008	14903	5223	0.820	0.879	4353	570	0.208
	Local accessibility NQPDA(1.2)	0.000*	0.033	14766	5088	0.510	0.762	7923	1122	0.215

*P-value < 0.02.

aggregation of more similar land-use types, such as residential and commercial land use, can enhance street accessibility. On the contrary, clustering of dissimilar land-use types, such as residential areas and transportation, is recommended for the purpose of accessible street networks in the areas showing negative effects (Fig. 7). The conflict over inter-land-use locations can be additionally observed in the context of accessible street planning.

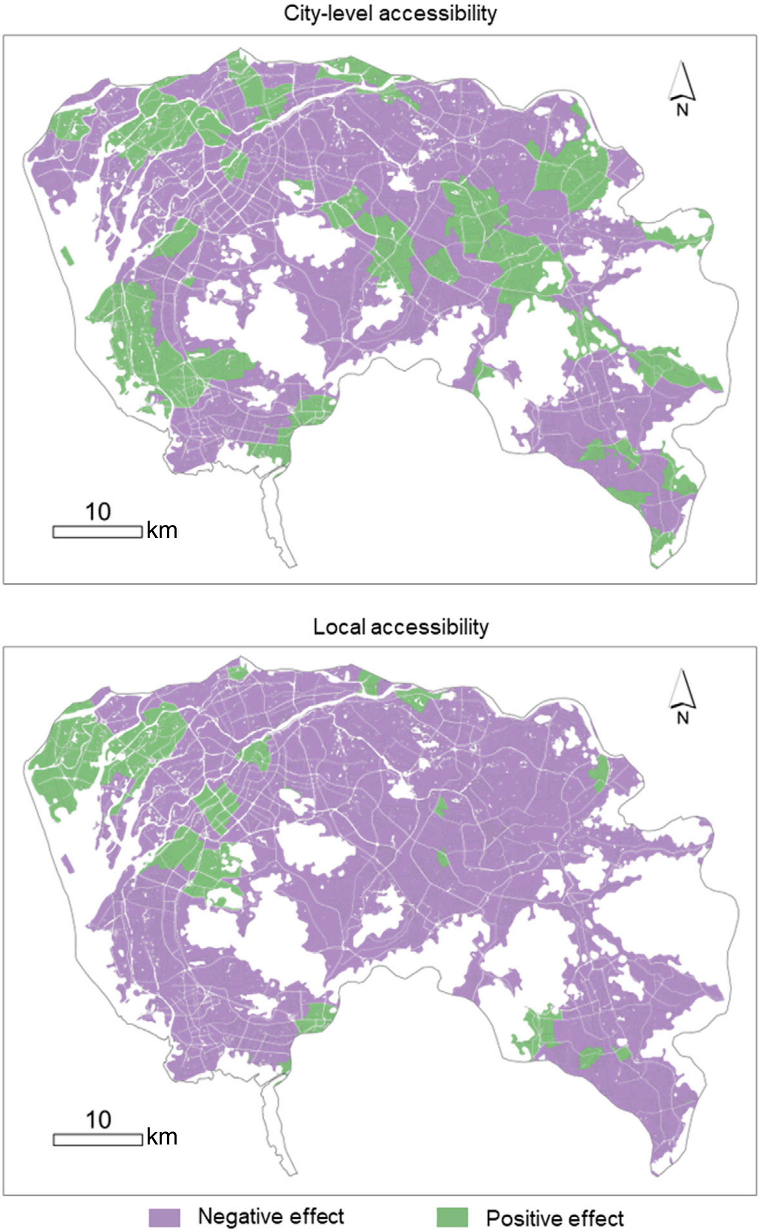


Figure 7. The GWR models illustrated the spatial-varying impacts of inter-land-use configurations on two-level accessibility.

Discussion

Intra-land use configurations may not necessarily affect street accessibility

A large body of literature has reported the impacts of land use on street accessibility. Residential, commercial, and transportation land use were typically considered to be highly accessible (Wang, Antipova, and Porta, 2011; Yin et al., 2018; Wang, Han, and de Vries, 2019). The reason for these statements is that correlation analysis instead of a causal mechanism has been explored in previous studies. Our findings extend previous research by demonstrating the cause-effect of land use configuration and street accessibility. This paper captures the statistically insignificant associations in residential and industrial land types (Table 1). It can be explained using urban functional zoning. Considering daily commutes to work, business, and socioeconomic activities, residential zoning may generally follow the distributions of office buildings, commercial building districts, and transportation hubs, for example. Meanwhile, moving industry out of the center of a city is a common practice. Although industry in Dongguan is flourishing, the most accessible streets will not be surrounded by industrial areas because of their low population. Consequently, we conclude that not all land-use configurations have impacts on street accessibility. A more targeted modification to land use is suggested.

Implications for street accessibility-oriented land-use planning

Spatial heterogeneity in land-use configurational effects on street accessibility

The comparisons of model evaluation parameters (i.e., adjusted R^2, AIC, RSS, and Moran's Index) demonstrate that GWR models are better fitting than OLS models when estimating both local and city-level accessibility from landscape metrics (Tables 1 and 2). Based on GWR results, we also provide planners with local knowledge including the positive or negative relationships between accessibility and spatial patterns of land-use patches, as well as the specific locations (Figs. 5–7), enabling the place-specific land use based on local unique situations. Spatial configurations of patches within the same land-use type and between different ones both show place-specific impacts on accessibility. These findings indicate that, to replace the conventional "one-size-fits-all" approach, land planning should emphasize heterogeneous land-use situations throughout the city (He et al., 2020; Zhang et al., 2020), in line with the "adapt to local conditions" proposed by An et al. (2022). Otherwise, the general correlation descriptions may miss the local spatial information and then lead to biased estimations of how many spatial characteristics of land-use patches can explain street-network accessibility. Spatial heterogeneity in land use and accessibility interactions contributes to the social equity of accessible street networks (Kim et al., 2021). Particularly in those regions or cities with complex administrative and regulatory systems, spatially-varying evidence allows the sharing of local knowledge among governments and organizations (Pfeffer et al., 2013) and provides direct visual presentations for planners to identify the planning locations and strategies.

Neighborhood effect of spatially-varying land-use planning

The fact that GWR models outperform OLS models at each target location implies that, in addition to its own configurational attributes, the configurations of its nearby land patches should also have an impact. This inference is consistent with the GWR process, which assigns the weightings of neighboring areas based on distance decay in order to estimate land-use configuration effects on accessibility. In other words, GWR-based spatially-varying coefficients will interact between intra-urban sites. It is recommended that neighborhood effects should be considered while taking local street accessibility-oriented actions.

Hierarchical multiscale land-use planning

The findings of this study indicated the scale-dependence of land configuration impacts street accessibility, and suggested the compromises required in land use planning for better accessibility at the local and municipal levels. As a result, hierarchical multiscale land-use planning is necessary. Urban land-use planning at multiple scales from a hierarchical perspective has been extensively studied (Kang et al., 2013; Li, Li, and Wu, 2018; Wei et al., 2020). For example, the hierarchy of cities is helpful to better understand rapid urban growth (Li et al., 2015). Fernandez and Wu (2016) also highlighted the importance of scale-dependent measurements in interpreting and translating findings accurately. Otherwise, the scale of land-use decisions may not match the scale of accessibility improvement decision-makers want. Hierarchical multiscale land reconfigurations enable to minimize the conflicting policies and knowledge between institutions (Waddell, 2011).

Conclusion

This research provides empirically local knowledge to test the hypothesis that urban configurational patterns could provide spatially-heterogeneous urban functions in terms of street-network accessibility at multiple scales. The key findings, firstly, specify the land-use types in which spatial patterns have statistically significant effects on both city-level and local accessibility. Among the predefined five land use types, land-use arrangements in residential and industrial areas have no statistical impact on accessibility. Regardless of intra- and inter-land use configurations, their impacts on accessibility vary by geographical location, because of the better model performance of GWR than OLS. We suggest that spatial factors, such as heterogeneous land-use situations locally, should be emphasized when establishing land-use guidance. Moreover, scale-dependent land-use plans for achieving two-level accessibility are suggested. The hierarchical multiscale land-use planning should be desired in street accessibility-oriented land-use decisions. In summary, this study provides empirical evidence to challenge the traditional "one-size-fits-all" land-use approach, and assist decisions and implementations of place-specific accessibility-oriented land use, by utilizing multiscale accessibility measurements and geospatial statistical techniques.

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