South African Geographical Journal

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/rsag20

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To cite this article: Prudence Machebele & Gina Weir-Smith (27 Jul 2024): Exploring the role of spatial mismatch on educational attainment in South African metropolitan areas: spatial data analysis, South African Geographical Journal, DOI: 10.1080/03736245.2024.2381019

To link to this article: https://doi.org/10.1080/03736245.2024.2381019

Published online: 27 Jul 2024.

SOUTH AFRICAN GEOGRAPHICAL JOURNAL
https://doi.org/10.1080/03736245.2024.2381019

Routledge
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Exploring the role of spatial mismatch on educational attainment in South African metropolitan areas: spatial data analysis

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ABSTRACT

The spatial location of job opportunities contributes to people's livelihood outcomes. Privileged communities are well located and have access to advanced educational systems, while poor communities are marginalized with deprived education outcomes. Understanding the influence of spatial mismatch on educational attainment requires information about job locations and education levels. Using a regression model, the study examined the role of spatial mismatch in explaining education attainment in South African metropolitan areas. Data were acquired per sub-place from Stats SA, CSIR, and GeoTerraImage. The regression models in all metros confirmed the relationship between spatial mismatch and educational attainment, which is valuable for area-based and people-based development approaches. The findings presented a significant relationship between spatial mismatch and educational attainment. Through the results, the study concluded that spatial mismatch is one of the significant determinants of educational attainment in South African metro areas.

ARTICLE HISTORY
Received 8 September 2023
Accepted 12 July 2024

KEYWORDS
Spatial mismatch; educational attainment; inequality; regression model; Job proximity measure

1. Introduction

South Africa is among the most unequal countries (Abrahams et al., 2018; Baffi et al., 2018; Budlender & Royston, 2016; Cousins et al., 2005; Mahajan, 2014; Noyoo, 2021; Seekings, 2010; Turok, 2018; Turok et al., 2017). The apartheid geographic and racial legacy created extreme spatial disparities in which economic opportunities are unevenly distributed, and segregated residential areas (Budlender & Royston, 2016; Turok, 2016; Turok, 2018; Turok et al., 2017; Baffi et al., 2018; Seekings, 2010; Cousins et al., 2005; Seekings & Nicoli, 2010; South African Cities Network, 2011. After years of transition into post-apartheid, the country's space economy remains imbalanced (Abrahams et al., 2018; Gotz & Todes, 2014; Seekings & Nicoli, 2010). Economic activities have decentralized to suburban

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areas where affluent people live while poor people remain in marginalized peripheral locations (Naudé, 2008; Abrahams et al., 2018; Gotz & Todes, 2014; Squires & Kubrin, 2005). This has created a physical separation between where people stay and work, hence the spatial mismatch hypothesis (Naudé, 2008; Budlender & Royston, 2016; Gobillon & Selod, 2014).

The spatial mismatch concept describes a condition where communities are physically separated from job opportunities. The concept has been used in various studies by Naudé (2008, 2010), Budlender and Royston (2016) Gobillon et al. (2007) to understand the relationship between unemployment, the labour market, and the city structure. Some of the explanatory factors of spatial mismatch are the location of job opportunities, the location of low-income communities, the affordability of housing where jobs are, and the accessibility of jobs in terms of travel costs (Naudé, 2008; Gobillon et al., 2012, 2014).

Some of the work links the concept of spatial mismatch with terms such as spatial imbalances, inequalities, and disparities. The work explored so far, embodies a significant research base for testing the space economy and spatial mismatch in South African cities. Naudé (2008) tested the relation between the spatial mismatch and unemployment rate in South Africa's metropolitan areas. He argued that distance to job opportunities explains the difference between black and white people's unemployment rates. The same research also discussed the implications of decentralizing jobs from city centres to suburban areas. Budlender and Royston (2016) worked on the Socio-Economic Rights Institute (SERI) report that also examined spatial mismatch and unemployment. This specific study also touched on the significance of city structures, inequality, poverty, and critiques of the housing policy, precisely the 'breaking new grounds' approach to its intervention to provide affordable housing.

No research has been undertaken to explain the influence of spatial mismatch on educational attainment. The SERI (2016) report made assumptions that areas close to job opportunities also have high education levels while those afar have lower education levels. However, there is no empirical work done to explore the spatial mismatch and education attainment in South African metros. The study's novelty is expanding the existing spatial mismatch models by focusing on educational attainment. The paper examines the spatial relationship between the proximity to jobs and educational attainment in all eight South African metropolitan areas.

The state of South Africa's education remains unequal and inadequate to eradicate socio-economic issues (Moyo et al., 2022; Blommaert et al., 2005). This paper is relevant as it outlines the importance of equitable and quality education for everyone since quality education has an impact on people's cognitive development and their success in the labour market (Branson et al., 2012; Burger & Zoch, 2016; Coetzee, 2014; Moyo et al., 2022; Powell et al., 2017). The findings from this study will determine whether job proximity plays a role in determining educational attainment. The metro areas include the City of Johannesburg (CoJ), City of Tshwane (CoT), City of Ekurhuleni (CoE), City of Cape Town (CoC), eThekwini, Mangaung, Buffalo City, and Nelson Mandela Bay metropolitan area as shown in Figure 1

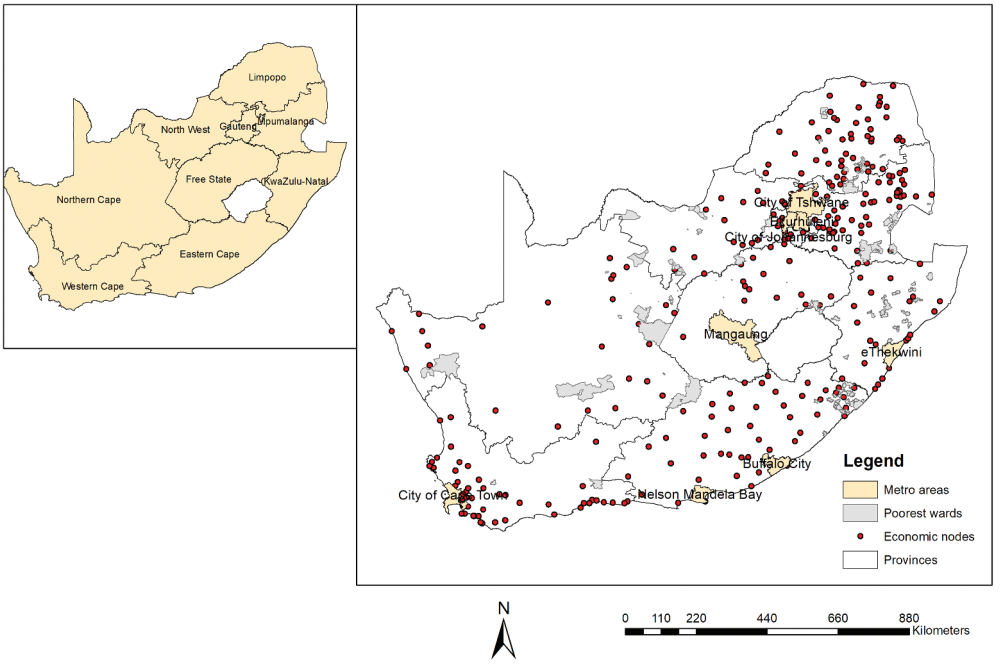

Figure 1. Map showing the location of South African Metropolitan areas.

2. Methods and materials

2.1. Data

Analysing the role of spatial mismatch on educational attainment requires data for job locations and education attainment levels. The data for the study was acquired at sub-place, main-place, and mesozone geographic levels. The job location data were created by CSIR in 2011 at a mesozone geographic level. Only census data get reported at a lower geographical level, and Statistics South Africa (StatsSA) does not do a direct collection of job opportunities data. Furthermore, there is no overarching body in the private sector, which coordinates the capturing of spatial data related to where jobs are located. Proxy data like Gross Domestic Product (GDP) is also reported at higher geographic levels, like municipalities. Therefore, acquiring good-quality data for job opportunities at a lower geographic level than mesozones in South Africa is impossible, unless one undertakes a country-wide data collection which will be a costly exercise. In terms of the geographical hierarchy of areas, mesozones are higher than the main places, and the latter will be used for analyses. Mesozones are uniform hexagons, while the main places are irregularly shaped to follow official boundaries. The demographic data for 2020 was acquired from GeoTerraImage (GTI), while 2011 education data were obtained from Statistics South Africa (StatsSA, 2011). The 2011 census data has been used instead of the 2021 General Household survey data since the household survey data is reported at a provincial level which makes it unfit for the analysis in this study. The education level data are in the following categories: 3 to 4-year-olds who are enrolled in preschool, 6 to 15-year-olds who have completed

Table 1. Datasets used in the study.

DATA	SOURCE	TYPE
Job opportunities	CSIR	Attribute data per mesozone
Education Attainment for 2011	Census 2011 of Stats SA	Area attribute data per main-place
3–4-year-olds enrolled in preschool		
3–4-year-olds		
6–15-year-olds enrolled in primary school		
16–19-year-olds enrolled in secondary school		
25-year-olds and above with higher education		
Education Attainment for 2020	GEO TERRAIMAGE(GTI)	Area attribute data per sub-place
3–4-year-olds enrolled in preschool		
3–4-year-olds		
6-15year olds enrolled in primary school		
16–19-year-olds enrolled in secondary school		
25-year-olds and above with higher education		
Sub place boundaries	StatsSA	Polygon data
Main place boundaries	StatsSA	Polygon data

primary education, 16 to 19-year-olds who have completed secondary school, and 25-year-olds and above who have completed higher education. The summary and sources for the datasets are shown in Table 1.

2.2. Pre-process

The StatsSA (2011) education data were projected to 2020 using the GTI (2020) population statistics. The process of projection included dividing the 2011 education data for each age category by the total number of people in that specific year and then multiplying it by the 2020 total number of people in that particular year. i.e. 6 to 15-year-olds enrolled in primary school in 2011 divided by the total number of 6–15-year-olds in 2011 multiplied by the total number of 6 to 15-year-olds in 2020. The projection was made to update the education data for this study. The second step was to calculate the education rate for each age category and then average all categories to get the education attainment factor for each sub-place (Statistics South Africa, 2011b). The sub-place population data were then aggregated into main places (Statistics South Africa, 2011a) to undertake spatial analysis at a uniform level.

2.3. Measuring proximity to jobs

Proximity was calculated to determine how far or close people are to jobs. Centroids were created for the mesozones and sub-place polygons, which were used to calculate the distance between the two geographic areas. The distance was used for calculating proximity indexes. The equation was introduced by (Budlender & Royston, 2016) and expressed as follows:

$$E1_i = \sum_j \frac{1}{\sqrt{m_{ij}}}(Ej) \tag{1}$$

Where M*ij* is the total distance between the mesozones and the sub-places. The square root of distance was used to minimize the distance differences. E*j* is the total number of jobs per mesozones. The following equation has been used the proximity value to create

indexes out of 100 where a score of 0 indicates that an area is far away from jobs and 100 means an area is closer to jobs

$$Zi = \frac{\text{xi} - \min}{\max - \min} \text{x}100 \tag{2}$$

2.4. Establishing the relationship between job proximity and education attainment

Multiple regression is a statistical technique that establishes a relationship between dependent variables and several predictor variables (Khandelwal et al., 2017; Mekanik & Imteaz, 2012). Gasparrini et al. (2012), Khandelwal et al. (2017), and Blum and François (2010) indicate how the model was used successfully to analyse demographic data in different case studies. This study used the model to predict educational attainment using job proximity. Educational attainment is a function of the distance between mesozones and sub-places (job proximity), employment rate, and total population. The equation for the multiple regression used is presented as:

$$\text{EA} = \alpha 0 + \beta 1(\text{Xs} - \text{Xm}) + \beta 2\ \text{X2} + \beta 3\ \text{X3} + \text{c} \tag{3}$$

Where EA is the dependent variable, which is Education attainment, α is a constant, (Xs – Xm) (proximity to jobs) is the distance between mesozones and sub-places, β1, β2, and β3 are the coefficient estimates, X2 and X3 are independent/predictor variables (employment rate and total population), and c is a random error term.

3. Results

3.1. Proximity measure

The proximity indexes were calculated, and visual representations were created to display the physical proximity of jobs in relation to where people stay. It should be noted from the results that the higher the proximity, the closer the area is to job opportunities, the lower the proximity the farther the area is to job opportunities. The proximity maps are presented concurrently with the job location maps to understand job concentration per metro. The total jobs (Map 2a-9a) are displayed at mesozone while proximity counts (Map 2b-9b) are displayed at a main place level. The proximity count for each metro is determined by the total jobs and the distance calculated between the mesozones and the sub-places, hence the different proximity index intervals for each metro area. Total job intervals are displayed using Natural breaks and Quantiles were used to display the proximity index.

In Figure 2a, jobs are concentrated in the western part of Ekurhuleni which represents relatively well-off places, while the surrounding townships have fewer jobs. The areas close to jobs have a high proximity index in comparison to those located farther away from job locations (see Figure 2b). A high proximity of between 25 and 100 is prominent in areas such as Kempton Park, Germiston, Boksburg, Edenvale, and Alberton. Areas such as Springs, Brakpan, Tembisa, and other townships located next to zones of a high proximity index, also have moderate proximity between 15 and 20. Townships like

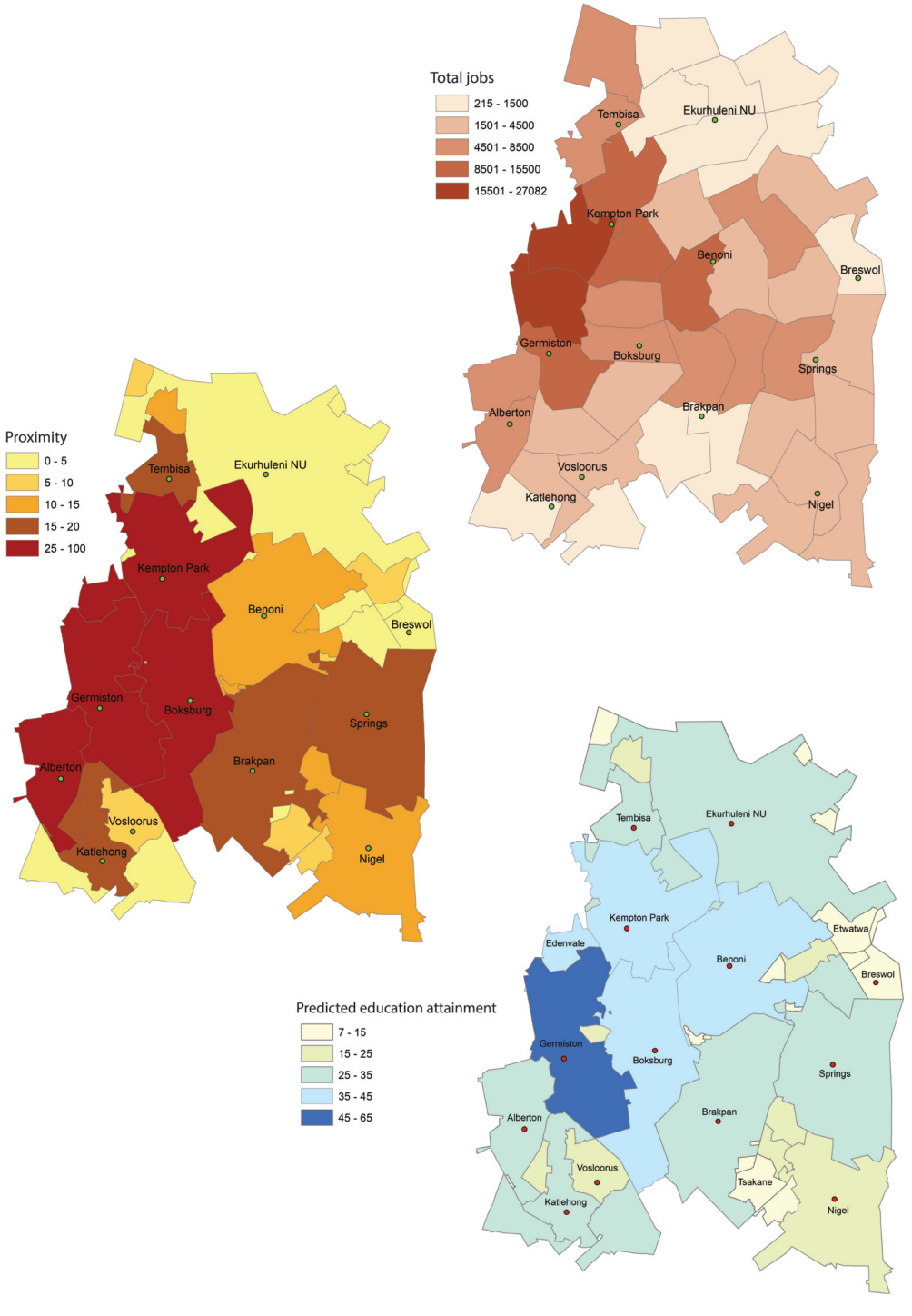

Figure 2. (a) total jobs, (b) proximity to jobs, and (c) predicted education attainment in Ekurhuleni.

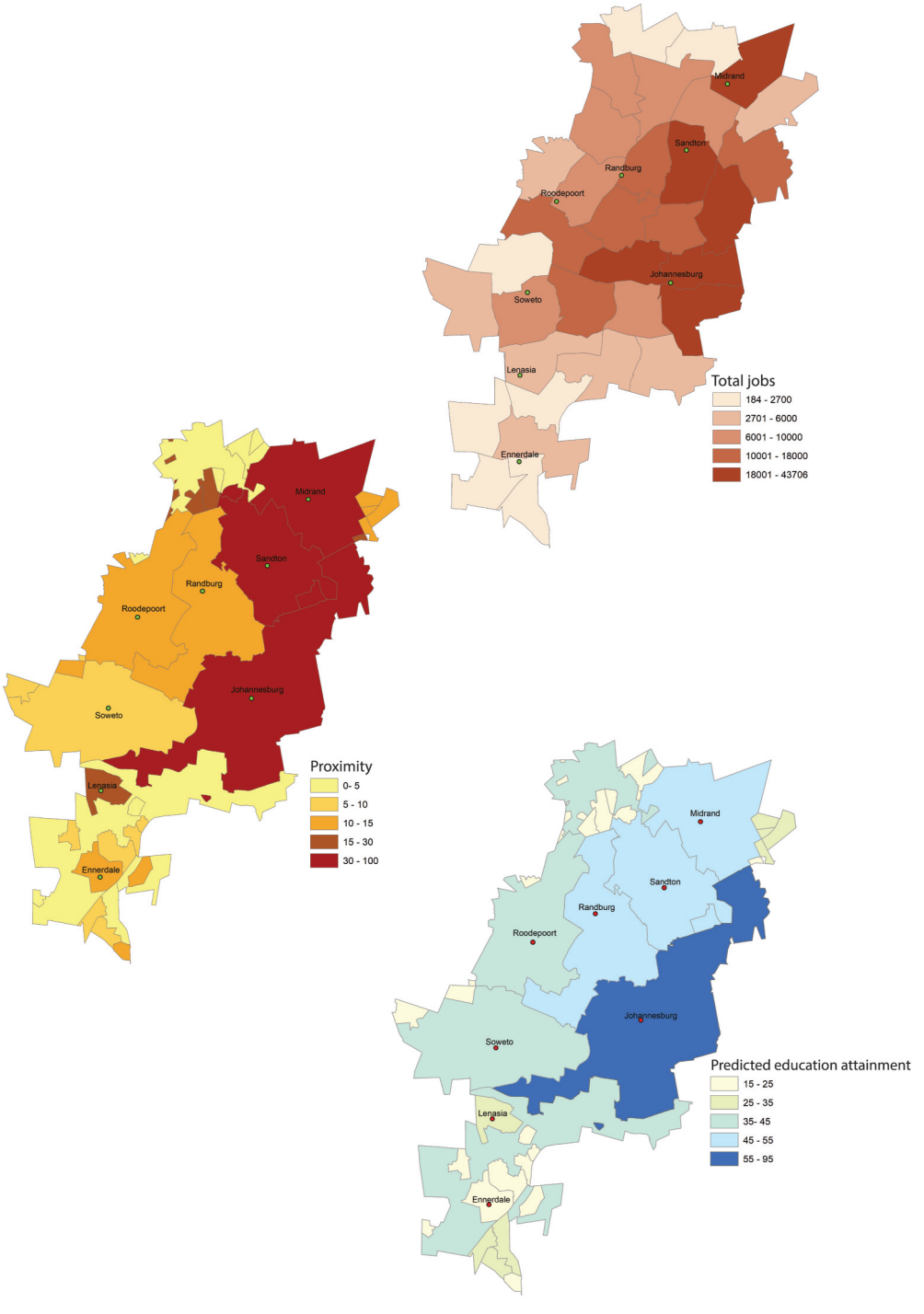

Figure 3. (a) total jobs, (b) proximity to jobs, and (c) predicted education attainment in Johannesburg.

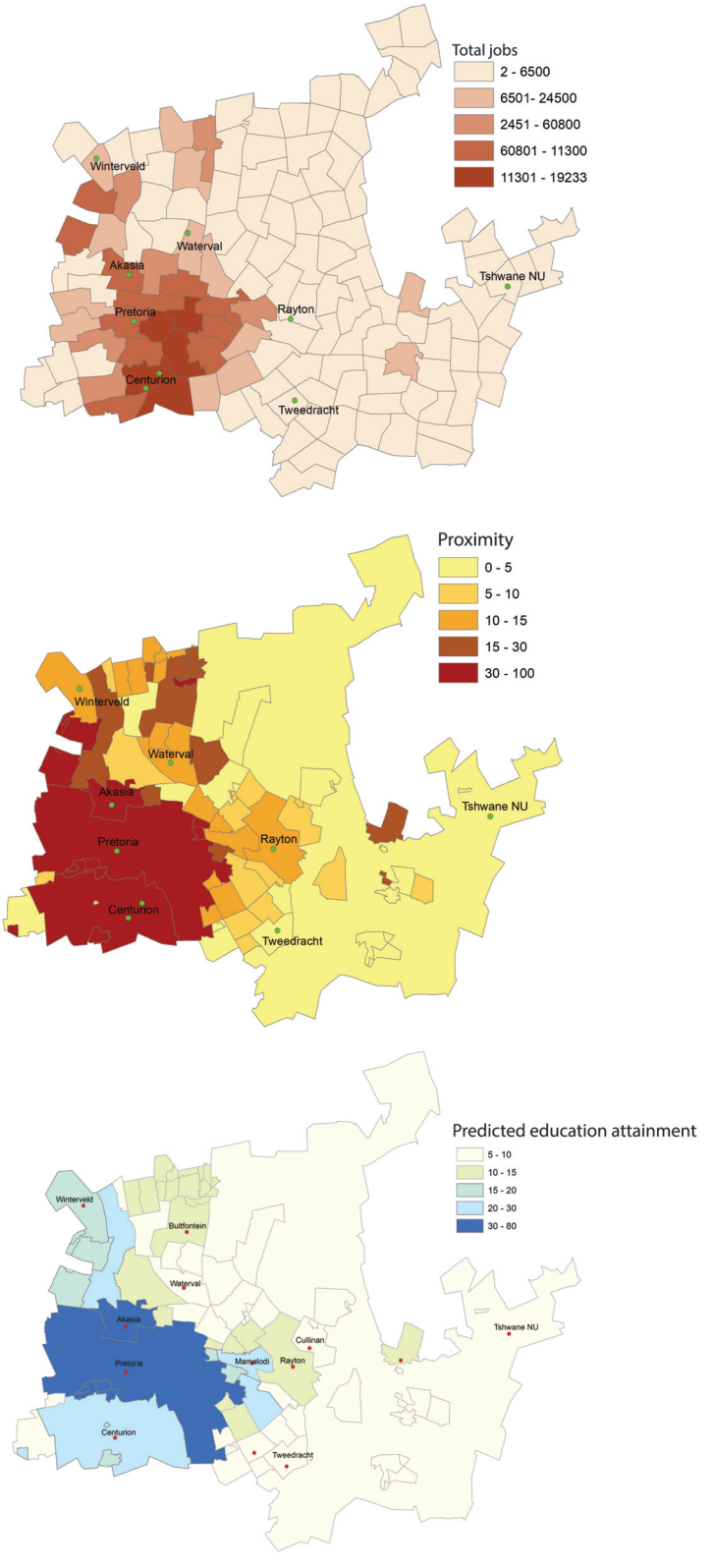

Figure 4. (a) total jobs, (b) proximity to jobs, and (c) predicted education attainment in Tshwane.

Etwatwa, Tsakane, and Breswol have fewer jobs and a lower proximity index between 0–5.

In Johannesburg, jobs are concentrated in the city centre and the northern suburbs (Figure 3a). Most of the northern suburbs such as Sandton, Midrand, and Johannesburg are close to jobs, while areas that have the lower proximity index are peripheral townships like Diepkloof, Ennerdale, and Soweto, which are located towards the south, southwestern, and far northwest of the metro (Figure 3b). Figure 4a shows that jobs are in the southern and southwestern areas of the Tshwane metro area. Pretoria, Centurion, and Akasia are the centres of a high proximity index between 30 and 100. In contrast, townships, and rural areas in the northern and southeastern areas away from the job opportunities, are indicated by a lower proximity index (Figure 4b).

Figure 5a shows that jobs are concentrated mainly in the central part of the City of Cape Town (around areas such as Cape Town, Milnerton, and Parow, with a high proximity index of 30 to 100 shown by Figure 5b. Areas with fewer jobs and lower proximity are Khayelitsha, Atlantis, and Philippi. In eThekwini (Figure 6a), job opportunities are clustered in the eastern coastal parts of the metro, with areas around Durban and Pinetown having high clusters of jobs. Although neighbourhoods around Westville, Chatsworth, Umlazi, and Phoenix also have high proximity of 30 to 60, there is a clear distinction between them and Durban and Pinetown, which have a proximity count of 60 to 100, see Figure 6b. The surrounding townships, such as Mgangeni, Nungwani and Madundube, have fewer jobs and a lower proximity index.

Figure 7a presents a cluster of jobs in different centres of Buffalo City. Most jobs are concentrated in the eastern part of the metro (East London) and the western part (King William's Town/Qonce), with the highest proximity index of between 30 and 100 shown in these areas (see Figure 7b). Fewer jobs and a lower proximity index are notable in other parts of the metro. In Mangaung (Figure 8a), jobs are concentrated mainly around Bloemfontein with the highest proximity index being between 20 and 100, while the surrounding areas are far from job opportunities. The majority of the main places in the metro (except Bloemfontein and Botshabelo) have a very low proximity index between 0 and 5 (see Figure 8b). Figure 9a shows the distribution of jobs in the Nelson Mandela Bay metropolitan area. Jobs are concentrated in areas such as Port Elizabeth, Uitenhage, and Bethelsdorp, with a high proximity index between 40 and 100 shown in Figure 9b. While the rest of the surrounding areas have fewer jobs and a lower proximity index.

3.2. Relationship between job proximity and education attainment

The regression model presents the relationship between proximity to jobs and educational attainment in each metro. The null hypothesis of the model states that the model is not significant. Theoretically, if the regression model is not significant, it does not suffice to explain the relationship between proximity to jobs and educational attainment. In Ekurhuleni it is clear from Table 2 that the p-value (<0.0001) suggests that the model is significant, which implies that the null hypothesis can be rejected. The model explains 63% of the variation ($R^2 = 0.63$). Every unit increase in proximity to jobs is associated with a (0.27) increase in educational attainment. The predicted educational attainment (Figure 2c) shows that job proximity determines educational attainment. Areas such as Germiston and Edenvale recorded a high proximity index and high predicted education

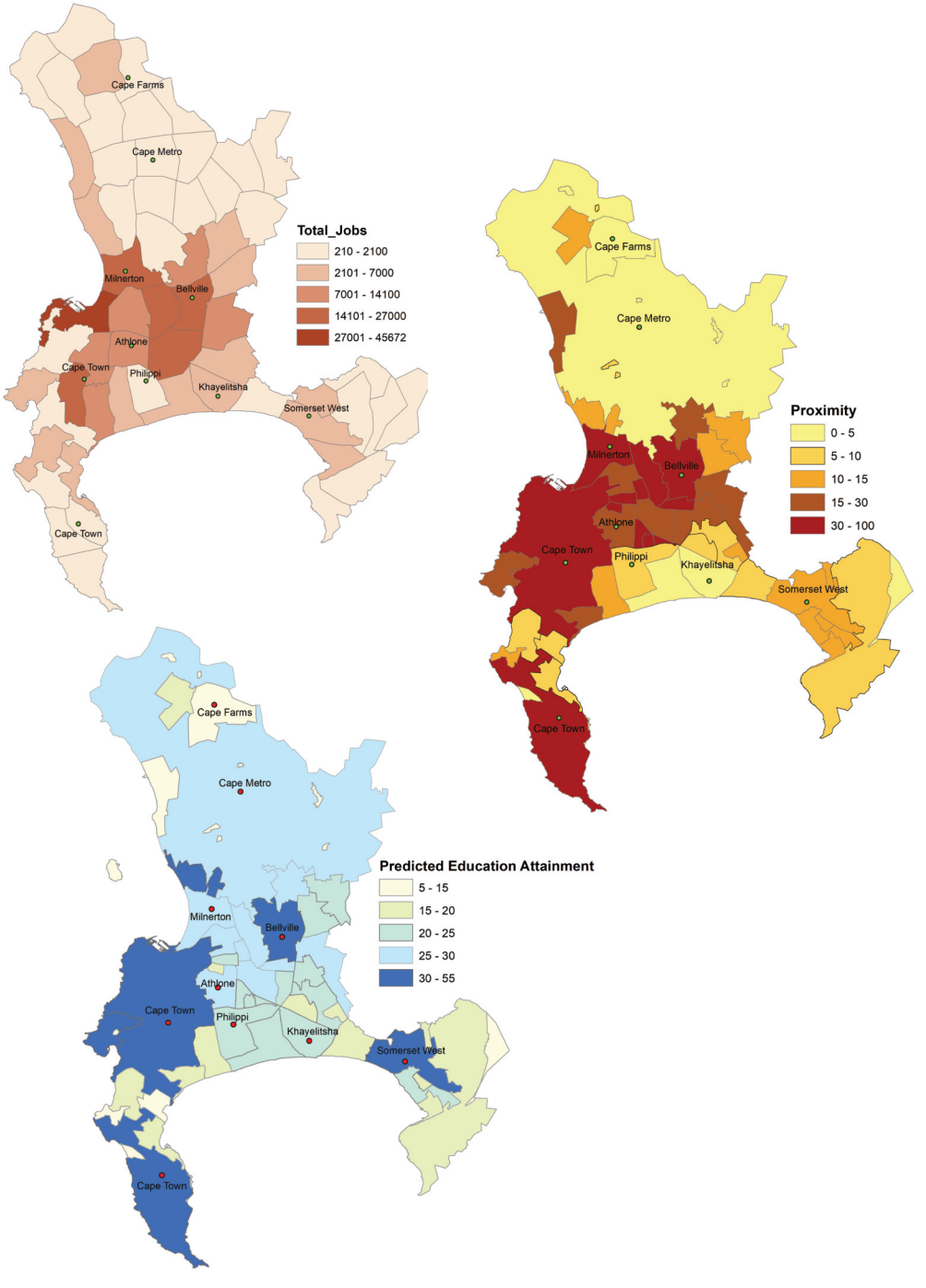

Figure 5. (a) total jobs, (b) proximity to jobs, and (c) predicted education attainment in Cape Town.

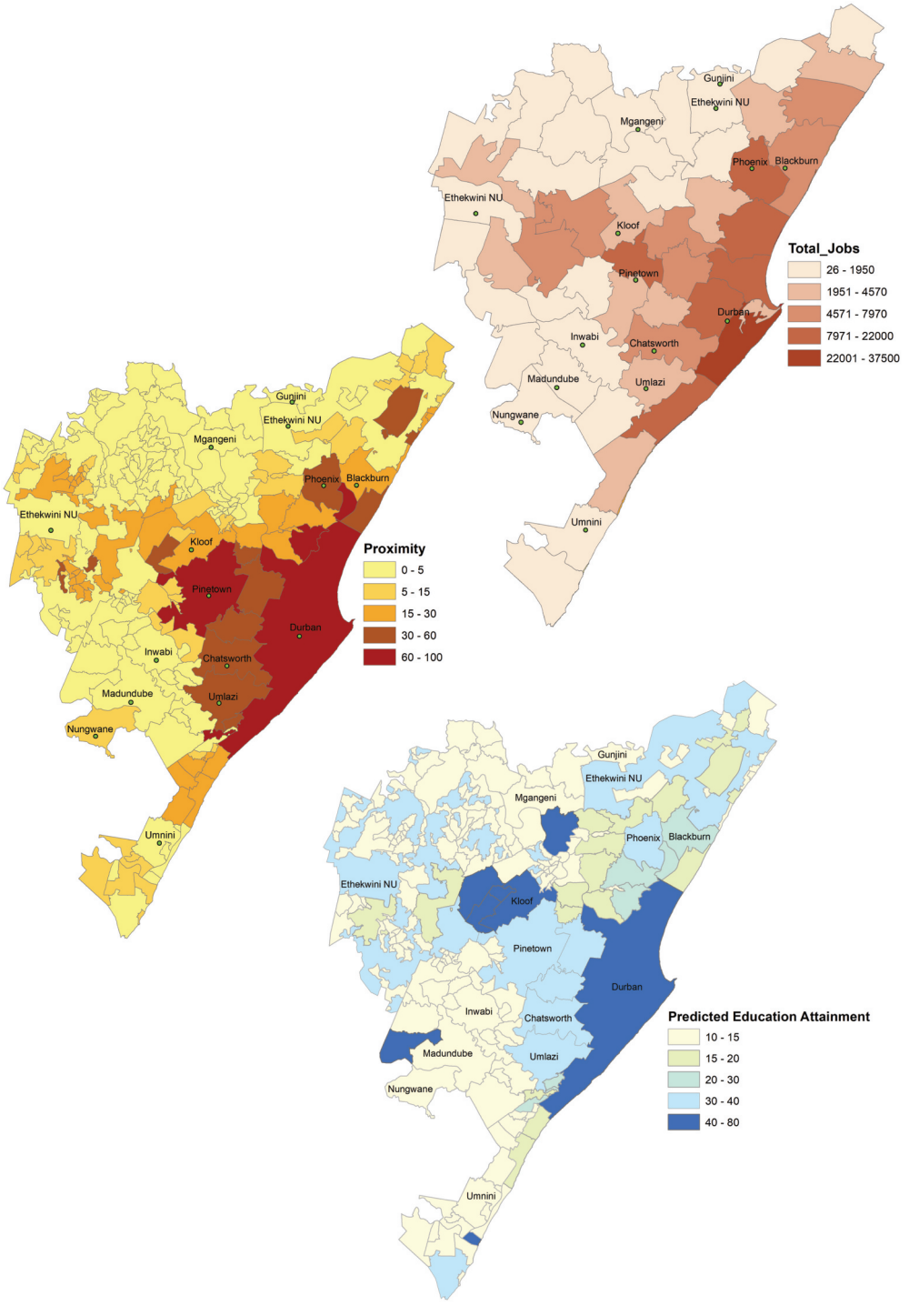

Figure 6. (a) total jobs, (b) proximity to jobs, and (c) predicted education attainment in eThekwini.

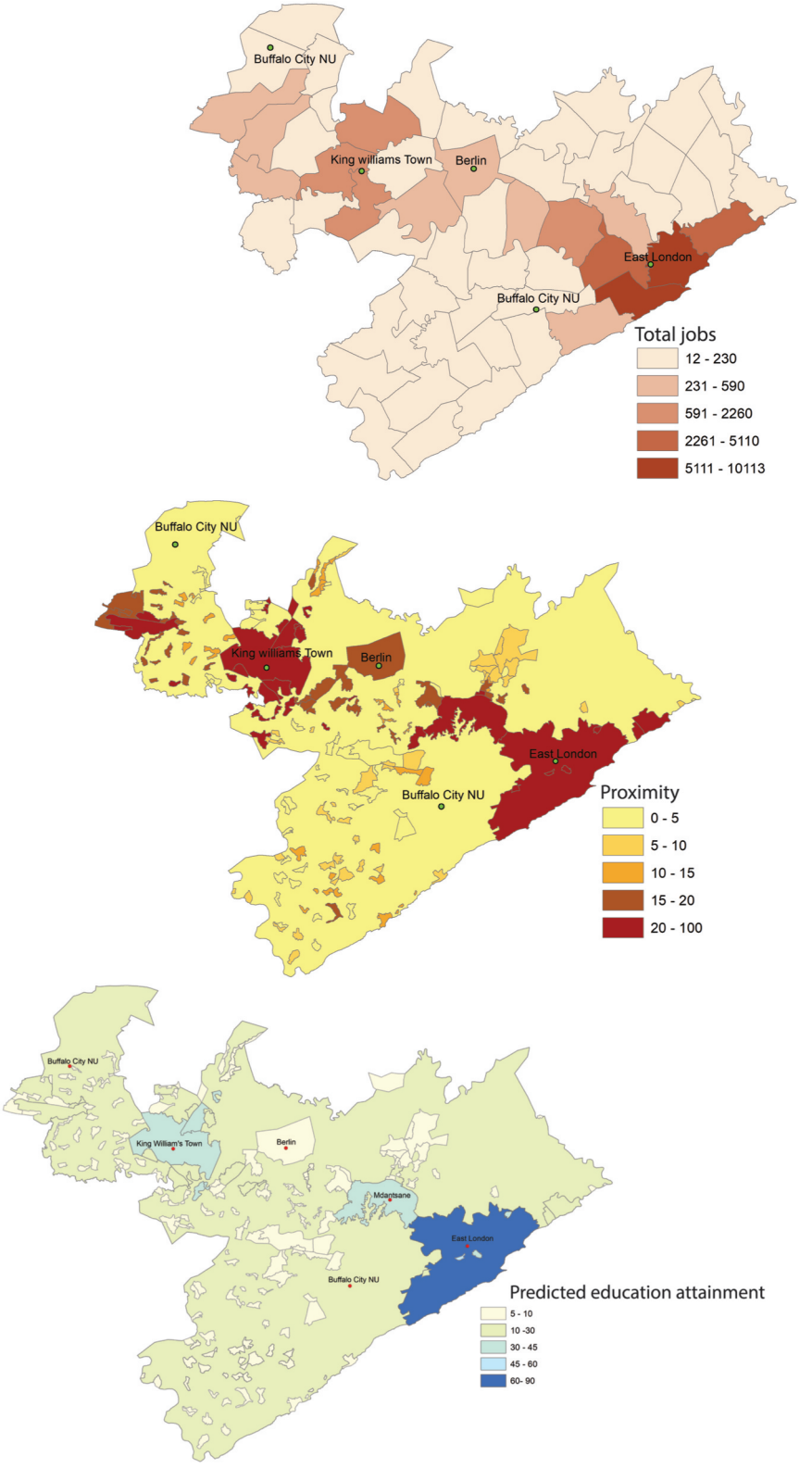

Figure 7. (a) total jobs, (b) proximity to jobs, and (c) predicted education attainment in Buffalo City.

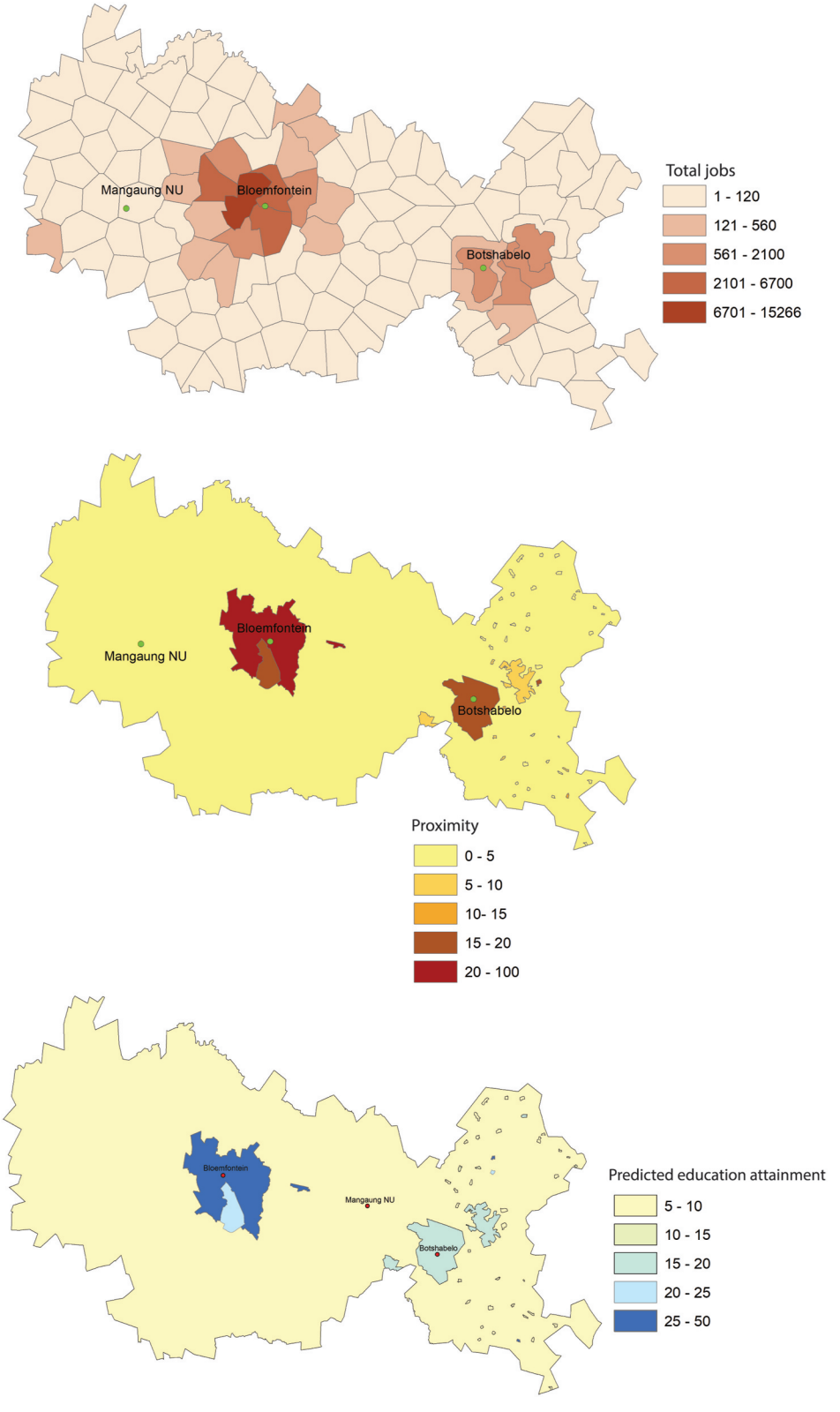

Figure 8. (a) total jobs, (b) proximity to jobs, and (c) predicted education attainment in Mangaung.

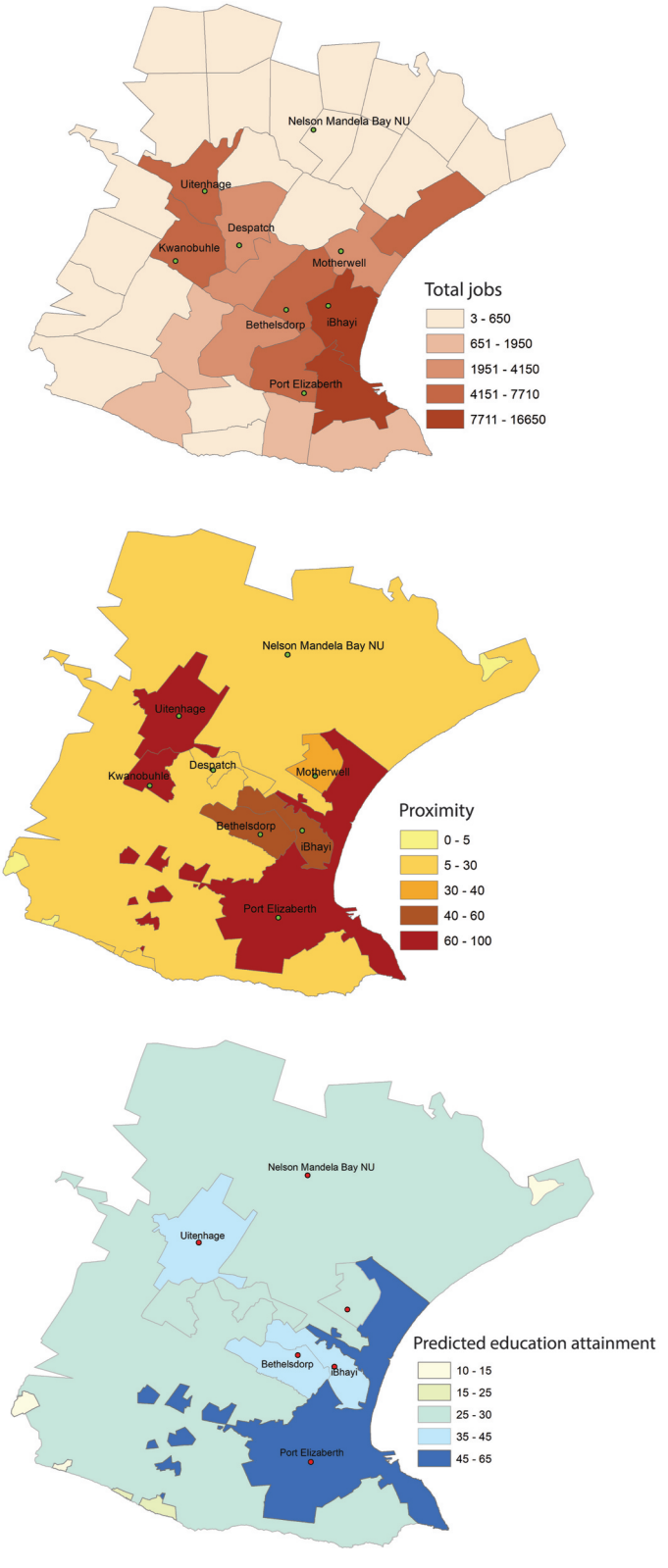

Figure 9. (a) total jobs, (b) proximity to jobs, and (c) predicted education attainment in Nelson Mandela.

Table 2. Ekurhuleni regression model results.

Variable	Estimate	Pr > |t|
Intercept	1.24391	<.0001
Proximity	0.27296	<.0001
Root MSE	0.25969	
R-Square	0.6342	
Pr > |t|	<.0001	

Table 3. Johannesburg regression model results.

Variable	Estimate	Pr > |t|
Intercept	0.18181	<.0001
Proximity	0.20568	<.0001
Root MSE	0.20831	
R-Square	0.7617	
Pr > |t|	<.0001	

attainment. While areas such as Breswol, Tsakane, and Vosloorus have low proximity and education attainment.

The regression output for Johannesburg (Table 3) suggests that the model is significant with a p-value of (<0.0001), and the R^2 of (0.76) indicates that 76% of the variation is explained by the model. The table also shows that every unit increase in proximity to jobs is associated with a 0.20 increase in educational attainment. The spatial visualization indicated by Figure 3c shows the predicted educational attainment in the Johannesburg metro area. Areas with high education attainment (Sandton, Midrand, and Randburg) are associated with a high proximity to jobs. It is also crucial to note that most townships such as Lenasia and Ennerdale are associated with low educational attainment.

Predicted education attainment for Tshwane (Figure 4c) shows that areas with high proximity to jobs such as Centurion, Pretoria, and Akasia have high educational

Table 4. Tshwane regression model results.

Variable	Estimate	Pr > |t|
Intercept	0.81878	<.0001
Proximity	0.02454	<.0001
Root MSE	0.30187	
R-Square	0.5331	
Pr > |t|	<.0001	

Table 5. Cape Town regression model results.

Variable	Estimate	Pr > |t|
Intercept	0.52368	<.0001
Proximity	0.03070	<.0001
Root MSE	0.21607	
R-Square	0.6408	
Pr > |t|	<.0001	

attainment. In contrast, the surrounding areas such as Winterveld, Tierpoort, and Waterval have low educational attainment. Table 4 shows a significant relationship between proximity to employment and educational attainment, and for every unit increase in proximity to jobs is associated with a (0.020) increase in educational attainment.

The Cape Town regression output (Table 5) indicates a significant relationship between proximity to jobs and educational attainment. The model explains about 64% of the variation in the data. For every unit increase in proximity to jobs is associated with a (0.030) increase in educational attainment. The visual representation in Figure 5c indicates that Cape Town, Bellville, and Somerset West have high educational attainment. Some areas, such as Athlone, Parow, and Milnerton, have high proximity to jobs and moderate educational attainment compared to Cape Town and Bellville. Areas like Philippi, Khayelitsha, and Kraaifontein have very low educational attainment.

Figure 6c shows a significant relationship between job proximity and educational attainment in the eThekwini metro area. High educational attainment is recorded in Durban (where job proximity is also high), Hillcrest, and Kloof (where proximity is moderate compared to Durban). While northern and southern townships show low educational attainment and low job proximity. For every unit increase in proximity to jobs is associated with a (0.54) increase in educational attainment, as indicated in Table 6.

The model, as indicated by Table 7, depicts that proximity to jobs explains the educational attainment in Buffalo City. Although not perfect, the model explains about 53% of the variation in the data. Table 7 shows that every unit increase in proximity to jobs is associated with a (0.083) increase in educational attainment. Educational attainment is high in East London, where jobs are also concentrated. Based on Figure 7c, the areas that have a lower proximity index also have low education attainment. Figure 7c also shows that areas such as King William's Town and Berlin (which showed high job proximity) have low to moderate education attainment.

The Mangaung map (Figure 8c) shows that job proximity is a determinant factor for educational attainment. The figure shows that educational attainment is high in

Table 6. eThekwini regression model results.

Variable	Estimate	Pr > |t|
Intercept	0.11005	<.0001
Proximity	0.5070	<.0001
Root MSE	0.35201	
R-Square	0.5323	
Pr > |t|	<.0001	

Table 7. Buffalo City regression model results.

Variable	Estimate	Pr > |t|
Intercept	0.65477	<.0001
Proximity	0.08331	<.0001
Root MSE	0.34803	
R-Square	0.539	
Pr > |t|	<.0001	

Table 8. Mangaung regression model results.

Variable	Estimate	Pr > |t|
Intercept	0.80527	<.0001
Proximity	0.14622	<.0001
Root MSE	0.31366	
R-Square	0.6011	
Pr > |t|	<.0001	

Table 9. Nelson Mandela Bay regression model results.

Variable	Estimate	Pr > |t|
Intercept	0.37412	<.0001
Proximity	0.21809	<.0001
Root MSE	0.29183	
R-Square	0.5499	
Pr > |t|	<.0001	

Bloemfontein (which also has a high proximity index) and low in surrounding townships. Table 8 indicates that the model explains 60% ($R = 0.6$) of the variation in the data. For every unit increase in proximity to jobs is associated with a (0.14) increase in educational attainment.

Job proximity determines the educational attainment in Nelson Mandela Bay metro. Figure 9c shows that educational attainment is high in Port Elizabeth, followed by Uitenhage, Bethelsdorp, and iBayi (which also have high proximity to jobs), while the other areas such as Motherwell have low educational attainment. For every unit increase in proximity to jobs is associated with a (0.29) increase in educational attainment shown in Table 9. The model explains 54% of the variation in the data.

4. Discussion

This study explored the relationship between proximity to jobs and educational attainment to explain the influence of spatial match on educational attainment. The proximity measure showed that job opportunities are located mainly in highly developed areas across the respective metros, while impoverished areas are located far from jobs. The regression model and spatial visualizations indicate a positive relationship between job proximity and education attainment in all metros, i.e. when proximity to jobs is high, educational attainment is also high, while low proximity was associated with low education attainment.

The proximity measure indicated that in Gauteng metros (Johannesburg, Tshwane, and Ekurhuleni), jobs are concentrated in affluent areas rather than in poor surrounding areas. In Johannesburg, jobs are in the city centre and towards the northern suburban areas such as Sandton, Midrand, and Randburg. During apartheid, economic activities were concentrated in the central business district (CBD). However, in the post-apartheid era, jobs are more suburbanized as Naudé (2008) alluded. Areas such as Ennerdale, Diepsloot, and Lenasia are located away from jobs. Moreover, these are mainly poor black townships. The City of Tshwane's job opportunities are clustered in the southern

and central parts of the metro (Pretoria, Centurion, and Akasia). In contrast, townships and the rural areas at the periphery are away from job centres. Jobs are located in industrial centres (such as Germiston, Boksburg, and Alberton) in Ekurhuleni while, the surrounding townships (Tembisa, Etwatwa, and Duduza) have fewer jobs located close to them. Even though Gauteng is the economic hub of South Africa (Nhamo et al., 2021), it is crucial to note that spatial inequality still exists, as some areas are more privileged while others are marginalized (De Visser, 2019).

The results indicate that areas in Gauteng metros with high proximity to jobs also have higher educational attainment. The results indicated that areas located close to job opportunities tend to have greater educational attainment than those that are further away from jobs. It is an indication that spatial disparities influence people's livelihood outcomes. This finding also supports the argument made by Van der Berg et al. (2011), Van der Berg (2007), and Gauteng provincial treasury (2009) that economic inequality plays an influential role in explaining the quality of education in the country. This is to say, although jobs and educational attainment are high in some areas, other areas experience the opposite. Thus, proximity to jobs is one of the critical determinants of educational attainment in Gauteng metros.

The location of jobs in the Eastern Cape metros is different from that of Gauteng due to their coastal locations. The Coega Special Economic Zone, Port Elizabeth Industrial Development Zones, and tourism attractions are primary job sources (Acheampong, 2016; Freund, 2014). According to the results, in Buffalo City, jobs are concentrated in East London and King William's Town, while the surrounding areas (like Berlin and Mdantsane) have a low proximity to jobs. In Nelson Mandela Bay, jobs are high in Port Elizabeth and Uitenhage, whereas a low proximity index was recorded in areas such as Motherwell and Despatch. The results show the disintegration of rural areas, towns, and regional economies (Hajdu et al., 2020; Moyo et al., 2022; Ngumbela, 2021). The findings also indicated that proximity to jobs determines education attainment in Buffalo City. Most of the remote areas within Buffalo City and Nelson Mandela Bay are associated with very low educational attainment while economically developed areas have high education attainment. Although the SEZ and the IDZ projects enhance the metro's economy, inequality still exists. Eastern Cape has a high level of poverty with most households located in rural areas and considered severely poor (Ebenezer & Abbyssinia, 2018; Hajdu et al., 2020; Moyo et al., 2022; Ngumbela, 2021). The rural nature of the Eastern Cape and the low level of human capital contribute to the high level of inequality within the province. Most parts of the province are rural areas with numerous poor schools and limited skills development (Moyo et al., 2022). Although one of the Eastern Cape Development Plan (PDP) aims to eradicate socioeconomic issues by improving skills development and quality education, the efforts remain inadequate to solve the level of inequality (Moyo et al., 2022). The disparities in the Buffalo City and Nelson Mandela Bay economy makes it challenging to solve the socio-economic issues within the Eastern Cape metro areas (Freund, 2014).

With notable similarities in the eThekwini metro, the results showed that most jobs are in the Durban coastal areas and Pinetown. In contrast, the peripheral areas such as Qhodela, Umnini, and Mgangeni are distant from job locations. The results also showed that educational attainment follows a similar trend as job proximity: high education attainment is notably high in areas where the number of jobs is high. This indicates that

in eThekwini, job proximity influences the level of educational attainment. Such results also depict that inequality is one of the critical social issues within the metro, which is also argued by Musvoto et al. (2016) and Chetty (2014).

The results indicated that in Cape Town, jobs are clustered in the city centre, Parow and Bellville. The Cape Town main place hosts most of the metro's job opportunities. Commercial services, ports, and industrial businesses are some of the primary sources of job creation in this metro (Western Cape Provincial Treasury, 2017). Low proximity to jobs is shown in areas such as Khayelitsha, Philippi, and Kraaifontein. The results also indicated that proximity to jobs is a crucial determinant of educational attainment. Areas with high educational attainment also have high proximity to jobs, while areas with low education attainment are those located away from job clusters. The results imply that although the Cape Town metro is flourishing economically, inequality has socioeconomic implications for some areas in the metro (Turok et al., 2021).

Mangaung results indicated a monocentric form of job locations: jobs are concentrated in Bloemfontein's main places, followed by other places such as Botshabelo. Most other places have fewer job opportunities. The results also indicated a significant relationship between the location of jobs and educational attainment. Areas of high job clusters also have high education attainment. The results indicate that Mangaung also faces spatial inequality, evident in proximity and predicted education.

Well-located communities are characterized by enhanced socio-economic status. However, economically segregated communities have negative societal outcomes (Turok, 2018; Turok et al., 2017; Gesthuizen et al., 2012). Findings indicate that all the metros in the country that are located close to jobs also have high educational attainment. In contrast, areas located away from job opportunities have low educational attainment. Various studies have alluded that marginalized neighbourhoods hinder people's progress compared to integrated communities (Hamnett et al., 2007; Bischoff & Reardon, 2014; Howell-Moroney, 2005; Musterd et al., 2017; Gesthuizen et al., 2012). These spatial forms have induced economic exclusions, poverty, and social inequality (Baffi et al., 2018; Budlender & Royston, 2016; Leibbrandt et al., 2012; Sinclair-Smith & Turok, 2012). The findings in this study presented cases of how well-located and segregated communities influence educational attainment.

The limitation of the approach used in this study is the boundary/edge effect. The study considers the jobs within the official boundaries only and ignores the interdependencies outside the metropole, which means that a location might be away from employment, but close to jobs in the neighbouring municipality. For instance, Diepsloot township appears to have low proximity to jobs (within Johannesburg), but at a regional scale, it is closer to jobs in Tshwane. Despite the limitations, the results answer the main objective of the study.

5. Conclusion

The study demonstrated the relationship between proximity to jobs and educational attainment. The study revealed that developed areas tend to be located closer to jobs while poor places are distant from where jobs are. The predicted education attainment was high in areas closer to jobs and lower in areas away from job

opportunities, indicating that distance from job centres influences educational attainment.

South African metro areas contribute significantly to the country's economic growth but still face spatial disparities and inequality. The findings also revealed that metro areas are facing uneven geography of job opportunities and educational attainment. Although similar, the disparities are unique to the context of each metro area. Therefore, development approaches should also be unique for each metro. In some areas, development should be geared towards economic development while others should be for human capital and personal development. With these findings, the study concludes that spatial mismatch in South Africa's metro areas influences educational attainment. Future research could explore the relationship between spatial mismatch and other social factors such as crime.

Acknowledgments

First, and most importantly, I would like to thank my Lord and Saviour Jesus Christ for the strength and grace He gave me. I also appreciate my co-author, Dr. Gina Weir-Smith who is also my supervisor for her continuous support and guidance.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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