RESEARCH PAPER

THE SOCIAL EQUITY OF PUBLIC GREEN OPEN SPACE ACCESSIBILITY: THE CASE OF SOUTH TANGERANG, INDONESIA

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Received: August 17th, 2022 / Accepted: February 15th, 2023 / Published: March 31st, 2023
https://DOI-10.24057/2071-9388-2022-124

ABSTRACT. Public Green Open Space (PGOS) is widely known to provide many benefits for the well-being of urban community, especially the socially vulnerable. Achieving equitable PGOS access is crucial for the sustainability and livability of cities. This study aims to 1) observe the accessibility of PGOS and 2) investigate the social equity of PGOS access in South Tangerang, Indonesia. This study employed network-based accessibility analysis through GIS and constructed a green space access index at urban village level to observe the accessibility of PGOS for urban residents. Furthermore, statistical correlation tests were conducted to examine the social equity of PGOS access against socio-demographic variables. The spatiality of equity was explored by using Bivariate Moran's I. The results found that in South Tangerang, PGOS access is unequal, showing 61.2% of residential areas being underserved. This study also found that PGOS access is higher in elite private neighborhoods. Furthermore, statistical tests showed that PGOS access is inequitable for the low-income group. As for the elderly and population density, PGOS access was found to be equitable. However, no correlation was found between children and PGOS access. Additionally, causes of inequality and inequity in PGOS access and its implications are further discussed. This study addresses several key policy implications for urban planners and specifically for the government of South Tangerang such as the need to reform PGOS planning & policy and developing alternative funding for PGOS.

KEYWORDS: accessibility, equality, equity, GIS, public green open space

CITATION: Kurniawan H. B., Roychansyah M. S. (2023). The Social Equity Of Public Green Open Space Accessibility: The Case Of South Tangerang, Indonesia. Geography, Environment, Sustainability, 1(16), 45-54
https://DOI-10.24057/2071-9388-2022-124

ACKNOWLEDGEMENTS: The authors would very much like to thank the reviewers for their valuable input for the improvement of this article. The authors would also like to thank Dhimas Bayu Anindito, Yori Herwangi, Luthfi Muhamad Iqbal and many more of those who have contributed to giving insights and who have helped the authors improve the research.

Conflict of interests: The authors reported no potential conflict of interest.

INTRODUCTION

Public Green Open Space (hereafter: PGOS) such as park and urban forest, has long been considered a vital resource for the urban community's health that is constantly experiencing the negative effect of the intense urban activity and development (Satterthwaite 1993). Prior research findings have indicated the significance of PGOS in which it provides many essential benefits for urban dwellers' well-being (Chiesura 2004; Coombes et al. 2010; Ward Thompson et al. 2012; Krefis et al. 2018). PGOS stimulates physical & social activities and establishes interaction with nature which leads to the improvement of the urban community's quality of life, overall health, and social cohesion (Ward Thompson et al. 2012; Holt et al. 2019; Dushkova & Ignatieva 2020; Rigolon et al. 2021; Sharifi et al. 2021). The significance of PGOS benefits is particularly relevant and evident in the context of the recent health crisis, the pandemic of Covid-19 (Marconi et al. 2022; Noszczyk et al. 2022). Noszczyk et al. (2022) revealed that PGOS eases the negative effect of pandemic crisis on urban population.

Accessibility to PGOS as represented by distance is one of the main factors that influences its use and further has an implication on how the urban community can derive benefit from the PGOS optimally, besides its size, quality, and quantity (Coombes et al. 2010; Haq 2011; S. Feng et al. 2019; Zhan et al. 2021). Empirically, Coombes et al. (2010) and Toftager et al. (2011) found that the closer urban residents live to PGOS, the more likely they visit PGOS regularly to exercise, therefore obtaining better health conditions. Consequently, urban residents having different degree of PGOS accessibility may experience different health outcomes which leads to health and quality of life disparity (Rigolon et al. 2021; Sharifi et al. 2021).

PGOS service should be prioritized in areas where the demand is highest, often associated with social vulnerability such as proportion of the vulnerable (e.g. children, the elderly, & the low income group) and population density (Lee & Hong 2013; Yuan et al. 2017; Pham & Labbé 2018; Wolff & Haase 2019; Geneletti et al. 2022). This is due to numerous reasons. Children & the elderly have mobility limitation which restricts them to go long distance and as for the low-income group, they have limitation in financial resource to afford private facilities to carry out exercise and recreation (Romero 2005; Maas et al. 2008; Boone et al. 2009; Reyes et al. 2014). Thus, they have a greater need for nearby public recreation facilities, especially one which enables them to interact with nature (Rigolon et al. 2021). Past empirical research findings suggest that the aforementioned vulnerable group may obtain greater benefit from PGOS than the non-vulnerable (Takano 2002; Feng & Astell-Burt 2017; Twohig-

Bennett & Jones 2018; Rigolon et al. 2021; Geneletti et al. 2022). As for population density, higher population density is often associated with higher urban stress and potential overcrowding of green space use (Wolff & Haase 2019; Liu et al. 2020).

The concept of the spatial match between service level and the social demand is widely known as social equity (Yuan et al. 2017). Social equity is further understood as having two dimensions: 1) horizontal equity, which concerns about the condition of which everyone has the same access to resource (equality) and 2) vertical equity which concerns about the quality of being fair and considers different need and demand of social group in regard to receiving access to resource (access to resource is distributed proportionately) (Boone et al. 2009; Yuan et al. 2017; He et al. 2020). Achieving social equity in the context of urban infrastructure such as PGOS has been recognized as a crucial aspect of sustainable and resilient urban development (Zhou & Wang 2011; Wolch et al. 2014; Meerow et al. 2019; Zheng et al. 2020; Chen et al. 2020; Li et al. 2021). Thus, the study to evaluate the social equity of PGOS accessibility is considered important (Rigolon 2016; Li et al. 2021). Findings of such a study could inform the decision makers to further mitigate the negative impact of which PGOS inequity exists (Rigolon et al. 2021; Xu et al. 2022). Recently, there has been an increasing number of research focused on evaluating the equity of PGOS accessibility in various cities, of which most studies found that the non-vulnerable such as those with higher Socio-Economic Status (SES) tend to have better access to PGOS than the vulnerable (Tan & Samsudin 2017; Yuan et al. 2017; Chen et al. 2020; He et al. 2020; Sharifi et al. 2021; Herreros-Cantis & McPhearson 2021). However, the issue of equity in PGOS in the context of developing countries is still relatively less explored (Chen et al. 2020; Du et al. 2020).

Based on the previous discussions, using the case of South Tangerang, Indonesia, this study aims to 1) observe the accessibility of PGOS and 2) investigate the social equity of PGOS access to understand whether the access is distributed in line with social demand. South Tangerang, Indonesia makes an ideal case study for the topic of green space equity for several reasons. First, South Tangerang is a suitable representation of a city undergoing adverse spatial segregation in Indonesia, indicated by the existence of a number of massive-sized elite settlement areas built by private developers termed as new town (Apriyanto et al. 2015; Winarso et al. 2015). Secondly, South Tangerang aspires to be an equitable, livable, and sustainable city, a condition that's currently on progress to be achieved through the long-term development plan of South Tangerang City (RPJPD 2005-2025). Such vision implies that equitable access to basic public resources such as green space should be fulfilled, therefore increasing the urgency for a PGOS equity study to be conducted. In addition, South Tangerang is one of municipalities within Jakarta Metropolitan Region (Jabodetabek) which has extreme urbanization rate with annual population growth reaching 6.87% (Saifullah et al. 2018). This may impact the availability and distribution of PGOS in South Tangerang. The result of this study is expected to add discussion to the existing studies of green space equity as results are often contextual in which it varies along different geographical areas, cultures, and cities with different development histories (He et al. 2020; Sharifi et al. 2021).

To achieve the objectives set out, this study goes through two steps. First step is accessibility analysis which is done through network analysis in Geographic Information System (GIS). This study incorporated residential land use in the accessibility analysis to identify the optimality of PGOS service for urban residents. Previous studies rarely consider the residential land use variable to assess urban community's accessibility level to green space, rather only focus on administrative boundary alone (He et al. 2020; Mushkani & Ono 2021). Furthermore, this study advanced the accessibility analysis by constructing index of PGOS accessibility at urban village (kelurahan) administrative level to observe the PGOS service in quantitative measure. Secondly, to understand the equity of PGOS access, this study assessed the association between PGOS accessibility and the socio-demographic variables by employing Spearman correlation test. This study further explored the spatiality of the association by using Bivariate Local Indicator of Spatial Association (BiLISA). The socio-demographic variables which are considered in this study are the vulnerable (children, the elderly, and the low-income group) and the population density as previously discussed.

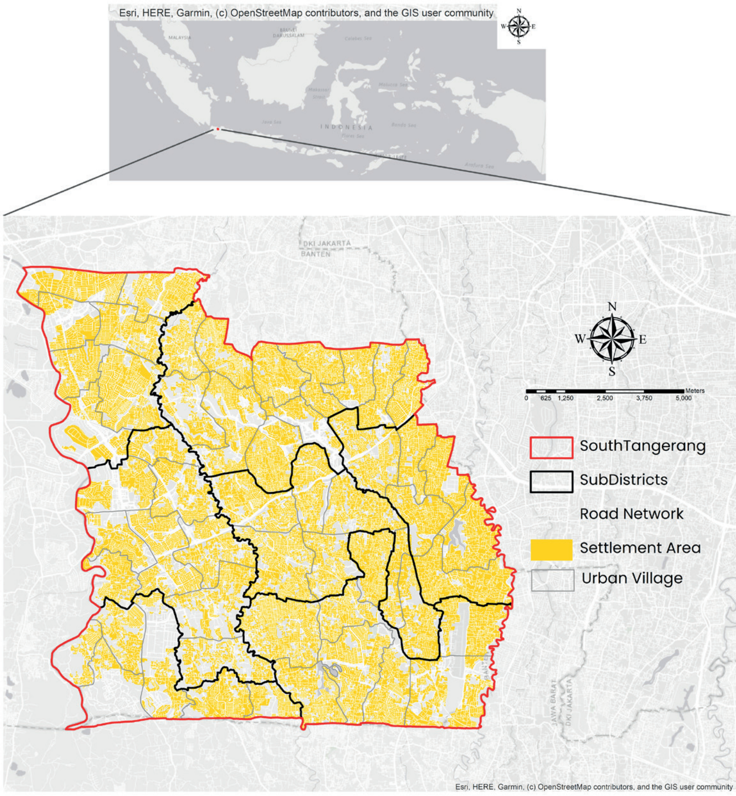

Fig. 1. South Tangerang City

Data Source: The Development Planning Board of South Tangerang

STUDY AREA

The study area is South Tangerang City located in Banten, Indonesia. South Tangerang is part of the highly urbanized Jakarta Metropolitan Region. South Tangerang City is 147.19Km² in size, consisting of 54 urban villages with seven sub-districts (administrative level above urban village: kecamatan), namely Setu, Ciputat, East Ciputat, Serpong, North Serpong, Pamulang, and Pondok Aren. In 2021, based on data provided by Agency of Population and Civil Registration, South Tangerang City has 1.3 million population with its density of 10.484 population/Km². It is evident that low-income population is aggregating in the urban outskirts (Agency of Population and Civil Registration, 2021), quite possibly due to the low housing prices in urban fringe as argued by Covington (2015). The affluent group generally reside in areas known as kota mandiri or new towns (massive-sized elite housing developed by private sector) (Winarso et al., 2015). There are 3 developers that develop new towns in South Tangerang, namely Bumi Serpong Damai (hereafter: BSD), Bintaro, and Alam Sutera (Firman 2004). The existence of new towns in South Tangerang City has been studied by many to have produced spatial segregation, especially regarding how access to facilities and infrastructure is distributed such as PGOS (Firman 2004; Winarso et al. 2015; Roitman & Recio 2020). South Tangerang has been experiencing various environmental problems, mostly caused by its rapid urban development and lack of green space such as Urban Heat Island and poor air quality (Andriarsi 2021; Prastiwi 2022).

MATERIALS AND METHODS

In this study, PGOS is referred to as public parks and urban forest (human-modified green space), following the definition of PGOS by Du et al. (2020) & Sharifi et al. (2021). In this research, human-modified PGOS is an artificially built recreational green space with open access (free of charge), usually managed and/or built by the government (Sharifi et al. 2021). PGOS in this study was validated by using Google Street View. This study acquired the PGOS data (in shapefile) from OpenStreetMap since access to PGOS spatial database from government officials was unavailable. Furthermore, OpenStreetMap was chosen as the data source because it's open source and its data completeness is reliable for researcher and policymaker (Barrington-Leigh & Millard-Ball 2017; Wibowo et al. 2021). It was identified that there are 128 PGOS in South Tangerang as of 2021. Furthermore, this study also collected the data of PGOS entrance distribution which would be used to model accessibility in the network analysis, by using Google Street View (GSV). GSV was used as it is cost-effective, safety, time-efficient, and reliable to audit built environment (Biljecki & Ito 2021; Haddad et al. 2021) and considering the restricted outdoor activities due to Covid-19 pandemic during data survey.

Network data was obtained from OpenStreetMap as a basis data for accessibility analysis. Administrative boundary at urban village level and the data of residential land use in 2018 were obtained from The Agency of City Development Planning South Tangerang. Both data respectively will be used for accessibility analysis. Specifically for residential land use, this study argues that by considering residential land use for the accessibility analysis, it will provide better accuracy in assessing the PGOS accessibility to urban residents. Furthermore, since the latest data of residential land use beyond 2018 was unavailable for the analysis, this study assumes that residential land use pattern in 2018 remains the same in 2021. Other than that, this study also obtained data of boundary of new town from the private developer's website (BSD: www.bsdcitycommercial.com, Alam Sutera: alam-sutera.com, Bintaro: www.jayaproperty.com) to compare PGOS accessibility based on housing type. Socio-demographic data in 2021 at urban village level was obtained from the Agency of Population and Civil Registration which comprises of population based on age and low-income group. The data will be used in correlation analysis against the PGOS accessibility level to justify social equity.

Examining the Green Space Accessibility

To examine the PGOS accessibility (the equality of service), network analysis method was employed. Network analysis method was chosen since it measures the service coverage of an object based on actual road network, therefore accurately representing accessibility or proximity towards the object of interest. The PGOS accessibility was measured in network analyst tool in ArcGIS 10.3, based on 800 meters distance or 10 minutes' walk, a distance most residents are willing to walk for (Du et al. 2020; He et al. 2020). The result of this analysis is PGOS accessibility coverage which was then intersected against the residential land use in South Tangerang City. Based on the previous analysis, Green Space Accessibility Index (hereafter: GSAI) was constructed to observe varying accessibility (service) level among urban villages in quantitative measure. GSAI was also used in the correlation analysis against the socio-demographic variables. In constructing the accessibility index, this study followed Tan & Samsudin (2017) specified below.

$$Green\ Space\ Accessibility\ Index\ (GSAI) = \frac{Gc}{rA}$$

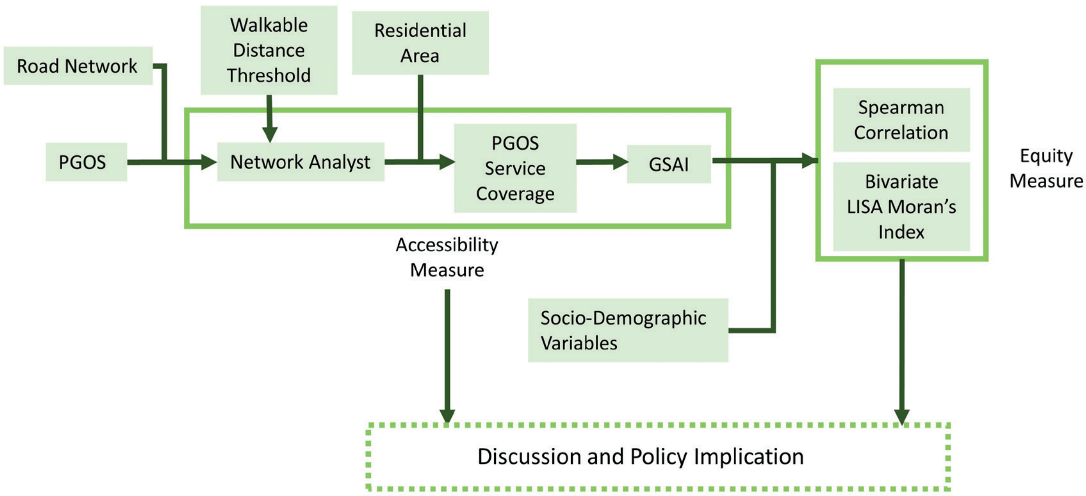

Fig. 2. Methodology Flow

Gc is defined as PGOS coverage over residential area (in Ha) in an urban village, divided by rA which denotes the total residential area (in Ha) in an urban village. Gc considers all PGOS service which covers residential area within the same urban village. It was done to reduce the potential issue of boundary effects encountered when assessing green space service coverage at administrative unit (Zhou & Kim 2013; Tan & Samsudin 2017). GSAI allows to better understand whether urban village has enough green space service covering the residential area, providing urban residents sufficient access to PGOS (within walkable distance). Furthermore, this study classified the GSAI results of 54 urban villages using Jenks method in ArcGIS 10.3 into 5 classes: very low (0-0.12), low (0.13-0.3), moderate (0.31-0.47), high (0.48-0.69), and very high (0.70-0.96).

Analyzing Socio-Demographic Conditions

Socio-demographic data was analyzed at the level of urban village using simple quantitative analysis on the low-income group, the elderly, and the children respectively. Other than that, this study also conducted population density analysis. Prior to analyzing the socio-demographic data, this study classified each socio-demographic character. Firstly, as the data provided by Development Planning Board of South Tangerang already classified low-income population based on Ministerial Decree of Ministry of Social Affairs No 88/HUK/2021, this study only calculates the proportion of the low-income group at urban village. As for the elderly, this study classified the elderly as those who are aged over 60, following the definition from The Law of The Republic Indonesia on Elderly Welfare Number 13 of 1998. As for the children, this study followed He et al. (2020) which stated that children are those who are aged between 0-14. After classifying the demographic characteristic, this study calculates the proportion of each group and the population density.

$$Proportion\ of\ children\ at\ urban\ village\ i = \frac{Number\ of\ Children_i}{Total\ population_i}$$

$$Proportion\ of\ the\ elderly\ at\ urban\ village\ i = \frac{Number\ of\ Elderly_i}{Total\ population_i}$$

$$Proportion\ of\ low\ income\ group\ at\ urban\ village\ i = \frac{Number\ of\ Low-Income_i}{Total\ population_i}$$

$$Population\ density\ at\ urban\ village\ i = \frac{Population_i}{Subdistrict\ area_i}$$

Analyzing Social Equity in Green Space Access

To examine the social equity in PGOS access, this study employed two statistical methods following Zhu et al. (2022). Firstly, the non-spatial statistics correlation analysis was conducted with the Spearman correlation test between GSAI and socio-demographic variables: low-income group, the elderly, children, and population density. The non-spatial correlation test was conducted in SPSS 20.0. The result of the test is an index ranging from -1 to 1 which indicates the correlation's strength and direction. Secondly, the spatial correlation was analyzed using Bivariate Local Indicator Spatial Autocorrelation (BiLISA) Moran's I in Geoda Software. BiLISA Moran's I was used to observe the spatiality of the correlation across study area (at the urban village level) between GSAI and the socio-demographic variables. Talen & Anselin (1998) and Anselin (1995) stated that using BiLISA approach is best when investigating spatial associations between accessibility and socio-economic variables. BiLISA uses Moran's Index for each urban village in South Tangerang with the formula as follows:

$$I_i = Z_i \sum_j W_{ij} Z_j$$

Where Z_i and Z_j respectively are GSAI and socio-demographic variables used in this study, W_{ij} denotes neighborhood weight matrix where sum of j across each row i equals 1. The result of the BiLISA analysis is a spatial correlation map showing areas of different clusters: High-High, High-Low, Low-High, and Low-Low. Low-High indicator means that the socio-demographic variable shows low value while GSAI is high (spatial mismatch), relative to other areas in the case study and vice versa for High-Low. As for the areas marked with High-High and Low-Low indicates equity which implies that PGOS service level (GSAI) is in line with the social demand level (socio-demographic variables). Lastly, this study also reported the results of Global Moran's Index of spatial association which produces spatial correlation index with a value ranging from -1 to 1 indicating similar meaning to the index of non-spatial correlation test (Sharifi et al. 2021).

RESULTS

Public Green Open Space Accessibility

Based on the calculation, PGOS per capita (M^2/capita) in South Tangerang is only 0.387, lower than the standard mandated by the World Health Organization (WHO) of 9M^2/capita. Further on the accessibility analysis (see figure 3), this study found that the PGOS service does not cover a large area of South Tangerang City. Specifically, calculation results showed that PGOS accessibility has only covered 38.8% of the residential area, leaving 61.2% residential area being underserved in South Tangerang. There's only 694,650 population being served by PGOS in 2021 which leaves 48.7% population with very poor access (>800 m) to PGOS. In this analysis, it was found that the pattern of PGOS service coverage tends to agglomerate in certain parts of South Tangerang.

Furthermore, this study calculated the GSAI for each urban village in which the result of GSAI analysis can be observed in Figure 4. Average GSAI from 54 urban villages is 0.37 and the median is 0.35 which suggests that green space service is sub-optimal in many urban villages, covering very small residential area. The lowest value of GSAI is 0 and the highest is 0.95 out of maximum 1 (100% coverage of green space/PGOS). From the result, it was found that there are 5 urban villages with 0 (zero) GSAI indicating that the urban villages are entirely isolated from any PGOS service within walkable distance. Urban residents living in those urban villages may have to put relatively greater effort to access PGOS.

Based on the Jenks classification, GSAI shows 9 urban villages classified as having very high index and 15 urban villages classified as having very low index. The spatial pattern of urban villages with high to very high GSAI aggregates in certain parts of the city such as in the north-eastern and south area. As seen in the chart of urban villages with different GSAI classification (figure 4), most urban villages in South Tangerang have relatively poor access to PGOS. They are urban villages with GSAI classification of Very Low to Low GSAI, amounting up to 46.29% or 25 urban villages of total urban villages as opposed to urban villages with GSAI classified as High to Very High amounting to only 31.48%. Based on both the PGOS service coverage analysis and GSAI calculation, this study confirms that the PGOS accessibility in South Tangerang shows inequality. This

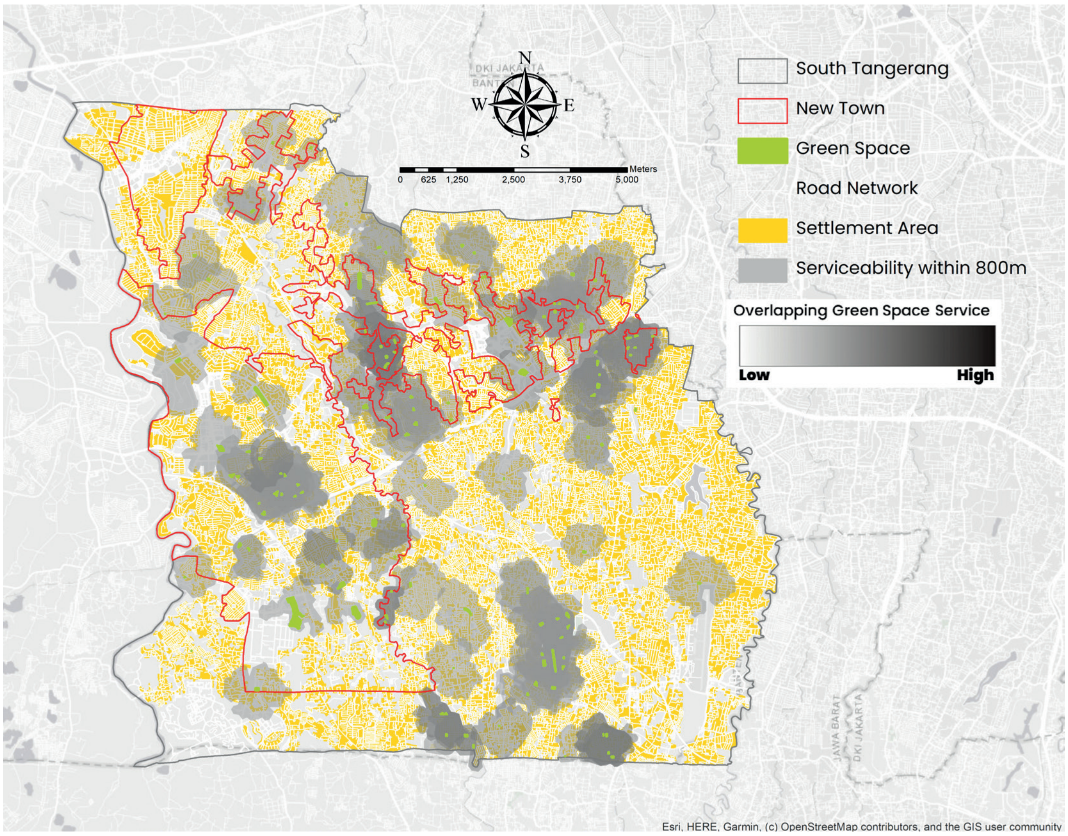

Fig. 3. The spatial accessibility of public green open space

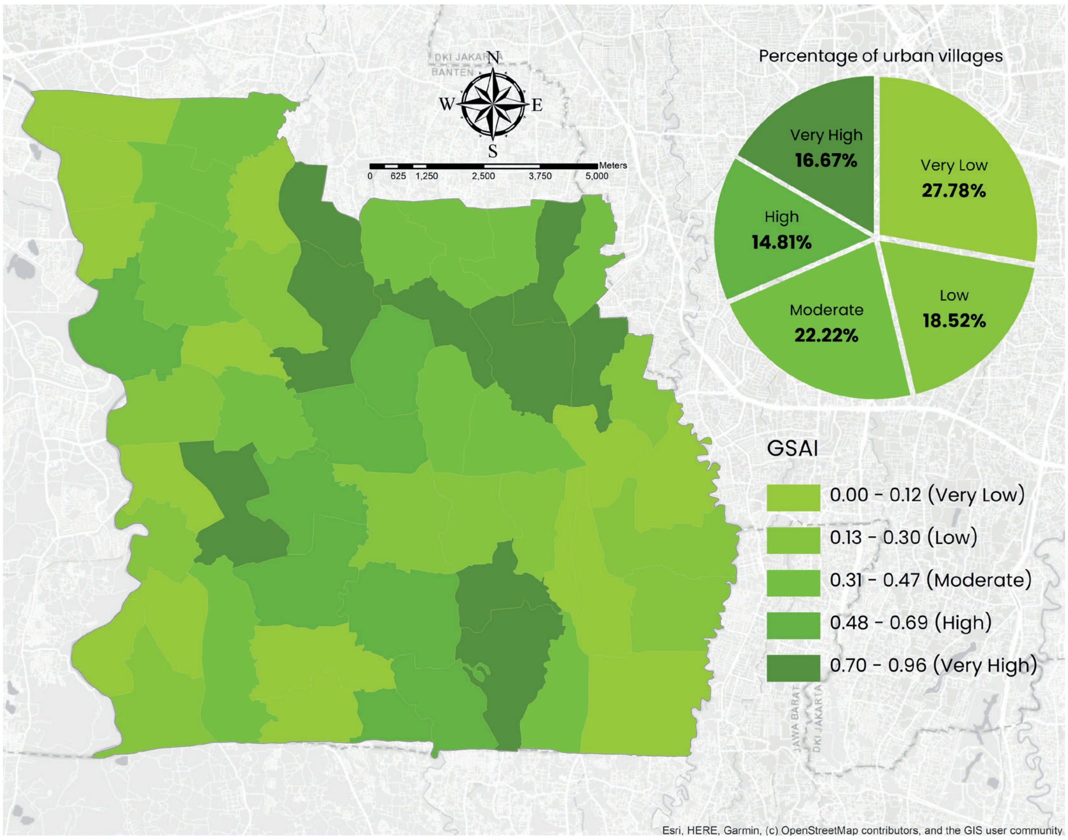

Fig. 4. Spatial distribution of GSAI and percentage of urban village based on GSAI

study also found that new town has more land allocated to PGOS. The coverage of public green space service is also higher in new town of 42.11% than the coverage of PGOS service outside of new town, which only amounts up to 33.5%.

Association Between Green Space Access and Socio-Demographic Variables

The results of the Spearman correlation statistics are presented in table 1. First, the result of the test on low-income and GSAI variable revealed a significant (P<0.01) negative correlation. It implies that areas with higher proportion of the low-income group generally have poor

PGOS access (implying inequity). As for the correlation test result of GSAI against the proportion of children, the study found no correlation with index showing 0 value. This study reports a positive Spearman correlation of the proportion of elderly and population density against GSAI, meaning that PGOS access level is generally in line with the demand from the perspective of population density and the elderly.

Furthermore, the spatial pattern of the association between socio-demographic characteristics and GSAI is identified through BiLISA analysis (see figure 5). The BiLISA result for low-income group and GSAI yields an interesting finding: Low-High clusters are prevalent with the Global Moran's index value showing negative spatial correlation. From the perspective of the BiLISA test, urban villages with few numbers of the low income group have higher PGOS accessibility which indicates spatial mismatch of demand & supply and thus an indication of inequity. As for spatial correlation analysis of the proportion of children & GSAI, the spatial association is positive, albeit very weak at 0.065. Furthermore, the result of BiLISA on the proportion of the elderly and population density against GSAI both revealed positive correlation with dominating clusters of High-High and Low-Low. Lastly, all the cluster maps from BiLISA analysis indicate a similar pattern in which the urban center to southwestern area generally show no statistically significant spatial association (clusters shaded in grey) between GSAI and socio-demographic variables.

DISCUSSION

PGOS Accessibility and Its Implication on Social Equity

The inequality of PGOS access in South Tangerang found in this research is consistent to previous studies in many cities (Tan & Samsudin 2017; Chen et al. 2020; Fasihi & Parizadi 2020; Mushkani & Ono 2021; Sharifi et al. 2021). Figure 3 shows that the urban fringe (the southwestern, northwestern & southeastern area) has relatively low PGOS access, possibly implying that urban fringe residents lack opportunities to public recreation facilities. In addition, this article also found many areas with overlapping PGOS service as can be seen in Figure 3. Interestingly, PGOS access tends to be relatively better in private elite neighborhood (new town) such as BSD and Bintaro (an exception for Alam Sutera in the northwestern part of South Tangerang, as many of its vacant land areas are still undeveloped). This study's finding further adds to the discussion of which neighborhoods built by private developers offers a better opportunity to facilities and infrastructures such as green space than public housing (Firman 2004; Tan & Samsudin 2017; Roitman & Recio 2020). It should be clarified that green space in new town is made publicly accessible through The Law No. 1/2011 concerning Housing and Residential Areas and Regulation of The Ministry of Home Affairs of the Republic of Indonesia No. 9/2009, imposed to private developers. The regulations imply the obligation that private housing developers need to fulfill regarding

Table 1. Results of Correlation Test

			Green Space Access Index
Spearman	Low-Income Group	Correlation Coeff.	-0.388**
	Children		0.000
	The Elderly		0.179
	Population Density		0.255

(Note: ** means that the correlation is significant at P<0.01 (2-tailed)

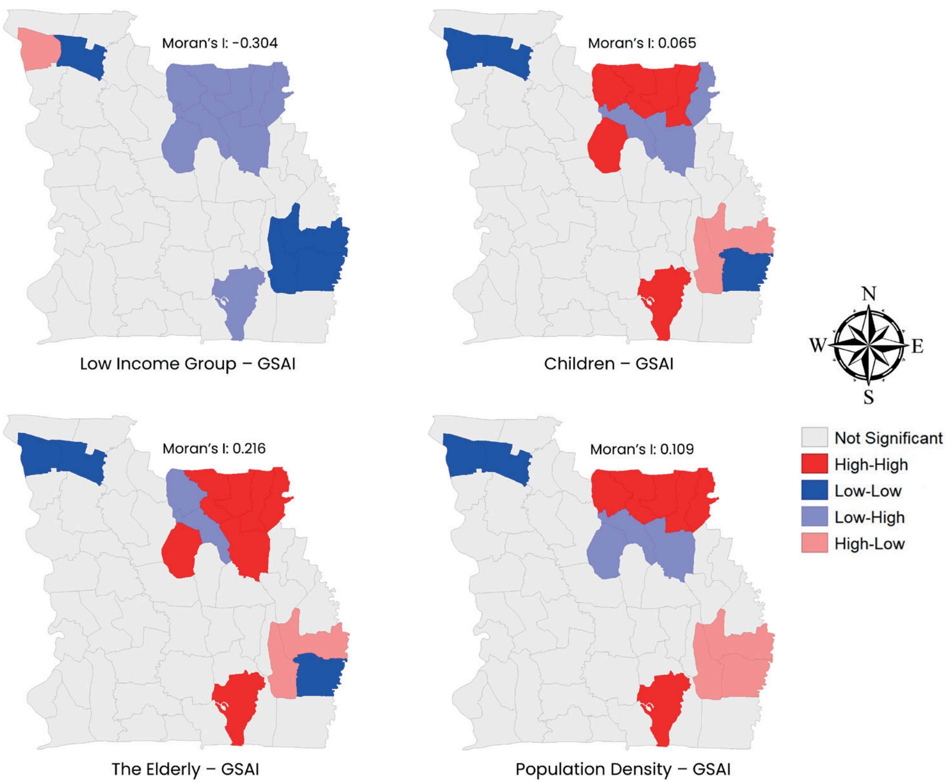

Fig. 5. Spatial distribution of GSAI and percentage of urban village based on GSAI

the provision of facilities & infrastructure and the delegation of the ownership and management responsibility to the town government.

In terms of social equity (the vertical dimension of equity), this study revealed that PGOS access is inequitable for the low-income group in South Tangerang, confirmed by the Spearman and BiLISA results. Here this study argues several reasons which contribute to the formation of dominant cluster of Low-High in the northeastern area of South Tangerang (see figure 5 for low-income vs GSAI). Firstly, the existence of new town Bintaro in the cluster contributes to the high GSAI since green space in Bintaro area has been extensively developed by the private developer. In addition, as Firman (2004) and Winarso et al. (2015) maintain, most occupants of the new town are generally considered elites with high income and social status, resulting in the cluster of very few low-income residents in the area. This finding is also similar with an abundance of prior studies regarding how neighborhoods with dominant affluent group tend to have better green space access, leaving the low income group with poor access to PGOS (Tan & Samsudin 2017; Yuan et al. 2017; Chen et al. 2020; He et al. 2020; Sharifi et al. 2021). The low income having poor access to PGOS can exacerbate their health issues and lead to intergenerational health problems (Sharifi et al. 2021). Regarding children and GSAI, correlation analysis results shows a zero value on Spearman index and a very weak Moran's Index. This article argues that the findings suggest unpatterned equity, a term usually used to describe when there is no apparent systematic relationship between the service of public resource and the socio-demographic variable (in this case, GSAI and the children proportion), as found in the studies of Wilson et al. (2004), Abercrombie et al. (2008), and Maroko et al. (2009). As for correlation of GSAI between proportion of the elderly and population density, it was identified that they indicate equity, albet not significant at 0.179 and 0.255. However, although supply of PGOS service is generally in line with the demand of population density and the elderly, some areas still need to be paid attention to increase green space, especially as suggested in BiLISA result, regarding clusters of High-Low which implies high demand with relatively low supply.

Factors Affecting PGOS Accessibility Pattern and Its Equity

This study argues that the causes of inequity (both in horizontal and vertical dimensions) in PGOS access is contextual. For example, in Ilam City – Iran, the disparity in the distribution of PGOS is mainly caused by the socio-cultural process of the ancient community affecting the early development of the city, followed by the cost and ownership factors of land (Fasihi & Parizadi 2020). Chen et al. (2020) in their study revealed that inequity in PGOS access in Shanghai – China is caused by the urban spatial restructuring policy of which industrial areas were relocated to the urban outskirts causing the massive decrease in green space while later the urban center received intensive PGOS development. Furthermore, green gentrification has also contributed to inequity (Chen et al. 2020). Meanwhile, in the context of South Tangerang – Indonesia, lack of considerations on spatial accessibility and socio-demographic aspect in the PGOS planning & policy may contribute to shaping the inequitable pattern of green space. PGOS planning & policy in South Tangerang (also in most cities in Indonesia) only focuses on the quantitative standard of 30% green space ratio of urban area (overlooking spatial and socio-demographic aspect) which refers to The Law No. 26/2007 concerning Spatial Planning. Tan & Samsudin (2017) argued that ignorance of spatial accessibility measures in PGOS planning contributes to the disparity of PGOS access. Moreover, in terms of PGOS planning, fine spatial scale also matters to be considered (Tan & Samsudin 2017). In addition, according to The Strategic Planning of Agency of Building and Spatial Planning 2016-2021 of South Tangerang, the limited city fiscal budget hinders the optimal development of PGOS, which this study argues, may also manifest into the disparity of PGOS access as observed in Figure 3 & 4. Furthermore, this article argues that the existence of new towns also created the imbalance of PGOS availability between new town areas and areas outside of new town, producing inequitable outcome. Private housing developers intensively develop social infrastructures or amenities such as PGOS in the residential area they develop (new town in this context) for the intention to increase the marketability and attractiveness of the residences they sell. The sufficiency of social infrastructure such as PGOS is in fact one of the primary reasons for people to reside in new town (Firman 2004).

PGOS Accessibility Effect on Distribution of Social & Health Benefits

PGOS provides diverse Ecosystem Services (ES) which benefit the urban residents. Compared to other types of ES, cultural services are provided in greater amounts by PGOS (Milcu et al. 2013; Chang et al. 2017). Cultural services of PGOS include recreation, physical activities facilitation, aesthetic, and spiritual which lead to the well-being (mental and physical health) benefits of the urban community (Chan et al. 2011; Daniel et al. 2012). Researchers argue that the optimality of benefits received by urban residents through ES are associated with distance (Chang et al. 2017; Herreros-Cantis & Mcphearson 2021). Especially for cultural services of PGOS since they can only be obtained in-situ. Evidently, this is because the further residents reside from PGOS, the less willingness they grow to visit PGOS regularly to do physical activities and recreation (Neuvonen 2007; Toftager et al. 2011; Wang et al. 2019), in line with the concept of *distance decay* (Tan & Samsudin 2017). This argument is further supported by empirical studies in cities of Indonesia. Widyahantari & Rudiarto (2019) in the context of Bandung, indicated that urban residents tend to prefer to visit PGOS that is located within walkable distance (easy access). Additionally, other studies taking the context of various cities of Indonesia reported outcomes of being distanced from PGOS (and consequently its ES), that the further urban residents reside from PGOS to an extent where distance is no longer walkable (>1 km), they show worse health such as higher risk of getting Acute Respiratory Infections (Nurimani and Suyud 2016; Wicaksono et al. 2021) and worse quality of life (Danurdara et al. 2019). Previous discussions imply that the inequality of PGOS access in South Tangerang that the study found may affect how PGOS benefits are derived and further may negatively impact the health equity of urban residents (Rigolon et al. 2021). Furthermore, the issue of health inequity may be further exacerbated when it is the vulnerable who get sub-optimal access to PGOS. That is, because green space has greater protective effects and social return to the vulnerable, such as low-income group, than the non-vulnerable (Rigolon et al. 2021; Sharifi et al. 2021).

The importance of good PGOS accessibility is even more amplified during the recent health crisis, the Covid-19 pandemic (Grima et al. 2020; Marconi et al. 2022).

Many recent studies have exemplified the significance of ease of access to PGOS in creating resilient community against health crisis, of which these studies also imply the increasing need for good access of PGOS during pandemic (Grima et al. 2020; Poortinga et al. 2021; Marconi et al. 2022; Noszczyk et al. 2022). Noszczyk et al. (2022) in his research revealed that mental health benefit during the pandemic is related to several factors, one of them is close access to PGOS. Noszczyk et al. (2022) also found that 75% of their respondents believe visiting PGOS during pandemic helps decrease stress level. Access to PGOS is beneficial to help combat the exacerbated depression during pandemic (Grima et al. 2020). Other researchers, Poortinga et al. (2021), reported that people living more than 10 minutes of walk show poorer health than those living closer to PGOS (<5 mins) during and after the first peak of Covid-19 pandemic.

CONCLUSIONS AND POLICY IMPLICATIONS

This study concludes that access to PGOS in South Tangerang hasn't achieved equity both in the horizontal dimension and vertical dimension. PGOS access is unequal for its residents, with 48.7% of population still residing in areas with very poor green space access and only 38.8% residential areas are covered by walkable green space service radius. It was found that PGOS service coverage tends to agglomerate in elite private housing area (new town). Furthermore, on the social equity (vertical dimension) implications, South Tangerang City has not yet provided green space equitably for low-income group indicated by the statistical analysis results of Spearman & Moran's Index, showing significant negative index. As for the children, this study found unpatterned equity as result of correlation tests revealed no discernable association. Furthermore, on the elderly and population density, PGOS is equitable with index from Spearman correlation showing positive value and the spatial association test result showing clusters which indicate equity being dominant. Furthermore, South Tangerang adds to the list of many cities in the world that still has not yet provided equitable green space access for the low-income group, such as Singapore, Ilam, and Melbourne. This acts as evidence that providing green space access that is equitable is a great challenge faced by many cities in many countries in the world. Findings of this study also imply that South Tangerang has not yet fulfilled its development goal of becoming a just and sustainable city.

This article addresses a few key policy implications derived from the findings. Firstly, this article suggests that there's a need to reform PGOS planning and policy in which spatial accessibility measure and aspect of socio-demographic (e.g., the vulnerable) should be taken into account as parameters and be prioritized. As discussed before, using quantitative measure alone in PGOS planning is simply insufficient as it neglects the spatial factor and socio-demographic characteristics (demand determinant as argued by Yuan et al. 2017). Secondly, as lack of funding and limited fiscal capacity is deemed as the main factor in the sub-optimal development of PGOS, this article argues that the town government should consider other types of alternative PGOS funding such as Tax Increment Financing (TIF), Transfer of Development Rights (TDR), and Development Charges. For instance of TIF application, the increased value of property affected by PGOS (Zygmunt & Gluszak 2015; Czembrowski & Kronenberg 2016; Engström & Gren, 2017) can be captured through TIF of which proceeds can be used to refinance the development of PGOS. Thirdly, the government should put more focus on developing PGOS for future PGOS planning (without compromising the quality matter of PGOS) in the residential area of the urban outskirts as that part of the town is relatively the most underserved in terms of PGOS service. In the case where land availability is low but still underserved by PGOS, the government can consider developing pocket parks. Lastly, this article also suggests that PGOS availability and its distribution should be regularly monitored and evaluated by the town government.

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