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Article

Economic valuation of South African urban green spaces using the proximity principle: Municipal valuation vs market value

Abstract

Urban green spaces (UGSs) deliver ecosystem services and potential economic benefits like increases in proximate residential property prices. The proximity principle (PP) premises that property prices increase as distance to UGS decreases. The PP has generally been confirmed by studies using municipal valuations and market values internationally. Conversely, South African studies have mostly employed municipal valuations and results have rejected the PP. There is an accepted interrelationship, but also often discrepancies, between municipal valuations and market values. Cumulatively, presenting scope for this article to explore whether negative results are confirmed when market values replace municipal valuations in PP studies in the South African context. Accordingly, a statistical analysis of market values is completed in the Potchefstroom case study, where five test sites are replicated from studies that employed municipal valuations for longitudinal comparison. Results verify generally higher market values than municipal valuations and confirm the PP in two, but reject the PP in three, of five test sites. Previous studies employing municipal valuations in the case study confirmed the PP in one instance. Thus, presenting certain, but limited, inconsistencies between findings based on municipal valuation versus market value. Results suggest that the market's willingness to pay for UGS proximity is sensitive to the ecosystem services and disservices rendered by specific UGS, but not significantly more than reflected in municipal valuations. Overall, findings underscore the need to protect and curate features that encourage willingness to pay for UGS proximity to increase municipal valuations and property taxes to help finance urban greening.

Keywords

Green infrastructure; market value; municipal valuation; proximity principle; South Africa; urban green space

1. Introduction

Urban green spaces include land parcels of various types located within the urban boundary, covered by permeable surfaces, soil or flora (Girma et al., 2019, p. 138). Zoning classifications include residential, recreational, commercial or agricultural categories to accommodate land uses like communal parks, playgrounds, sport facilities, greenways, green walls and roofs, urban forests, private gardens, areas surrounding water bodies and street-side vegetation. Urban green spaces may also encompass informal, residual or unattended parcels, including derelict properties, vacant lots and spaces along transportation corridors (Cilliers, 2013, p. 100; Girma et al., 2019, p. 138). Scholarly interest in urban green spaces has peaked in recent years, recognising their potential contributions to urban quality of life and service delivery as components of green infrastructure (du Toit et al. 2018, p. 249), defined as "the connected network of multifunctional, predominantly unbuilt, spaces that support both ecological and social activities and processes" (Venter et al., 2020, p. 2) to deliver benefits as ecosystem services.

Although academic support for the prioritisation of urban green space planning and development is mounting, in practice these spaces are often side-lined as urbanisation causes land use change and conflict (Garcia-Garcia et al., 2020, p. 1). In South Africa, urban green spaces are often outcompeted by land uses deemed more deserving in terms of basic needs, political cachet or economic potential (Cilliers et al., 2015, p. 349; Afriyanie et al., 2020, p. 2). Accordingly, natural landscapes and existing urban green spaces undergo land use conversion, often following official densification strategies or informal land grabs by the destitute (Lategan & Cilliers, 2016a, p. 15; Girma et al., 2019, p. 140). South Africa's urban green spaces are particularly vulnerable, considering the country's growing housing backlog and a burgeoning population accommodated in the informal sector (Lategan et al., 2020, P. 2). This is exacerbated in a context where basic service delivery is declining and urban green spaces are considered luxuries and not necessities by many decision-makers (Girma et al., 2019, p. 139), even as residents in the global south may generally depend significantly on certain regulating ecosystem services provided by urban green spaces (see section 2) (Balbi et al., 2019, p. 5; Shackleton, 2021, pp. 217-219). Existing urban green spaces face additional challenges from inadequate institutional commitment, funding and human capital resources (Chishalesha et al., 2015, p. 822). Government officials and planning practitioners in South

Africa, and beyond, often present limited knowledge regarding green infrastructure and potential urban green space contributions (Jacobs, 2019; Van Zyl, 2021). Countless urban green spaces are furthermore plagued by illegal dumping, pollution, crime and invasive species that threaten indigenous biodiversity (Lategan & Cilliers 2016b, p. 5). To defend existing greenery and promote the development of more urban green spaces an argument for the social, environmental and specifically economic benefits urban green spaces can deliver, must be made. Economic valuation is not intended to commodify greenery and view it solely through a financial lens, but to clarify an important and often misunderstood component of the multiple values presented to inform more balanced decision-making (Boyer & Polasky, 2004, p. 746; Pascual et al., 2017, p. 9).

This paper departs with a review of the ecosystem services and ecosystem disservices potentially delivered by urban green spaces, emphasising prospective economic contributions. The next sections discuss economic valuation methods, focussing on Hedonic Price Analyses and the proximity principle, which states that property prices will increase as distance to urban green space decreases; review findings from relevant studies, showing that South African examples have rejected the proximity principle and have utilised municipal valuations in their investigations; and detail the interrelationship between municipal and market values. Cumulatively, presenting scope to explore whether negative results are confirmed when market values replace municipal valuations in proximity principle studies in the South African context. From there, the case study of Potchefstroom, South Africa and the methodology followed in testing the proximity principle based on estimated market values there is explained, before delivering results that inform main conclusions and recommendations.

2. Urban Green Spaces as part of Green Infrastructure: Ecosystem Services and Ecosystem Disservices

Urban green spaces may constitute components of the links and nodes that comprise multifunctional green infrastructure networks (Pauleit et al., 2021) that accommodate urban ecosystems and provide various ecosystem services. These ecosystem services deliver several potential environmental, social and economic benefits (Grafius et al., 2018, p. 558). Environmental and social benefits are frequently more obvious (Van Oijstaeijen et al., 2020, p. 1) than economic benefits given the complexity of calculating and articulating such values (Cilliers & Timmermans, 2013). Identifying economic contributions is vital towards greener planning agendas as decision-makers require evidence of such offerings to mainstream green infrastructure at strategic management level (Van Oijstaeijen et al., 2020, p. 2), to capitalise on the full range of benefits presented and to address the disadvantages, or ecosystem disservices, potentially rendered. The ecosystem disservices concept recognises that the same ecosystem functions that provide social, environmental and economic benefits, may render contrasting negative impacts (Davoren & Shackleton, 2021). Table 1 summarises the ecosystem services and ecosystem disservices concepts below.

Table 1. Summary of urban green space Ecosystem Services and Ecosystem Disservices

Categories	Examples of Ecosystem Services	Examples of Ecosystem Disservices
Provisioning	Protection and restoration of natural resources delivering water, food, medicine, firewood and material for construction, arts and crafts.	Invasive species outcompete indigenous species; Altered species interactions and populations; Reduced air quality from production of volatile organic compounds; Urban trees may decrease access to sunlight; Keeping of livestock in urban areas damages plants and creates unhygienic conditions.
Regulating	Improved air and water quality; Regulating urban temperature (reducing urban heat island effect); Carbon sequestration; Waste water treatment; Soil erosion control; Moderation of extreme events (e.g. flooding); Pollination; and biological control.	
Supporting	Enhancing urban biodiversity (urban habitats), conserving natural ecosystems.	
Cultural	Improving mental and physical health; Aesthetic contributions; Recreation and eco-tourism; Encouraging social cohesion; Reinforcing cultural heritage and values; Spiritual enrichment; Strengthening sense of place.	Security concerns (shelter for criminals, obscured views); Negative emotions such as discomfort, anxiety or fear towards urban animals and their excreta and plants and their litter; Negative health impacts (allergic reactions); Increased noise (e.g. bird and frog calls); Aesthetic impacts (e.g. wild spontaneous vegetation (weeds)); Unpleasant exposure to the elements (e.g. excessive winds); Safety hazards (e.g. tree falls); Poisonous plants; Pests and diseases.

Economic	Replacing expensive conventional and technical environmental management systems (e.g., storm water management), water retention, microclimate regulation, etc.); Increase in city marketability; Increase in property value and reciprocal increase in property tax returns.	Infrastructure damage (e.g. tree roots that damage roads and kerbs and block drains and water pipes); Impairment of human health due to impacts of disease, e.g. malaria; Maintenance costs for green infrastructure components and surrounding buildings; Catastrophic effects of natural disasters such as floods; Negative impact on property prices.

Source: Own construction from Cilliers et al. (2013, p. 5); Cilliers and Cilliers (2015, p. 15); du Toit et al. (2018); Grafius et al. (2018, p. 558); Davoren and Shackleton (2021); Steenkamp et al. (2021).

Many of these ecosystem disservices are prevalent in South Africa, deterring users from accessing facilities and influencing willingness to buy properties in proximity to urban green spaces (Goméz-Baggethun & Barton, 2013, p. 238). Urban green spaces are potential hotspots for criminal activity, especially when lushly vegetated, poorly lit and unmaintained, as is often the case in South Africa (Lategan & Cilliers, 2016b, P. 9). Such disservices and the others noted above, in conjunction with the restorative power and aesthetic appeal of green views, result in many property owners preferring green vistas (Panduro & Veie, 2013, p. 126; Sharmin, 2020, p. 100) and not immediate proximity. Several economic valuation methods of urban green spaces attempt to account for the complex relationship of push and pull factors that may underpin a cost-benefit analysis of such land uses.

3. Economic Valuation Methodologies and the Proximity Principle

Influential economic valuation approaches include the market price method; the replacement/substitute method; contingent valuation, the contingent choice method, benefit transfer, and hedonic pricing (Cilliers & Cilliers, 2015, p.3). Hedonic Price Analysis is highlighted for its broad application internationally and in South Africa. Hedonic Price Analysis considers that residential properties are not homogeneous, but reflect discrete attributions that influence property value that are each studied individually (Daams et al., 2016, p. 389). A prominent example includes proximity to urban green space, encapsulated in the proximity principle (Cilliers & Cilliers, 2015, p. 5), revealing the market's willingness to pay for access to such spaces. Examples of studies are captured in Table 2.

Table 2. Select studies employing the PP

Authors	Case study	Municipal valuation/ Market value	Proximity principle
Bolitzer and Netusil (2000)	Portland, Oregon, USA	Market value	Confirmed
Kim and Johnson (2002)	Corvallis, Oregon, USA	Market value	Confirmed
Morancho (2003)	Spain	Market value	Confirmed
Tajima (2003)	Boston, Massachusetts, USA	Market value	Confirmed
Boyer and Polasky (2004)	Multiple	Market value	Confirmed
Crompton (2005)	Multiple	Market value	Confirmed
Anderson and West (2006)	Minneapolis – St Paul Metro, Minnesota USA	Market value	Confirmed
Dehring and Dunse (2006)	Aberdeen, Scotland	Market value	Confirmed
Kong et al. (2006)	Jinan City, China	Market value	Confirmed
Conway et al. (2008)	Los Angeles, USA	Market value	Confirmed
Payton et al. (2008)	Indianapolis/ Marion County, USA	Market value	Confirmed
Arvanitidis et al. (2009)	Several European Cities	Not specified	Confirmed
Chen and Jim (2010)	Shenzhen, China	Market values	Confirmed
Biao et al. (2012)	Beijing, China	Market value	Confirmed

Kovacs (2012)	Portland, Oregon	Market value	Confirmed
Cilliers (2013)	Potchefstroom, SA	Municipal valuation	Rejected
Konijnendijk et al. (2013)	Multiple	Market value	Confirmed
Panduro & Veie (2013)	Aalborg, Denmark	Market value	Confirmed
Gibbons et al. (2014)	England	Market value	Confirmed
Cilliers & Cilliers (2015)	Potchefstroom, SA	Municipal valuation	Rejected
Wen et al. (2015)	Hangzhou, China	Market value	Confirmed
Immergluck and Balan (2017)	Atlanta, Georgia, USA	Market value	Confirmed
Loret de Mola et al. (2017)	Bogotá, Colombia, Buenos Aires , Argentina, Lima, Peru, Mexico City, Mexico and Santiago, Chile	Market value (real estate data at district level)	Confirmed
Chen & Li (2018)	Guangzhou, China	Market value	Confirmed
Daams et al. (2019)	Amsterdam, the Netherlands	Market value	Confirmed
Czembrowski et al. (2019)	Stockholm, Sweden	Market value	Confirmed
Combrinck et al. (2020)	Potchefstroom, SA	Municipal valuation	Rejected
Sharmin (2020)	Dhaka, Bangladesh	Market value	Confirmed
Samad et al. (2020)	Kuala Lumpur, Malaysia	Market value	Confirmed
Yu et al. (2020)	Shenzhen, China	Rental market value	Confirmed

Source: Own construction (2021) based on sources included

Table 2 demonstrates that the proximity principle has delivered fairly consistent results, depending on the parameters employed and study area identified. The majority of studies have confirmed the proximity principle using market values and not municipal valuations, with the exception of studies in South Africa.

4. Municipal Valuation versus Market Value

Municipal valuation refers to a value placed on a property by assessors for local authorities as the basis for property taxation as a source of municipal revenue (Janssen & Söderberg, 1999, p. 359; Cypher & Hansz, 2003, p. 305). Municipal valuation is bound by set regulations to ensure just outcomes (Ramakhula, 2010, p. 22). In South Africa, the Local Government Municipal Property Rates Act of 2004 regulates local government property taxation and allows for comparative analysis and computer aided mass appraisals (Nyabwengi et al., 2020, p. 1736). In South Africa, statutory requirements prescribe that municipal values should equal market values, but Ghyoot (2008) observed that valuers often allow for municipal valuations within a 10 % divergence of market values.

Market value refers to the price a property demands in the open market (Malaitham *et al.,* 2020, p. 154), reflecting demand and supply (Das & Thappa, 2018, p. 15). A property's market value depends on several variables (Janssen & Söderberg, 1999, p. 359; Das & Thappa, 2018, p. 16), appraised by a real estate agent or other professionals when properties are put up for sale (Janssen & Söderberg, 1999, 359). Unlike with municipal valuation, the determination of market value may not be bound by regulations but may follow standard approaches such as direct capital comparison, income capitalisation, the cost approach and residual or developers approach (Das & Thappa, 2018). Municipal assessors consider the market and professionals and estate agents may use municipal valuations as components in their assessments (Janssen & Söderberg, 1999, p. 360). Although determination processes for municipal valuations and market values differ, they present a complex interrelationship in their shared objective to determine property value (Cypher & Hansz, 2003, pp. 305-306).

It is widely recognised that valuations and actual market values rarely coincide (Babawale, 2013, p. 387). Various cases of municipal valuations being both lower and higher 1) than estimated market values, or reaslised sales prices, have been reported (Ghyoot, 2008; Ntuli, 2019; Sokutu, 2021). In cases of the latter, allowing for processes of appeal, but in cases of the first, rarely resulting in objections due to lower property taxes due by owners. The question is not necessarily if there is a difference, but rather to what extent the difference between municipal valuations and market values are manifested. In line with the focus of this paper, Malaitham *et al.* (2020, p. 154) suggests that there is uncertainty regarding the impact of municipal valuation versus market value in studies on the proximity principle and urban green space, as limited studies have been conducted to compare findings using both as variables. The following section elaborates on the choice of case study for this research and discusses the methodology employed to address the issues raised in the literature review.

5. Case Study and Methodology

Potchefstroom, South Africa (26°42’53’’S; 27°05’49’’E) was selected as case study based on the previous studies completed there by Cilliers and Cilliers (2015) and Combrinck et al. (2020) (See Table 2) who investigated the proximity principle by examining sites in five upper middle- to high income neighbourhoods where a central public urban green space and surrounding detached dwellings provided a research sample. Sample areas were categorised within socio-economic status levels (SES) of four and five. Thus, presenting shared characteristics in accordance with middle- to high income earners in terms of employment status; household size; number of rooms occupied; access to basic services and schooling status (Lubbe et al., 2016, p. 2903). Owing to this status, urban green spaces in the sample were fairly well-maintained as a result of both public and private ownership and management and presented significant plant diversity and species richness compared to those in lower income areas (Lubbe, 2011, p. 37). In keeping with Combrinck et al. (2020), test sites included urban green spaces and surrounding properties in Grimbeek Park, bordering a golf course and areas used for birdwatching and horseback riding; Van der Hoff Park, bordering an equestrian open space and wetlands with high biodiversity; Heilige Akker, bordering the sporting grounds of a local university and presenting limited vegetation and tree cover; Oewersig, with dense vegetation bordering the Mooi River and surrounding open space; and next to the Potchefstroom Dam with dense vegetation and tree cover (Cilliers & Cilliers, 2015; Combrinck et al., 2020). Properties within each sample area were divided into three zones depending on distance to an urban green space. Properties in zone 1 were situated directly adjacent to an urban green space; those in zone 2 were further away, mostly across the street from those in zone 1; and zone 3 properties were further away from the urban green space, mostly located in the same block, or one street away from those in zone 2. All properties included ranged between 1000 square meters to 2000 square meters in size, with a limited number presenting sizes below or above these parameters. Sample properties were furthermore endowed with ample private urban green space, in keeping with expectations for detached properties at this socio-economic level. Despite international evidence to the contrary (Dehring & Dunse, 2006, p. 565), Lategan and Cilliers (2016b) found that in South Africa, the availability of private urban green space did not necessarily compensate for public urban green space as private urban green spaces cannot fulfil the multiple functions of public spaces, specifically related to cultural ecosystem services, as part of local heritage and neighbourhood identity, as venues of communal gathering and social interaction or in terms of amenities provided. Several studies have commented on the impacts of location, density, urban green space type, size and quality as well as the availability of private urban green space on proximate property values in relation to public urban green spaces (e.g. Anderson & West, 2006; Konijnendijk et al., 2013; Sharmin, 2020), with the majority generally confirming the proximity principle internationally (See Table 2). This research is primarily interested in the degree to which public urban green spaces are valued in South Africa in fairly homogenous neighbourhoods and if and how such trends fluctuate when employing estimated market values versus municipal valuations. Combrinck et al. (2020) employed average price per square metre for each property in the sample derived from 2019 municipal valuations. This article compared these values to estimated market values for the same properties gathered in 2020. Market values were obtained from a reputable international real estate agency’s Potchefstroom branch who based its market valuations on four sources. Firstly, “Revolution” software that triangulates inputs by agents from the last 15 years and makes a comparison based on property characteristics. Secondly, Lightstone software, which collaborates with South Africa’s deeds offices and provides a mean property price compared to others of approximately the same size in the area. Thirdly, the latest municipal valuation role was consulted as part of standard practice. Lastly, the agency drew on the professional discretion of its agents as property experts.

Descriptive statistics were used to report municipal valuations for each property per square metre and compare these values with 2019 municipal valuations. A Dependent T-test compared 2019 municipal valuations and 2020 market value estimates. This was followed by Analysis of Variance (ANOVA) and Kruskal–Wallis tests to determine whether a practically significant difference existed between the delineated zones. Where results differed, the non-parametric test (Kruskal-Wallis) was preferred. This research replicates the methodologies employed by Cilliers and Cilliers (2015) and Combrinck et al. (2020) in recognition of their scientific contributions and for the purpose of direct longitudinal comparison. This paper should thus not be regarded as a critique of previous studies, Combrinck et al. (2020) in particular, but as an attempt to expand existing knowledge and deepen understanding of the South African exceptionalism exhibited in Table 2.

6. Results

The 2019 municipal valuations observed were 28% lower than 2020 market value estimates. This represents a considerable difference from standard deviation guidelines, often set at between 5% and 10% (Hager and Lord, 1985; (Babawale, 2013, p. 396). For contextualisation, when further compared to a general increase of 14,73% identified in average residential sale prices realised for detached properties in Potchefstroom during the same period (2019 to 2020) (Property24, 2021), findings thus represent a disproportional and significant difference. Table 3 captures these values and summarises the outcome of the Dependent T-test. An effect size of ≈0.2 indicates a small, no practically significant difference, an effect size of ≈0.5 indicates a medium, practically significant difference, and an effect size of ≈0.8 indicates a large, practically significant difference.

Table 3. Dependent T-Test results

Area	Zone	N (188)	Municipal R/m²	Market R/m²	Municipal Std. D.	Market Std. D.	Effect size	T-test
							a≈0,2 small b≈0,5 medium c≈0,8 large	Statistically significant difference between municipal and market (p<0,05)
Grimbeek Park	1	14	1260,7	1252,91	237,61	375,85	0,02a	0,941
	2	14	1611,67	1584,32	295,96	421,64	0,06b	0,668
	3	13	1699,25	1493,18	269,72	208,74	0,76c	0,019
Van der Hoff Park	1	15	1290,59	1683,48	341,15	753,19	0,52b	0,016
	2	15	1472,43	1579,05	237,86	224,65	0,45b	0,143
	3	13	1624,3	1902,34	279	339,58	0,82c	0
Heilige Akker	1	10	1751,96	2299,21	353,01	631,25	0,87c	0,012
	2	12	1904,15	2692,38	280,09	858,19	0,92c	0,005
	3	14	1850,28	1930,69	757,54	356,16	0,19a	0,603
Oewersig	1	14	1668,44	2355,76	338,6	642,54	1,07c	0
	2	14	1852,15	2480,35	360,64	876,91	0,72c	0,031
	3	13	1549,2	2037,73	415,18	255,85	1,52c	0
Potchefstroom Dam	1	9	1116,44	2139,69	336,36	1213,69	0,84c	0,019
	2	9	1303,45	2223,11	421,46	408,47	2,25c	0,001
	3	9	1448,64	2308,59	421,61	1009,9	0,85c	0

Results indicate an overall large practically significant difference (≈0.8) between municipal valuations and market value estimates. Market value estimates were significantly higher than municipal valuations in four of five test sites, with the exception of Grimbeek Park. Figure 1 A-E illustrates the differences captured in Table 3 regarding fluctuations from zone 1 to zone 3 in each test site.

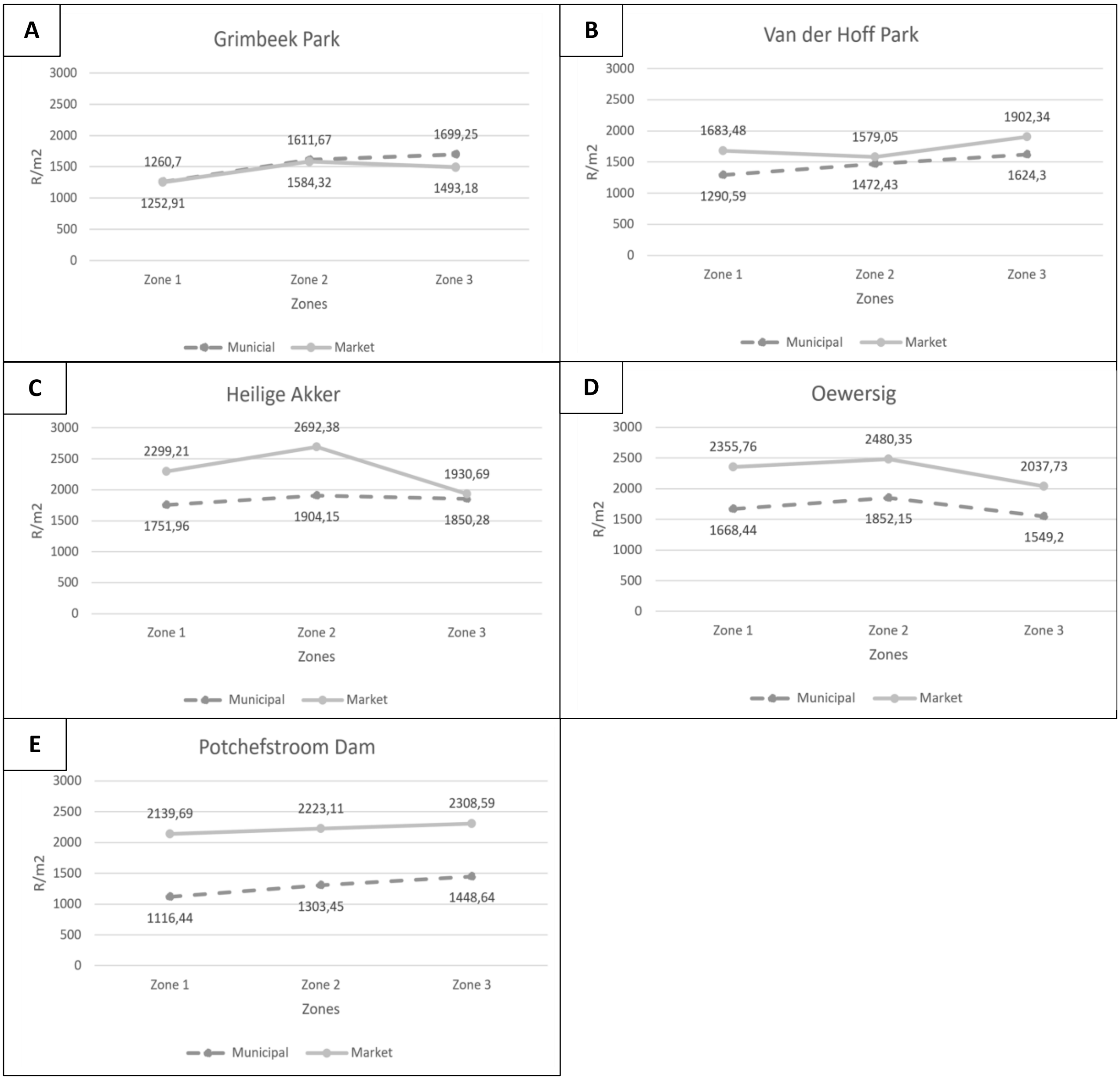

Figure 1. Mean R/m2 municipal valuation and estimated market values for the Potchefstroom sample

Source: Own construction (2021)

In Grimbeek Park, results presented a general rejection of the proximity principle from zone 1 to 3, but confirmed the principle between zones 2 and 3 with regard to estimated market values. Findings differed slightly in that municipal valuations showed a consistent upward trajectory to reject the proximity principle from zone 1 to 3. In van der Hoff Park, the proximity principle was confirmed between zone 1 and zone 2, but rejected between zones 1 and 3. Thus, differing slightly from municipal valuation findings that showed a consistent upward trajectory, but confirming findings on a rejection of the proximity principle in general terms. In Heilige Akker, the proximity principle was rejected between zone 1 and zone 2, but confirmed for zone 1 to zone 3. Findings concurred with data from municipal valuations showing a peak in zone 2, but departed where the proximity principle was rejected. For Oewersig, data rejected the proximity principle between zone 1 and zone 2, but confirmed the principle for zone 1 to zone 3. Results were mirrored in municipal valuations. For Potchefstroom Dam, zone 3 presented a higher market value estimate than zone 2 and zone 1, resulting in a rejection of the proximity principle. This trend echoed findings derived from municipal valuations.

Statistical substantiation to the above findings were provided via ANOVA and Kruskal-Wallis testing using 2020 market value estimates. For ANOVA an effect size of ≈0.2 indicates a small, no practically significant difference; an effect size of ≈0.5 indicates a medium, practically visible difference; and an effect size of ≈0.8 indicates a large, practically significant difference. For the Kruskal-Wallis test, an effect size of ≈0.1 indicates a small or no practically significant difference; an effect size of ≈0.3 indicates a medium or practically visible difference; and an effect size of ≈0.5 indicates a large or practically significant difference. Results are captured in Table 4.

Table 4. ANOVA and Kruskal-Wallis testing

Area	Zone	N (188)	Market R/m²	Std. D.	Effect size: ANOVA a≈0,2 small b≈0,5 medium c≈0,8 large		Effect size: Kruskal-Wallis a≈0,1 small b≈0,3 medium c≈0,5 large		ANOVA: Statistically significant difference between means (p<0,05)	Kruskal-Wallis: Statistically significant difference between mean ranks (p<0,05)
					1 with....	2 with...	1 with...	2 with...		
Grimbeek Park	1	14	1252,91	375,85					0,047	0,057
	2	14	1584,32	421,64	0.79c		0,373b			
	3	13	1493,18	208,74	0.64b	0.22a	0,411b	0,028a		
Van der Hoff Park	1	15	1683,48	753,19					0,237	0,022
	2	15	1579,05	224,65	0,14a		0,140a			
	3	13	1902,34	339,58	0,29a	0,95c	0,440c	0,457c		
Heilige Akker	1	10	2299,21	631,25					0,017	0,011
	2	12	2692,38	858,19	0,46b		0,197a			
	3	14	1930,69	356,16	0,58b	0,89c	0,287b	0,615c		
Oewersig	1	14	2355,76	642,54					0,208	0,35
	2	14	2480,35	876,91	0,14a		0,052a			
	3	13	2037,73	255,85	0,49b	0,50b	0,224a	0,252b		
Potchefstroom Dam	1	9	2139,69	1213,69					0,93	0,203
	2	9	2223,11	408,47	0,07a		0,468c			
	3	9	2308,59	1009,9	0,14a	0,08a	0,177a	0,135a		

The results from the Kruskal-Wallis test above were preferred when the outcomes of statistical tests differed. This is also reflected in Table 5 that summarises complete results in conjunction with Combrinck et al.’s (2020) main findings.

Table 5. Comparative summary of results

		Municipal Valuation (2019)						**Estimated market value (2020)**					
Test Site	Estimated market value higher than municipal valuation	Zone 1 vs Zone 2	Zone 2 vs Zone 3	Zone 1 vs Zone 3	Proximity Principle from zone to zone	General Effect size (non-parametric test)	Verdict Proximity principle based on municipal valuation	Zone 1 vs Zone 2	Zone 2 vs Zone 3	Zone 1 vs Zone 3	Proximity Principle from zone to zone	General Effect size (non-parametric test)	Verdict Proximity principle (Estimated market value)
Grimbeek Park	No	Lower	Lower	Lower (zone 3 Peak)	Rejected (zone 1 to 3)	Large	**Rejected**	Lower	Higher (Zone 2 Peak)	Lower	Confirmed (zone 2 to 3) Rejected (zone 1 to 3)	Medium	**Rejected**
Van der Hoff Park	Yes	Lower	Lower	Lower (zone 3 Peak)	Rejected (zone 1 to 3)	Medium	**Rejected**	Higher	Lower	Lower (Zone 3 peak)	Confirmed (zone 1 to 2) Rejected (zone 1 to 3)	Medium	**Rejected**
Heilige Akker	Yes	Lower	Higher (zone 2 peak)	Lower	Rejected (zone 1 to 3)	Small	**Rejected**	Lower	Higher (Zone 2 peak)	Higher	Rejected (zone 1 to 2) Confirmed (zone 1 to 3)	Medium	**Confirmed**
Oewersig	Yes	Lower	Higher (zone 2 peak)	Higher	Confirmed (zone 1 to 3)	Medium	**Confirmed**	Lower	Higher (Zone 2 peak)	Higher	Rejected (zone 1 to 2) Confirmed (zone 1 to 3)	Small	**Confirmed**
Potchefstroom Dam	Yes	Lower	Lower	Lower (Zone 3 peak)	Rejected (zone 1 to 3)	Medium	**Rejected**	Lower	Lower	Lower (Zone 3 peak)	Rejected (zone 1 to 3)	Medium	**Rejected**

7. Conclusions

Municipal valuations were considerably lower than estimated market values in almost all test sites and a large practically significant difference could be established. In general, by a significant 28%, which is well below accepted standards of deviation. Grimbeek Park presented an interesting case, as the only example in which municipal valuations exceeded estimated market values. It falls beyond the scope of this paper to investigate the reasons behind this and opportunities for further research are thus presented. As a point of departure for future investigations, it is interesting to note that in a review of the five test sites included in this research, based on attributes related to urban green spaces and the environmental, social and economic benefits (as ecosystem services) offered, Combrinck (2020) found that Grimbeek Park's urban green space delivered the highest overall scores. As a supplementary consideration, the urban green space in Grimbeek Park presented the only example of a golf course. Several international studies have indicated that golf courses specifically increase proximate property values at significant levels (Nicholls & Crompton, 2007; Yates & Cowart, 2019; Crompton & Nicholls, 2020).

Another interesting observation relates to the zone in which values reached a peak in each test site. Using municipal valuations, Combrinck et al. (2020) established peaks in zone 1 in no test sites; peaks in zone 2 in two test sites (Heilige Akker and Oewersig); and peaks in zone 3 in three test sites (Grimbeek Park, van der Hoff Park and Potchefstroom Dam). In contrast, estimated market values delivered peaks in zone 1 for no test sites (yet, in van der Hoff Park zone 1 presented a higher estimate than zone 2); peaks in zone 2 for three test sites (Grimbeek Park, Heilige Akker and Oewersig); and peaks in zone 3 for two test sites (van der Hoff Park and Potchefstroom Dam). Peaks were thus registered significantly differently using municipal valuation versus estimated market value.

The absence of peaks in zone 1 in both data sets, even where the proximity principle was confirmed (Heilige Akker and Oewersig) underscores the negative impacts of adjacency to urban green space in South Africa, ascribed to ecosystem disservices such as crime, a lack of maintenance and other nuisance factors (see Davoren & Shackleton (2021) and Table 1). The presence of a higher market value estimate in zone 1 than zone 2 in van der Hoff Park and more peaks in zone 2 than zone 3, when contemplating estimated market value versus municipal valuation, indicate that whilst immediate adjacency is not always valued, some proximity to urban green spaces may be appreciated to capitalise on ecosystem services (see Escobedo, 2021, p.227 and Table 1) and reduce the potential impacts of ecosystem disservices, despite the presence of domestic urban green spaces. This may also relate to the impacts of visual access to public greenery that offer pleasant vistas or amenities (Panduro & Veie, 2013, p. 126; Sharmin, 2020). Although the aim of this study was not to determine to what extent the market's willingness to pay is sensitive to the ecosystem services and ecosystem disservices produced by specific urban green spaces, the literature and findings underscore the importance of acknowledging these aspects (Davoren & Shackleton, 2021).

The results in Figures 1 A-E, together with the average medium practically significant differences established from zone to zone, confirmed the proximity principle in two test sites using estimated market values compared to one when employing municipal valuations. These are not overwhelming contrasts, but preliminary findings indicate that the relationship between urban green space proximity and willingness to pay for proximity may be less clear-cut and linear in South Africa than previously reported based on municipal valuations (Cilliers & Cilliers, 2015; Combrinck et al., 2020). Results still contrast with international norms on the general confirmation of the proximity principle using estimated market values as variables. These preliminary findings suggest that the influence of the variable employed (municipal valuation vs. market value) can thus potentially be disregarded as an explanation for exceptions identified in previous South African-based research on the proximity principle (Table 2).

Although efforts to quantify the value of urban green spaces have increased, more research is needed in the global south to provide case studies to guide context-based planning (Cilliers et al., 2021) and clarify the relationship between urban green space proximity and willingness to pay. Future studies may compare municipal valuations and market value estimates on a larger scale in various sites and may consider the physical attributes and specific ecosystem services and ecosystem disservices rendered by individual urban green spaces through more qualitative approaches to address certain limitations of this research. The complexity of developing integrated urban planning and management systems focusing on ecosystem services and ecosystem disservices, needs to be recognised, as one element in urban ecosystems may produce both ecosystem services and ecosystem disservices that may be perceived and valued according to individual interpretations and preferences (Blanco et al. 2019, p. 3). In line with this, it is pertinent to recognise the plurality of values assigned to nature and the influence of variables such as worldviews and power dynamics in the translation of the values identified to decision-makers and stakeholders (Pascual et al., 2017, p. 14). Davoren and Shackleton (2021) further reported on a dearth of research on ecosystem disservices, especially in the global south, and emphasised the importance of mapping the distribution of those ecosystem disservices that influence human health and well-being, in the same way as ecosystem services have been mapped (e.g. Plieninger et al., 2013).

Further refinement and substantiation of the findings presented in this paper should incentivise local authorities, specifically in South Africa with its contrasting results, to invest in urban green spaces to curate features that encourage willingness to pay for urban green space proximity and address those ecosystem disservices that deter property buyers from paying more to augment revenue from property taxes. Such proceeds should be reinvested in urban green spaces as green infrastructure to further capitalise on valuable green assets that may deliver indispensable services and potential economic returns.

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References

Afriyanie, D., Julian, M. M., Riqqi, A., Akbar, R., Suroso, D. S., & Kustiwan, I. (2020). Re-framing urban green spaces planning for flood protection through socio-ecological resilience in Bandung City, Indonesia. *Cities*, *101*, 102710.

Anderson, S. T., & West, S. E. (2006). Open space, residential property values, and spatial context. *Regional science and urban economics*, *36*(6), 773-789.

Arvanitidis, P. A., Lalenis, K., Petrakos, G., & Psycharis, Y. (2009). Economic aspects of urban green space: a survey of perceptions and attitudes. *International journal of environmental technology and management*, *11*(1-3), 143-168.

Babawale, G. (2013). Valuation accuracy–the myth, expectation and reality!. African Journal of Economic and Management Studies.

Balbi, S., Selomane, O., Sitas, N., Blanchard, R., Kotzee, I., O'Farrell, P., & Villa, F. (2019). Human dependence on natural resources in rapidly urbanising South African regions. Environmental Research Letters, 14(4), 044008.

Biao, Z., Gaodi, X., Bin, X., & Canqiang, Z. (2012). The effects of public green spaces on residential property value in Beijing. *Journal of Resources and Ecology*, *3*(3), 243-252.

Blanco, J., Dendoncker, N., Barnaud, C., & Sirami, C. (2019). Ecosystem disservices matter: Towards their systematic integration within ecosystem service research and policy. *Ecosystem Services*, *36*, 100913.

Boyer, T., & Polasky, S. (2004). Valuing urban wetlands: a review of non-market valuation studies. *Wetlands*, *24*(4), 744-755.

Chen, W. Y., & JIM, C. Y. (2010). Amenities and disamenities: A hedonic analysis of the heterogeneous urban landscape in Shenzhen (China). *Geographical Journal*, *176*(3), 227-240.

Chen, W. Y., & Li, X. (2018). Impacts of urban stream pollution: A comparative spatial hedonic study of high-rise residential buildings in Guangzhou, south China. *The Geographical Journal*, *184*(3), 283-297.

Cilliers S.S., Breed CA, Cilliers E.J., Lategan L.G. (2021). Urban ecological planning and design in the Global South. In: Shackleton C.M., Cilliers, S., Davoren, E., du Toit, M. (eds) Urban ecology in the Global South. Springer, Cham, pp. 365-401.

Cilliers, E. J., & Timmermans, W. (2013). Approaching value added planning in the green environment. *Journal of Place Management and Development*.

Cilliers, J. (2013). Ekonomiese waarde van groen ruimtes: Suid-Afrika in kontras met Europa. *Acta Academica*, *45*(3), 99-125.

Cilliers, J., & Cilliers, S. (2015). From green to gold: A South African example of valuing urban green spaces in some residential areas in Potchefstroom. *Town and regional planning*, *67*, 1-12.

Cilliers, S., Cilliers, J., Lubbe, R., & Siebert, S. (2013). Ecosystem services of urban green spaces in African countries—perspectives and challenges. *Urban Ecosystems*, *16*(4), 681-702.

Combrinck, Z. (2020). Reclaiming nature in cities: An economic valuation approach across the socio-economic gradient in Potchefstroom (Masters dissertation, North-West University) Available soon on NWU online repository.

Combrinck, Z., Cilliers, E. J., Lategan, L., & Cilliers, S. (2020). Revisiting the Proximity Principle with Stakeholder Input: Investigating Property Values and Distance to Urban Green Space in Potchefstroom. *Land*, *9*(7), 235.

Conway, D., Li, C. Q., Wolch, J., Kahle, C., & Jerrett, M. (2010). A spatial autocorrelation approach for examining the effects of urban greenspace on residential property values. *The Journal of Real Estate Finance and Economics*, *41*(2), 150-169.

Crompton, J. L., & Nicholls, S. (2020). The Impact on Property Values of Golf Courses in the United States. Journal of Park and Recreation Administration, 38(2).

Cypher, M., & Hansz, J. A. (2003). Does assessed value influence market value judgments?. *Journal of Property Research*, *20*(4), 305-318.

Czembrowski, P., Łaszkiewicz, E., Kronenberg, J., Engström, G., & Andersson, E. (2019). Valuing individual characteristics and the multifunctionality of urban green spaces: The integration of sociotope mapping and hedonic pricing. *PloS one*, *14*(3), e0212277.

Daams, M. N., Sijtsma, F. J., & Veneri, P. (2019). Mixed monetary and non-monetary valuation of attractive urban green space: A case study using Amsterdam house prices. *Ecological Economics*, *166*, 106430.

Das, N. C., & Thappa, S. (2018). A Study On Valuation Of Real Estate Property Within Guwahati Metropolitan City Area. *CLEAR International Journal of Research in Commerce & Management*, *9*(5).

Davoren E, Shackleton C.M. (2021). Urban ecosystem disservices in the Global South. In: Shackleton C.M., Cilliers, S.S., Davoren, E, du Toit, M. (eds) Urban ecology in the Global South. Springer, Cham, pp. 227-244

Dehring, C., & Dunse, N. (2006). Housing density and the effect of proximity to public open space in Aberdeen, Scotland. *Real Estate Economics*, *34*(4), 553-566.

Du Toit, M. J., Cilliers, S. S., Dallimer, M., Goddard, M., Guenat, S., & Cornelius, S. F. (2018). Urban green infrastructure and ecosystem services in sub-Saharan Africa. *Landscape and Urban Planning*, *180*, 249-261.

Escobedo F.J. (2021). Understanding urban regulating ecosystem services in the Global South. In: Shackleton C.M., Cilliers, S.S., Davoren, E, du Toit, M. (eds) Urban ecology in the Global South. Springer, Cham, pp. 227-244.

Gibbons, S., Mourato, S., & Resende, G. M. (2014). The amenity value of English nature: a hedonic price approach. *Environmental and Resource Economics*, *57*(2), 175-196.

Girma, Y., Terefe, H., Pauleit, S., & Kindu, M. (2019). Urban green spaces supply in rapidly urbanizing countries: The case of Sebeta Town, Ethiopia. *Remote Sensing Applications: Society and Environment*, *13*, 138-149.

Grafius, D. R., Corstanje, R., & Harris, J. A. (2018). Linking ecosystem services, urban form and green space configuration using multivariate landscape metric analysis. *Landscape ecology*, *33*(4), 557-573.

Ghyoot, V. G. (2008). The accuracy of the Johannesburg provisional valuation roll, 2001. Management Dynamics: Journal of the Southern African Institute for Management Scientists, 17(2), 2-13.

Hager, D. P., & Lord, D. J. (1985). The property market, property valuations and property performance measurement. Journal of the Institute of Actuaries (1886-1994), 112(1), 19-60.

Immergluck, D., & Balan, T. (2018). Sustainable for whom? Green urban development, environmental gentrification, and the Atlanta Beltline. *Urban Geography*, *39*(4), 546-562.

Jacobs, N. S. (2019). *Planning sustainable cities through nature-based solutions: perspectives from the Global South* (Masters dissertation, North-West University (South Africa).

Janssen, C., & Söderberg, B. (1999). Estimating market prices and assessed values for income properties. *Urban Studies*, *36*(2), 359-376.

Kim, Y. S., & Johnson, R. L. (2002). The impact of forests and forest management on neighboring property values. *Society &Natural Resources*, *15*(10), 887-901.

Kong, F., Yin, H., & Nakagoshi, N. (2007). Using GIS and landscape metrics in the hedonic price modeling of the amenity value of urban green space: A case study in Jinan City, China. *Landscape and urban planning*, *79*(3-4), 240-252.

Konijnendijk, C. C., Annerstedt, M., Nielsen, A. B., & Maruthaveeran, S. (2013). Benefits of urban parks. *A systematic review. A Report for IFPRA, Copenhagen & Alnarp*.

Kovacs, K. F. (2012). Integrating property value and local recreation models to value ecosystem services from regional parks. *Landscape and Urban Planning*, *108*(2-4), 79-90.

Laffaille, P., Baisez, A., Rigaud, C., & Feunteun, E. (2004). Habitat preferences of different European eel size classes in a reclaimed marsh: a contribution to species and ecosystem conservation. *Wetlands*, *24*(3), 642-651.

Lategan, L. G., & Cilliers, J. E. (2016a). Towards more compact South African settlements through informal housing: The case of backyard densification in Bridgton and Bongolethu, Oudtshoorn. *Town and Regional Planning*, *68*, 12-26.

Lategan, L., & Cilliers, J. (2016b). Considering urban green space and informal backyard rentals in South Africa: Disproving the compensation hypothesis. *Town and Regional Planning*, *69*, 1-16.

Lategan, L. G., Erasmus, S., Zietsman, M., Cilliers, E. J., Wolf, M., & Springer, C. A. (2020). Risking health for rental housing: Reviewing service access in the informal backyard rental sector. *Jàmbá: Journal of Disaster Risk Studies*, *12*(1), 1-11.

Lins, M. P. E., de Lyra Novaes, L. F., & Legey, L. F. L. (2005). Real estate appraisal: A double perspective data envelopment analysis approach. *Annals of Operations Research*, *138*(1), 79-96.

Loret de Mola, U., Ladd, B., Duarte, S., Borchard, N., Anaya La Rosa, R., & Zutta, B. (2017). On the use of hedonic price indices to understand ecosystem service provision from urban green space in five Latin American megacities. *Forests*, *8*(12), 478.

Lubbe, C. S. (2011). Comparison of the urban domestic garden flora along a socio–economic gradient in the Tlokwe City Municipality (Doctoral dissertation, North-West University).

Lubbe, C. S., Siebert, S. J., & Cilliers, S. S. (2010). Political legacy of South Africa affects the plant diversity patterns of urban domestic gardens along a socio-economic gradient. Scientific Research and Essays, 5(19), 2900-2910.

Malaitham, S., Fukuda, A., Vichiensan, V., & Wasuntarasook, V. (2020). Hedonic pricing model of assessed and market land values: a case study in Bangkok metropolitan area, Thailand. *Case Studies on Transport Policy*, *8*(1), 153-162.

Nicholls, S., & Crompton, J. L. (2007). The impact of a golf course on residential property values. Journal of Sport Management, 21(4), 555-570.

Ntuli, N. (2019). Msunduzi valuations roll in turmoil. THE WITNESS. Retrieved from www.news24.com/amp/witness/news/msunduzi-valuations-roll-in-turmoil-20190812

Nyabwengi, L. (2020). An Evaluation of the Property Valuation Process for County Government Property Taxation, Nairobi City. *Africa Habitat Review*, *14*(1), 1731-1743.

Panduro, T. E., & Veie, K. L. (2013). Classification and valuation of urban green spaces—A hedonic house price valuation. *Landscape and Urban planning*, *120*, 119-128.

Pascual, U., Balvanera, P., Díaz, S., Pataki, G., Roth, E., Stenseke, M., ... & Yagi, N. (2017). Valuing nature's contributions to people: the IPBES approach. Current Opinion in Environmental Sustainability, 26, 7-16.

Pauleit S., Vasquéz A., Maruthaveeran S., Liu L., Cilliers S.S. (2021). Urban green infrastructure in the Global South. In: Shackleton C.M., Cilliers, S.S., Davoren, E, du Toit, M. (eds) Urban ecology in the Global South. Springer, Cham, pp. 227-244.

Payton, S., Lindsey, G., Wilson, J., Ottensmann, J. R., & Man, J. (2008). Valuing the benefits of the urban forest: a spatial hedonic approach. *Journal of Environmental Planning and Management*, *51*(6), 717-736.

Plieninger, T., Dijks, S., Oteros-Rozas, E., & Bieling, C. (2013). Assessing, mapping, and quantifying cultural ecosystem services at community level. *Land use policy*, *33*, 118-129.

Property24. (2021). Potchefstroom Property Trends and Statistics. PROPERTY24. Retrieved from www.property24.com/potchefstroom/property-trends/125.

Ramakhula, M. (2010). *Implications of the Municipal Property Rates Act (No: 6 of 2004) on Municipal Valuations* (MSc Thesis, Faculty of Engineering and the Built Environment, University of the Witwatersrand).

Rioux, J. F., Cimon-Morin, J., Pellerin, S., Alard, D., & Poulin, M. (2019). How land cover spatial resolution affects mapping of urban ecosystem service flows. *Frontiers in Environmental Science*, *7*, 93.

Samad, N. S. A., Abdul-Rahim, A. S., Yusof, M. J. M., & Tanaka, K. (2020). Assessing the economic value of urban green spaces in Kuala Lumpur. *Environmental Science and Pollution Research*, 1-24.

Shackleton C.M. (2021). Provisioning services in Global South cities. In: Shackleton C.M., Cilliers, S.S., Davoren, E, du Toit, M. (eds) Urban ecology in the Global South. Springer, Cham, pp. 227-244.

Sharmin, F. (2020). Towards the Valuation of Open Spaces: A Hedonic Based Investigation for Sustainable Planning in the Dense Urban Context of Dhaka. *American Journal of Environmental and Resource Economics*, *5*(4), 97-103.

Sokutu, B. (2021). Residents up in arms over Ekurhuleni's property roll. THE CITIZEN. Retrieved from https://citizen.co.za/news/south-africa/government/2508387/residents-up-in-arms-over-ekurhulenis-property-roll/

Steenkamp, J., Cilliers, E. J., Cilliers, S. S., & Lategan, L. (2021). Food for Thought: Addressing Urban Food Security Risks through Urban Agriculture. *Sustainability*, *13*(3), 1267.

Tajima, K. (2003). New estimates of the demand for urban green space: Implications for valuing the environmental benefits of Boston's big dig project. *Journal of Urban affairs*, *25*(5), 641-655.

Van Oijstaeijen, W., Van Passel, S., & Cools, J. (2020). Urban green infrastructure: A review on valuation toolkits from an urban planning perspective. *Journal of environmental management*, *267*, 110603.

Van Zyl, B. (2021). The integration of Urban Planning and Urban Ecology: investigating multi-functionality and ecosystem services. (Masters dissertation, North-West University (South Africa).

Venter, Z. S., Shackleton, C. M., Van Staden, F., Selomane, O., & Masterson, V. A. (2020). Green Apartheid: Urban green infrastructure remains unequally distributed across income and race geographies in South Africa. *Landscape and Urban Planning*, *203*, 103889.

Wen, H., Zhang, Y., & Zhang, L. (2015). Assessing amenity effects of urban landscapes on housing price in Hangzhou, China. *Urban Forestry & Urban Greening*, *14*(4), 1017-1026.

Yates, S. R., & Cowart, L. B. (2019). The Impact of Shuttered Golf Courses on Property Values. Journal of Sustainable Real Estate, 11(1), 2-15.

Yu, Y., Zhang, W., Fu, P., Huang, W., Li, K., & Cao, K. (2020). The spatial optimization and evaluation of the economic, ecological, and social value of urban green space in Shenzhen. *Sustainability*, *12*(5), 1844.