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The Legacy Effects of Colonial and Apartheid Imprints on Urban Greening in South Africa: Spaces, Species, and Suitability

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Colonialism is a significant legacy across most aspects of urban form, the nature and distribution of public green spaces, and tree species composition in many cities of the Global South. However, the legacy effects of colonialism on urban green infrastructure and the uses thereof have only recently come under scrutiny. Here we collate information from South Africa on urban greening and interpret it through a colonial and apartheid legacy lens in relation to the distribution and types of urban nature found and their resonance with contemporary needs as an African country. The analysis indicates marked inequalities in public green space distribution and quality between neighborhoods designated for different race groups during the colonial and apartheid periods, which continues to be reproduced by the post-colonial (and post-apartheid) state. Additionally, in the older, former colonial neighborhoods non-native tree species dominate in parks and streets, with most of the species having been introduced during the colonial period. Such colonial introductions have left a burdensome legacy of invasive species that costs billions of Rands annually to keep in check. Lastly, the forms of nature and activities provided in public urban green spaces remains reminiscent of the colonial norm, with little recognition of African worldviews, identity and needs. We conclude in emphasizing the necessity for urban authorities and planners to address these anachronistic legacies through adopting a more inclusive and co-design approach with respect to the extent, location and types of urban nature provided, as well as the types of cultural symbols and activities permitted and promoted.

Keywords: apartheid, colonial, green space, legacy, urban nature

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INTRODUCTION

Urban greening and especially the planting of trees is increasingly advocated as an important strategy for promoting urban sustainability, liveability and resilience (Wachsmuth and Angelo, 2018; Du and Zhang, 2020). However, to meet these goals the types of green spaces developed and species of trees that are planted need to be appropriate to the biophysical setting and simultaneously

accord with the cultures and meet the needs of local residents because urban trees and green spaces represent symbols or expressions of particular cultures, preferences, histories and planning approaches (Stewart et al., 2004; Hunte et al., 2019). The latter is challenging as urban settings around the world become more multicultural, and especially so in the Global South due to the rapid rates of urban growth (Khan, 2014; Zwiers et al., 2018; Hunte et al., 2019). Moreover, because trees and parks are generally long-lived entities, preferences and decisions made in a particular period may persist for decades or even centuries, constituting a legacy of a former period. However, despite the history of a region, city or specific site within a city being a primary filter of what species mix is found (Aronson et al., 2016), it is rarely included as an interpretative lens in attempts to understand current species composition and dynamics (Roman et al., 2018), especially with respect to anthropogenic legacy effects (du Toit et al., 2016).

Examination and understandings of site legacy effects on current biodiversity patterns and processes are not unusual for rural or natural settings, but are still relatively rare in urban studies (Roman et al., 2018) and even less so in developing country contexts (du Toit et al., 2016; Hosek, 2019). The legacy effects of a site relate to how the current nature of the site is partly or wholly a reflection of how the site was used or disturbed previously, ranging from a few years beforehand to centuries ago. In this sense we follow the widely accepted definition of Monger et al. (2015:13) of legacy effects being "the impacts that previous conditions have on current processes or properties". Despite the growing recognition of legacy effects, only one study in South Africa has explicitly examined landscape history as a driver of species composition in urban areas, that being du Toit et al.'s (2016) work on grassland remnants in Potchefstroom, although the engrossing ecosystem services history of Cape Town by Anderson and O'Farrell (2012) has relevance.

A significant legacy across most aspects of urban form and society throughout many regions of the Global South is that of colonialism (Myers, 2003). Colonial administrations influenced all facets of life including urban planning and architecture (Ignativea and Stewart, 2009), alongside language, education, knowledge systems, social norms and cuisine, to name a few. Many facets of indigenous knowledge, beliefs and practices were suppressed, denigrated or outlawed (Johnson and Murton, 2007). They also influenced the location and layout of residential areas (Myers, 2003; Scholz et al., 2015; Titz and Chiotha, 2019), of formal public green spaces (Säumel et al., 2009; Abendroth et al., 2012; Scholz et al., 2015), and the extent and composition of tree species planted in public and private spaces (Stewart et al., 2004; Peckham, 2015; Hosek, 2019).

Much of the formal public green spaces in modern cities are found in the more low-density, affluent residential neighborhoods (Martin et al., 2004; Wolch et al., 2014), with evidence showing that low income and typically high density urban areas are usually the most susceptible to the uneven distribution of green infrastructure, evidenced by the general lack of trees (Li et al., 2015; Lee et al., 2019) and public green spaces (Thaiutsa et al., 2008; Kabisch and Haase, 2014). Roman et al. (2018) associated this distribution to underlying historical processes and causal mechanisms, among other things, as a result of past decisions because urban green spaces and trees are part of an inherited landscape. The extent and composition of tree species planted in public and private spaces included the introduction of species from the colonizing country for sentimental reasons or from other colonial dominions for aesthetic or economic reasons (Stewart et al., 2004; Abendroth et al., 2012; Roman et al., 2018; Hunte et al., 2019). For example, this pattern is evident in the greater Bandung area, Indonesia, a colonial city established by Dutch settlers at the end of the 19th century, where many shade trees and colorful ornamental species were introduced by the Dutch from species that come from Europe, tropical America, Southeast Asia, and tropical Africa (Abendroth et al., 2012), while Moro and Castro (2015) indicate that the *Azadirachta indica*, an exotic and invasive tree from India (connections that can be traced back to Portuguese coloniszation of Brazil), has become an important ornamental plant in Fortaleza, Brazil in the last decade. Similarly, the *Blighia sapida*, an African species abundant in Georgetown, Guyana, was brought to Jamaica in slave ships in the 18th century during the British colonial rule, and has since become an important livelihood source and integral to Jamaican food culture (Hunte et al., 2019). According to Abendroth et al. (2012), this directly impacts on, and induces a loss of local identity among the colonized communities because traditional natural elements are transformed or replaced by western garden culture.

South Africa offers an interesting case for the examination of the legacy effects of colonialism. As with many previously colonized countries, South Africa has a complex history of occupation and development, which continued for several decades even after independence. It was first colonized by the Dutch in 1652 who established a provisioning station for their ships traveling between Holland and their southeast Asian colonies. After approximately 150 years their hold over the still spatially small colony was broken by the British, who took control in 1806. Over the next century, as the now British colony expanded, there were multiple conflicts between the imperialist British and descendants of the original Dutch colonists (many of who had migrated to the north) and multiple indigenous groups, culminating in the Union of South Africa in 1902 under total British control. This lasted until 1961 when the country became a republic and formally independent of Britain. During this colonial period, the British style influenced urban design and planning (Miraftab, 2012; Scholz et al., 2015), including the establishment and design of several notable urban parks and botanical gardens (such as Kirstenbosch in Cape Town and the botanical gardens in Durban), as well as the introduction of over eight thousand plant species from other parts of the world (van Wilgen et al., 2001; Faulkner et al., 2015). For example, *Lantana camara* was introduced in approximately 1858 as an ornamental, whilst *Acacia mearnsii* was brought in from Australia in 1871 for fuelwood and shelter belts (it subsequently became the foundation species for a large tannin industry). Both have subsequently invaded millions of hectares and are regarded as priority species for control (Robertson et al., 2003).

Almost two decades before becoming a republic, and for three decades afterward, South Africa entrenched many existing

and new sweeping racially-discriminatory laws that suppressed the livelihoods, wellbeing, cultures and aspirations of all who were then termed 'non-white' people (we do not subscribe to racial categories but use them to reflect the historical reality, which remains entrenched in urban spatial geographies in South Africa to the present day). Every facet of life of black South Africans was restricted and dictated by a whites-only government and brutally enforced under the central policy of 'apartheid.' These laws restricted which black South Africans could work in urban areas, and where they were allowed to live (Horn, 2019). The urban living areas prescribed for black South Africans became known as townships, and were characterized by systemic underdevelopment with respect to housing, electricity, sanitation, social services (such as education and health), recreational spaces and economic opportunities. They became sites of deep poverty and depravation, which still remains evident today although perhaps not to the same degree (Carruthers, 2008; Horn, 2019). The same applied to most black households who were not allowed to live in urban areas, with millions forcibly relocated to ethnically defined bantustans. With the advent of democracy after the fall of apartheid in 1994, the newly elected government instituted a massive program to address the dire situation in the townships (and bantustans) and the lack of urban housing generally (Miraftab, 2012). Millions of housing units were built under what is known as the Reconstruction and Development Program (RDP) (Horn, 2019), although a monumental backlog remains due to the continued high rates of rural to urban migration. Neighborhoods dominated by RDP houses are now termed RDP areas and are characterized by rows upon rows of tiny houses of identical design, with occupancy prioritized for the indigent. Despite providing shelter for millions, they have been criticized for the small size of the dwelling units, the general lack of social infrastructure such as community halls, sports facilities and public green spaces, and overall not meeting internationally accepted criteria for 'adequate' housing (Goebel, 2007; Moolla et al., 2011; Rapelang et al., 2018) and environmental justice (Ernstson, 2013; Venter et al., 2020).

The legacy effects of colonialism on the composition and distribution of urban forests have only recently come under scrutiny (e.g., Pawson, 2008; Ignativea and Stewart, 2009; Säumel et al., 2009; Hosek, 2019; Hunte et al., 2019), and a great deal more is required to better understand the patterns, processes and implications across, local, national and international scales (Pawson, 2008; Anderson et al., 2020). For example, Hunte et al. (2019) show how distance from the colonial center of Georgetown (Guyana) influenced the type of trees found in particular parts of the city, whilst Gwedla and Shackleton (2017) show how the location of a town in the former racially prescribed bantustans in South Africa influenced the current abundance of street trees. Hunte et al. (2019) argue that generally, literature on urban tree species composition in much of the Global South is largely descriptive with comparatively little understanding of patterns and drivers. Within the context of the above the objective of this paper is to collate and re-interpret existing information and data in South Africa on urban greening using an explicit lens of colonial and apartheid legacy effects, which has not been done before. We consider the distribution and types of urban nature found, and its resonance with contemporary needs as an African country. We do so for three components, namely (1) the public urban green spaces, (2) the woody plant species in public spaces, and (3) the suitability of the spaces and species for the diversity of South African cultures. We focused on these three aspects because most of the studies and knowledge in South Africa cover one or more of these three aspects. Whilst the effects of colonialism on urban form and greening could be examined through other domains and measures, there are insufficient studies to allow detailed examination.

SPACES

The current distribution patterns of private and public urban green spaces and trees in South Africa is extensively reminiscent of colonial planning (Shackleton et al., 2018), and continues to be so even with the development of new low-cost housing residential areas under the RDP (McConnachie and Shackleton, 2010). Drawing on results from several studies in South Africa (McConnachie et al., 2008; McConnachie and Shackleton, 2010; Shackleton and Blair, 2013; Gwedla and Shackleton, 2015, 2017; Shackleton et al., 2018; Radebe, 2019; Anderson et al., 2020; Makakavhule and Landman, 2020), the extent of urban green space and tree distribution reveals inequalities that disproportionately favor the affluent and previously 'white' residential areas, with the poor and predominantly 'black' areas having markedly less public green space and trees.

Public Green Spaces (PUGS)

A few studies in South Africa have revealed that urban green spaces constitute a relatively small portion of the total land cover in urban areas. For example, McConnachie et al. (2008) calculated across 10 towns that PUGS coverage was 10.6% of the area, while Radebe (2019) reported that 21.5% of total land cover of the urban core (excluding wasteland) across eight towns was PUGS. Churchyards and cemeteries also constitute a sizeable portion of the public green spaces of urban areas, as reported by De Lacy and Shackleton (2017) that the green space in these institutions accounts for 13.6% of the total public green space area in Grahamstown. A recent, national remote-sensing survey showed that on average white urban households live within 700 m of a public park, whilst black African households are, on average, 1.7 km away from one (Venter et al., 2020).

Radebe (2019) found that the RDP neighborhoods of eight small to medium-sized towns in the Eastern Cape province had only small areas of PUGS compared to both the township and affluent areas; ranging between 0.9% (Queenstown) to 26.0% (Bedford). On the other hand, the affluent areas were found to have relatively larger areas of PUGS, ranging from 34.8% (King William's Town) to 74.1% (Queenstown) (Radebe, 2019). These findings echo those of McConnachie and Shackleton (2010), who found evidence of relatively poor provision of PUGS in terms of both the size and proportion of the spaces in the RDP areas (0.7 ± 0.3; 3.6 ± 1.5) of a different set of nine towns in the province than both the township (1.7 ± 0.1; 12.0 ± 1.9) and affluent (1.8 ± 0.3; 11.8 ± 1.3) areas. In the same light,

Shackleton and Blair (2013) concluded that, based on residents' perceptions on the use and their estimates of PUGS in two towns, the RDP and township areas had markedly lower proportions of PUGS than the affluent areas. Moreover, the proportional area under PUGS in black areas has declined during democracy over the last 25 years, but not so in the white neighborhoods, leading Venter et al. (2020:11) to label it as "green apartheid."

Street Trees

In addition to the disparities in the distribution of PUGS, further inequalities in the distribution of street trees are also prevalent across the country, both between towns and between neighborhoods. For example, in one of the first studies, Kuruneri-Chitepo and Shackleton (2011) found that in three towns the affluent suburbs boasted approximately 76% of all street trees, compared to 20% in the CBD and <5% of the trees were in the townships and RDP neighborhoods, despite the larger size of township and RDP neighborhoods. In an assessment of the distribution of street trees between towns, the legacy of colonial planning was more pronounced in other parts of the province at both the town (Gwedla and Shackleton, 2015) and suburb scales (Gwedla and Shackleton, 2017). At town scale, Gwedla and Shackleton (2015) reported a low abundance of street trees per 200 m transect (0.6 ± 0.3) among the former bantustan towns, which are generally poor, compared to those that were not part of the bantustans (5.8 ± 1.6) during apartheid and are relatively wealthier. Synonymous to this was the distribution of trees between suburbs, where mean street tree density in the affluent suburbs across all towns was 7.8 ± 0.9 trees per 200 m transect, 1.0 ± 0.3 trees in the townships and 0.2 ± 0.1 in the RDP neighborhoods (Gwedla and Shackleton, 2017). Elsewhere in the country, Schäffler and Swilling (2013) concluded that in Johannesburg approximately 24% of the city's historically wealthy northern suburbs had tree cover, whilst the poorer southern region, dominated by townships, it was approximately 7%.

SPECIES

With respect to the tree species present in public spaces, there have been a few studies in South Africa (mostly in the Eastern Cape province in the southeast) reporting on the composition of street trees in several towns. In some instances we drew from published works and theses, and in a few instances we did analyses or counts from the existing datasets collected during these various studies. All the studies revealed significant inequities in the abundance of street trees between the different neighborhoods, with many streets in RDP and townships having no street trees at all (Kuruneri-Chitepo and Shackleton, 2011; Dotwana-Zona, 2012; Gwedla and Shackleton, 2017). Thus, the former colonial core of the CBD and more affluent areas are generally characterized by higher densities and species diversity of street trees than the townships and RDP areas. Anderson et al. (2020) shows that in Cape Town this pattern translates into a greater diversity of functional traits, conferring greater ecosystem resilience and productivity.

This legacy is further evidenced by the usually higher proportion of non-native species in the CBD and older, more affluent areas than the townships (**Table 1**), and a tendency for a greater proportion of native species in the most recent areas characterized by the RDP neighborhoods (if there are any street trees). This was echoed in parking lots where 83% of trees in parking lots of 10 years or older were non-native, compared to 38% in lots younger than 10 years (O'Donoghue and Shackleton, 2013).

The colonial legacy of species introduction goes beyond just what tree species are found in urban streets and parks to include the effects of those species introductions in terms of the ecosystem services and disservices that they provide. The disservices aspects in relation to some introduced species becoming invasive has received significant attention in South Africa as a mega-diversity country (van Wilgen et al., 2020), albeit only recently in urban settings

TABLE 1 | The proportion (%) of non-native street trees species in 14 towns and neighborhoods in the Eastern Cape, South Africa (nd, no data) (towns were selected by the original studies, and all studies reporting street tree composition in the province have been included).

Site	Town as a whole	CBD	Affluent	Township	RDP	Source
Burgersdorp	89	nd	91	100	No trees	Gwedla (2016) unpubl data
Cradock	81	nd	75	83	No trees	Gwedla (2016) unpubl data
Graaff-Reinet	81	nd	81	77	No trees	Gwedla (2016) unpubl data
Grahamstown	59	69	59	100	Nd	Kuruneri-Chitepo and Shackleton (2011) unpubl data
Libode	100	nd	100	nd	No trees	Gwedla (2016) unpubl data
Matatiele	81	nd	63	25	0	Gwedla (2016) unpubl data
Peddie	50	nd	100	nd	0	Gwedla (2016) unpubl data
Port Alfred	58	69	61	45	Nd	Kuruneri-Chitepo and Shackleton (2011) unpubl data
Port St Johns	100	nd	80	nd	No trees	Gwedla (2016) unpubl data
Queenstown	90	nd	84	50	No trees	Gwedla (2016) unpubl data
Somerset East	74	80	72	57	Nd	Kuruneri-Chitepo and Shackleton (2011) unpubl data
Tsolo	100	nd	100	nd	No trees	Gwedla (2016) unpubl data
Umtatha	55	nd	57	50	44	Dotwana-Zona (2012) unpubl data
Willowmore	75	nd	100	0	No trees	Gwedla (2016) unpubl data
Mean	78 ± 18	73 ± 6	80 ± 16	65 ± 26	15 ± 25	

(Shackleton and Shackleton, 2016; Potgieter et al., 2017; Mclean et al., 2018; Mabusela, 2019; Potgieter et al., 2019; van Wilgen et al., 2020). For example, Mclean et al. (2018) recorded 298 non-native species in a street drive-by survey of the small town of Riebeek-Kasteel (population of 1,150 people) of which 105 were declared invasive species, most of which were introduced during the colonial period. Domestic gardens harbored the greatest number of species. Similarly, Lubbe et al. (2010) reported a higher number of non-native species in domestic gardens than other landuse types in Tlokwe. At a town scale, McConnachie et al. (2008) revealed that the PUGS in former apartheid bantustan towns had significantly greater proportions of invasive alien woody species and numbers of individuals than non-bantustan towns. Of the top 20 invasive alien species in South Africa ranked by Robertson et al. (2003), the approximate dates of introduction are known for 14. All were within the colonial period (one in the 18th century, eight in the 19th century and five in the first half of the 20th century), representing a significant burden from the colonial period, which costs the fiscus billions of Rands annually in control efforts and billions in lost ecosystem services (such as water yield, agricultural production and biodiversity) and major ecosystem disservices such as increased wild fires and stream sedimentation (van Wilgen et al., 2012; van Wilgen and Wannenburgh, 2016).

SUITABILITY

The 'suitability' of a particular green space is in the eye of the beholder or aspirant user. Additionally, attitudes toward and needs for green spaces and urban nature are complex. This is because they are a function of at least three, if not more, overlapping domains including (1) availability and accessibility, (2) the quality, condition and amenities within a particular green space, and (3) the expectations or needs for a particular type of urban nature experience as shaped by user attributes such as age, gender, education, culture and belief systems. The first has been covered in Section "Spaces" of this paper.

The second considers the amenities and maintenance of PUGS and whether they meet local residents' needs. There are several studies from South Africa that mention or report residents' perceptions of local PUGS (Shackleton and Blair, 2013; Kaoma and Shackleton, 2014; Shackleton et al., 2018; Adegun, 2019; Gwedla and Shackleton, 2019; Manyani, 2019). Most indicate that, on the whole, residents from the poorer towns and neighborhoods, already disadvantaged by relatively poor provision of PUGS and trees, feel that the PUGS are poorly maintained by the responsible urban agency (Shackleton et al., 2018; Gwedla and Shackleton, 2019; Manyani, 2019). There are frequent criticisms pertaining to the absence of litter bins (or if present, not emptied on a regular basis) resulting in accumulations of unsightly and perhaps dangerous litter, rare or irregular maintenance with respect to the mowing of lawns or tendering of flower beds (if any) and upkeep to children's play equipment, vandalism of infrastructure not attended to, and the depredations and dung of livestock. There are even reports of deaths resulting from poorly maintained and hence unsafe play equipment (Maclennan, 2019). These all create an aura of neglect across many urban parks in the township and RDP neighborhoods, which deter some potential users (Manyani, 2019; Makakavhule and Landman, 2020). For example, Walton (2012) reported a significant, positive relationship between the number of visitors over a 2-week period and a participatory-derived 'condition' score for eight PUGS in King Williams Town (now named Qonce). Similarly, Shackleton and Njwaxu (2021) monitored 11 public parks in six towns over 3 years and found that as the condition of a park declined, so did spot counts of the number of users. The qualitative assessment of de Vries and Kotze (2016) found that most of the ten parks they assessed in downtown Johannesburg were in an unsatisfactory condition and that the maintenance cycle for most of them was too infrequent to keep them in a state that would attract users. Makakavhule and Landman (2020) echo similar sentiments for parts of Tshwane, the capital city, whilst also noting some parks that are well used and maintained.

Whilst the same narratives are voiced in the more affluent areas, they are fewer, indicating greater levels of satisfaction with PUGS maintenance in those areas (Shackleton and Blair, 2013). Indeed, the little work on condition rating of PUGS shows that the park condition is generally better in the more affluent towns and neighborhoods (Walton, 2012; Seboko, 2019). For example, using data from Walton (2012) the mean participatory condition score for 11 PUGS in the affluent neighborhoods of King Williams Town (200 ± 70) was 63% greater ($t = 3.08$; $p < 0.01$) than 11 parks in the townships (123 ± 42) of the same town. It might also be a result of them requiring less maintenance as there are fewer people in the affluent areas and hence fewer potential users. Additionally, in most affluent neighborhoods households have access to private green space to provide some of their nature needs (Shackleton et al., 2018). Nevertheless, management agencies could accommodate different levels of demand and use and allocate resources accordingly so to eliminate the stark differential in the conditions of PUGS between the richer and poorer communities.

In turning to the expectations or needs of local users, much has been overlooked by adopting a colonial and subsequently a Eurocentric lens. Roman et al. (2018) discuss how biophysical and human drivers leave legacies with respect to the design and tree species composition of PUGS in the United States and Canada. However, they did not examine whose legacies 'counted' nor how the prevailing legacies facilitated or excluded the use of parks by particular social groups, especially native peoples. In South Africa, there is generally a strong appreciation of and affinity to nature, including trees, in urban spaces. For example, Gwedla and Shackleton (2019) reported that 74% of urban respondents agreed that trees were important for quality of life, and that the considerable majority have one or more trees in their home yards (Kaoma and Shackleton, 2014; Gwedla, 2020), being appreciated for a diversity of provisioning, regulating and cultural services (Shackleton et al., 2015). However, with respect to private space, most of the township and RDP neighborhoods lack sufficient space for residents to have a

satisfactory quantity or diversity of trees (Gwedla, 2020), and perhaps other flora that are important to them for provisioning or cultural benefits (Haynes et al., 2018). For example, Gwedla (2020) reported that a lack of space was the most commonly reported barrier to homestead tree planting (58% of respondents) across eight towns. It was also the second-most cited reason against tree planting in public spaces, with the high housing density in poorer neighborhoods resulting in very few PUGS and that many of the streets were too narrow to accommodate street trees (Gwedla, 2020). Municipal officials also thought that a lack of space was a significant constraint against tree planting in public areas of RDP and township neighborhoods (Gwedla, 2020). Similar sentiments were reported by Haynes et al. (2018) regarding urban respondents in RDP and township neighborhoods lamenting that they did not have sufficient space in their small yards to grow specific plants of cultural significance that were deemed crucial to their cultural identity and place-making.

In the public arena, the Eurocentric legacy has shaped not only the distribution and abundance of formal green spaces and species, but also the form that they take. Most follow some variation of the English-style park, with large trees and extensive lawns, interspersed with flowerbeds and perhaps some artworks or memorial plaques (such as to those who died in one of the World Wars, or during the liberation struggle) (Cocks et al., 2020; Makakavhule and Landman, 2020). This applies to formal public parks established during the colonial and apartheid periods, as well as in the post-apartheid period (Cocks et al., 2020). This form is designed to provide recreational services associated with exercise and relatively passive recreation with family or friends, and some parks have play equipment for children. Whilst these are important services appreciated by many urban South Africans, they do not adequately serve the "deeper and more multifaceted relationships" (Cocks et al., 2016, p. 821) and meanings that many black South Africans seek from nature. Indeed, it is not "from" nature, which implies a unidirectional relationship, but rather that some indigenous cultures view themselves indivisible from nature, i.e., nature and humanity are an integral part of one and the same entity (Cocks et al., 2016). Accordingly, some cultures believe that ancestral spirits are present in nature and have an influence over daily happenings, fortunes and misfortunes and psychological wellbeing (Cocks et al., 2016). Thus, access to particular forms of nature is vital in respecting and nurturing the bonds with one's ancestors, as evidenced through Cocks et al. (2016) reporting that 84% of urban Xhosa respondents in a survey in Grahamstown said that it was necessary to have access to nature to communicate with their ancestors, and 92% affirmed that their household performs cultural rituals to communicate with their ancestors. Consequently, English-style parks and the limited suite of cultural ecosystem services they provide and the activities they allow are not suitable for some urban black South Africans, and do not meet the diversity of needs and cultures, and hence do not promote a sense of "ownership and attachment to place" (Makakavhule and Landman, 2020, p. 5). A further example is that collection of plants required for cultural or medicinal rituals is generally not permitted in urban parks in South Africa, nor is the holding of religious or cultural ceremonies or observances, although the latter is tolerated by some municipal authorities. The grazing of livestock, which are an integral part of Xhosa culture and rituals, is also generally prohibited (Davenport and Gambiza, 2009).

One consequence of the unavailability or unsuitability of many formal PUGS, is that some urban citizens seek specific nature experiences in informal green spaces (Adegun, 2019; Manyani, 2019) or they delay them until they visit relatives or 'home' in rural settings (Njwambe et al., 2019). Informal green spaces provide the opportunities for more deeply held cultural or religious activities and rituals away from constant scrutiny and urban distractions. For example, informal urban green spaces in southern Africa are often used as places to 'escape' and to communicate with one's ancestral spirits (Cocks et al., 2016). Similarly, such informal spaces may be used as places for outdoor religious practices and worship (Ngulani and Shackleton, 2019), with some urban residents regularly traveling considerable distances to gather and pray at specific sites (Ngulani and Shackleton, 2019). Informal green spaces may also be sites for collection of particular plant species used in traditional or spiritual rituals (Davenport et al., 2011; Cocks et al., 2012). Amongst some ethnic groups in South Africa informal green spaces in or on the periphery of urban settlements are the main sites for coming-of-age male initiation ceremonies (Kepe et al., 2015). The informality of these green spaces also fosters some grazing of livestock, although most urban authorities attempt to exclude livestock from the urban core, and seek to restrict them to the urban periphery, not always successfully (Shackleton et al., 2017). However, use of informal green spaces is not an option available to all because of fears of crime or the poor state of many informal green spaces (Adegun, 2019; Manyani, 2019).

A second consequence is that the PUGS do not contribute to a sense of place and belonging (Njwambe et al., 2019), and consequently many suffer neglect and vandalism (Shackleton and Njwaxu, 2021). This has led to the ironic situation of PUGS, supposedly for public use, being gated and locked, including those that offer memorials to liberation struggle heroes (Cocks et al., 2020; Makakavhule and Landman, 2020; Shackleton and Njwaxu, 2021). There has been only limited consideration of sense of place in urban settings in South Africa, but the inklings we have suggest that it is potentially significant for formal and informal green spaces that meet a diversity of local needs and belief systems (Cocks et al., 2016; Njwambe et al., 2019).

DISCUSSION

This paper has collated evidence that the colonial and apartheid legacies have left a marked and continuing imprint on the distribution, tree species composition and suitability of urban green spaces in South Africa that remain very visible and very real in the current day. Whilst the intensity and nature of colonial domination (and subsequently apartheid in South Africa) had particular nuances in different continents and countries, many

of the legacy effects are similar across different socio-cultural settings (Ignativea and Stewart, 2009). Thus, the historical patterns of development and the social environment of cities play a significant role in the availability, amount, distribution and 'accepted' uses of urban green spaces and trees (Ignativea and Stewart, 2009; Kendal et al., 2012; Gwedla and Shackleton, 2017; Fan et al., 2019; Titz and Chiotha, 2019).

Green Spaces

The inequitable distribution of PUGS in and between towns in South Africa as presented in this paper is not unique to South Africa. The inequitable distribution has been reported from a number of countries, typically showing that ethnic/racial minorities (Landry and Chakraborty, 2009; Wolch et al., 2014), and those of lower socio-economic means have comparatively worse provision, or quality, than their counterparts in more affluent areas (Vaughan et al., 2013). For example, low density, more affluent neighborhoods of Delhi, India, boast a green index (amount of urban green space) of 0.44 and an urban neighborhood green index of 0.58, compared to 0.29 and 0.47, respectively, in the high density, less affluent neighborhoods (Gupta et al., 2012). Shanahan et al. (2014) present evidence that socio-economic bias between neighborhoods occurs in both public parkland and residential yards in Brisbane, Australia, stating that the more advantaged neighborhoods had slightly more park area and greater lot sizes than the socio-economically disadvantaged ones.

The same pattern is frequently reproduced with respect to street trees. Globally, municipalities and towns with higher populations and relative affluence tend to have a higher density of street trees (Conway and Urbani, 2007; Landry and Chakraborty, 2009). Shams et al. (2020) found that most of the low-income areas of Karachi, Pakistan, had substantially lower street tree densities than the affluent parts, which they attributed to high land value and better infrastructure of the roads and the sidewalks. The socio-economic determinants of street tree cover are also true for suburb types, and neighborhood socio-economic conditions thus play a significant role. Similar patterns can also be found in Brazil, where dos Santos et al. (2010) reported that less than 10% of neighborhoods in Rio de Janeiro had sufficient street trees, and these were generally older, well established neighborhoods hosting households with greater mean income, compared to the poorer, newer, and more peripheral neighborhoods which had low arboreal index values, and rarely had street trees. Such findings were echoed by Szantoi et al. (2012) in Miami-Dade County, Florida.

Despite the prevalence of such disparities they cannot be interpreted solely as a legacy effect of colonialism, because they are also evident to some degree in former colonizing countries of Europe. For example, Wüstemann et al. (2017) revealed that more high income neighborhoods in German cities had significantly more urban green space within a 500 m distance than households in poorer neighborhoods. Similarly, in the United Kingdom, Pauleit et al. (2005) reported that the cover of trees and shrubs in residential areas in Merseyside increased with increasing affluence, concluding that tree cover appears to be a good indicator of the socio-economic status. However, the crux is that in many former colonized countries there is commonly a strong overlap between wealth and race (Gradin, 2014), including in South Africa (Gradin, 2014; Cheteni et al., 2019), such that a greater proportion of households of indigenous communities are poorer than households that are descendants of colonizing groups. This inevitably raises environmental equity concerns (Tooke et al., 2010; Wolch et al., 2014) where some residents have access to the benefits of urban green spaces and trees, and the ecosystem services they provide, while others do not or to a far lower degree (Li et al., 2015; Nyelele and Kroll, 2020). Thus, the legacy effects are felt not only in the lower provision of urban green infrastructure, but also in lower economic opportunities.

Species

South African towns exhibit significant variability in the composition and diversity of urban trees in public spaces. This is a consequence of the interplay of biophysical (Kirkpatrick et al., 2007) and socio-economic factors (Kendal et al., 2012) and, as we argue here, historical factors too. Non-native trees account for the majority of trees in PUGS and streets across various towns and suburb types in the Eastern Cape province of South Africa. According to Moran et al. (2013), this is a widespread pattern in the southern Africa region as a whole, and can largely be attributed to the region's colonial history. In essence, tree species in cities located in areas colonized by Europeans have traditionally been chosen from a European species pool (Ignativea and Stewart, 2009; Nitoslawski et al., 2016), as well as transfers between colonies (Kemp et al., 2020). A substantial proportion of the non-native urban flora in South Africa was introduced during the colonial period to provide, augment or restore specific ecosystem services (Bennett and Van Sittert, 2019; Potgieter et al., 2019; Shackleton et al., 2020). Ordóñez and Duinker (2013) also attributed the abundance of non-native trees across cities in countries like Canada to their respective colonial histories, with similar interpretations in Christchurch (New Zealand) where more than 80% of street and parkland tree species are exotics (Stewart et al., 2009). The high and even majority proportions of non-native species, introduced mostly during the colonial period, is common across many former colonized countries, such as Niger (Moussa et al., 2020), Brazil (Moro and Castro, 2015), India (Nagendra and Gopal, 2011) and the Caribbean islands (Kemp et al., 2020). It can even be more than just adding to the local species diversity, as specific non-native trees can be the dominant species in many cities, such as in Christchurch, New Zealand (Stewart et al., 2009). The two most dominant species (*Azadirachta indica* and *Mangifera indica*) in two Nigerian cities were both introduced from Asia (Dangulla et al., 2020), while the most dominant species (*Terminalia catappa*) in Rio de Janeiro, Brazil, originates from the tropical regions of Asia, Africa, and Australia (dos Santos et al., 2010). There is some evidence that in public spaces at least, the proportion of native species is increasing in newer neighborhoods as some countries adopt more pro-native species and conservation

policies (Stewart et al., 2004; O'Donoghue and Shackleton, 2013; Sjöman et al., 2016; Hernández and Villaseñor, 2018). Non-native species are also common, although rarely dominant, in public spaces of former colonizing countries of Europe, but this was not an external imposition and is driven by a desire to augment the low number of native species available (Sjöman et al., 2016), in contrast to many colonized countries which have far greater native species diversity to select from.

Of particular concern with respect to non-native urban tree species is the potential of some to become invasive and thereby pose threats to native biodiversity and ecosystem services in towns and cities, as well as surrounding landscapes (Säumel et al., 2009; Sjöman et al., 2016; Ward and Amatangelo, 2018). Whilst there is increasing concern over the effects of invasive species, most of the research and control efforts are in rural and protected areas, rather than urban ones, and policies and control efforts are highly variable between countries and regions within countries. For example, *A. indica*, originally from India, is classified as an invasive alien species in Ethiopia (Witt and Luke, 2017), Ghana (Vietmeyer, 1992), and South Africa (Henderson, 2001), but not in Nigeria (despite many similar bioclimatic similarities to the other countries), where Dangulla et al. (2020) found it to be a common and in places, dominant species. Moreover, permitting invasive species in urban settings in a specific region where it might be regarded as safe, as argued by Sjöman et al. (2016), ignores the fact that many species are transferred between regions in countries by individual citizens swapping or sharing planting materials, and also that many current day invasive species were first introduced in urban settings and invade surrounding landscapes by various long-distance dispersal mechanisms (Richardson and Rejmánek, 2011).

Suitability

Considering the suitability of the PUGS in South Africa for urban residents, the results echo those reported from other post-colonial settings w.r.t. the colonial design and legacy of permitted activities and relationships with nature, excluding many citizens from practicing indigenous beliefs and 'relationships' in and with nature. Cocks and Shackleton (2020) describe these as "severed biocultural links," whilst Gobster (2007, p. 100) refers to it as the "museumification of nature." This dislocation between the nature needs of many indigenous peoples in urban settings was instigated during colonial rule (and apartheid later on in South Africa) that systematically suppressed, denigrated and sought to transform indigenous cosmologies, cultures and practices associated with nature (Rozzi, 2012; Mashford-Pringle, 2015). This occurred through the combined onslaught of religious and educational conversion, through which western knowledge systems, religions and worldviews were advanced. This dominance of one specific scientific and cultural representation over others, that alienated those with different views and needs, continues to the current day. For example, Low et al. (2002) describe how long-standing immigrant communities to the United States were alienated from PUGS in Philadelphia via various means, such as cultural symbols with which they had no affinity, codes of dress and behavior, or signage that they cannot understand, or neglect of their history and contributions to the neighborhood and perhaps even development of the park. Interestingly, this feeling was greatest amongst the African-Americans, with similar sentiments reported by Byrne (2012) for Spanish–Americans in Los Angeles. Elands et al. (2019) argue for greater recognition of the need to restore and nurture the diversity of biocultural relationships in PUGS as cities globally become more multicultural. Ignativea and Stewart (2009) describe the ubiquity of the English style parks (and city planning generally) in former colonial cities across the Antipodes, including the introduction of species typical of such parks in the United Kingdom to create the necessary effect, which was only questioned toward the last decades of the twentieth century.

CONCLUSION

This paper has adopted a colonial legacy lens in summarizing and interpreting current information on the distribution, species composition and suitability of PUGS in South Africa. It shows that there are marked and seemingly still indelible colonial legacies indicated by all three of these measures, whereby indigenous South Africans were, and continue to be, disadvantaged, first during the colonial period, then the immediate post-colonial apartheid period, which modern urban planning and delivery consciously or unconsciously continues to reproduce to this very day. Colonial authorities and institutions deliberately undersupplied urban green spaces and street greening to neighborhoods designated for indigenous black South Africans, which was continued by the overtly racist apartheid regime. Simultaneously, the introduction of thousands of species from other continents during the colonial period has left the country with a staggering hangover of biological invasions, which threaten urban and rural biodiversity, ecosystem services and human wellbeing, and which cost billions of Rands annually in control efforts. Yet, the stark inequities in urban greening inherited from the colonial and apartheid periods have not been addressed during the democratic period (since 1994). There has been further alienation due to the largely Eurocentric types of urban nature catered for and promoted, even to this day. Current green space planning and delivery is consciously or inadvertently myopic to the different worldviews held by some black South Africans and consequently, the diverse needs of and experiences in urban nature that need to be satisfied. Consequently, it is imperative that urban authorities and planners address these anachronistic legacies through adopting a more inclusive and co-design approach with respect to the extent, location and types of urban nature provided in South African towns and cities, as well as the types of cultural symbols and activities permitted and promoted in urban nature. With the increased pressure to provide housing to a growing population and thus an expectation for more RDP housing developments to be established, opportunities exists for urban authorities and planners to do this in the quest for sustainable human settlements. This will require concerted effort from

municipalities and community leaders, urban authorities, and planners to lobby for the inclusion of urban trees and green space planning to national land use or development plans in line with Afrocentric needs and preferences for urban nature. Furthermore, a focus on indigenous species with contributions to residents' livelihoods could enhance efforts to introduce urban nature in residential areas while increasing the abundance of native species at the same time.

DATA AVAILABILITY STATEMENT

The original contributions generated for this study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

CS conceived the manuscript. CS and NG wrote it together. Both authors contributed to the article and approved the submitted version.

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