Urban landscaping choices and people's selection of plant traits in Cape Town, South Africa

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ABSTRACT

As cities increasingly become the dominant settlement form across the world, it is critical to gain a deeper insight into their dynamics, in order to better direct environmental management towards enhancing urban sustainability and environmental quality. People are a key driver shaping the ecological makeup of cities, not least through landscaping actions and choices. In this study, we explore social factors shaping plant selection in Cape Town, South Africa through interviews with stakeholders responsible for managing and landscaping across three land use types: private residential gardens, public parks and open space, and conservation areas. We combine an interdisciplinary, multi-scalar framework on residential landscape dynamics and a plant traits lens to structure our approach to examining the influence of social factors on plant selection across spatial and institutional scales in the city, from a bottom-up perspective. Residents name a variety of reasons for plant selection at the household scale related to plant traits, including aesthetics, utility (e.g., food provision), environmental suitability, and personal symbolic meanings. Parks managers select for ecological suitability as well as aesthetic concerns, and conservation managers select chiefly for ecological integrity. All stakeholders describe factors at other scales (e.g., property structure, government policies) that influence their plant selection. We indicate that a complementary patchwork of private gardens and public open spaces could serve as a source of trait diversity and provide a variety of ecosystem functions and services in the urban landscape, and suggest that management and policy efforts can focus on leveraging synergies towards this end. This study contributes to a greater understanding of the social-ecological dynamics in a global south city and biodiversity hotspot.

1. Introduction

Understanding the dynamics of urban environments is of increasing importance, as more than half of the world's people live in cities, and two-thirds of the global population is projected to be urban by 2050 (UNDESA, 2014). Cities will continue to be the predominant form in which people experience ecosystems (Fuller and Irvine 2010). Thus, it is critical to understand what kind of environments are being created in urban areas and how they are being created, in order to better direct management towards functional landscapes for social-ecological integrity and sustainability. It has been suggested that the endeavor for global sustainability will be won or lost in cities (Ahern, 2011; Wackernagel et al., 2006).

Meeting this urban sustainability challenge requires thorough understanding of social-ecological system dynamics and functions. Human actions serve as a crucial filter of the pool of biota present in an urban landscape by selecting for specific species and their characteristics according to social factors (including preferences, norms, and cultural traditions) (Williams et al., 2009; Aronson et al., 2016; Fuller and Irvine, 2010). Several large-scale studies have set the stage for integrating how social factors influence urban ecological makeup, notably the urban long-term ecological research (LTER) programs (Grimm et al., 2000) in Baltimore, Maryland (Pickett et al., 2008) and Phoenix, Arizona, USA (Grimm and Redman, 2004; Grimm et al., 2013). Several of these projects have explored how broad socio-economic factors influence ecosystems (as reviewed in Warren et al., 2010). On a finer scale, Phoenix highlighted specific social factors that shaped residential yard landscaping preferences (Larson et al., 2009a; Yabiku et al., 2008; Larsen and Harlan, 2006). However, these emerging frameworks need to better combine individual and structural factors and be tested in different contexts.

In this study, we explore the social factors influencing the urban ecosystem (focusing on plant trait assemblages) in the context of Cape Town, South Africa. We utilize interviews with actors responsible for landscaping and managing three different urban land uses (residential, park, and conservation areas). To structure our approach, we employ two frameworks. The first is the conceptual framework of Cook et al. (2012), derived from LTER studies in Phoenix, that outlines social drivers (attitudinal, structural, and institutional factors) at multiple scales (household, neighborhood, and municipal-regional) influencing the biota of urban residential landscapes. Cook et al. (2012) identify the influence of: (1) governance and political economy (municipal-regional scale), (2) formal

and informal institutions (neighborhood scale), and (3) attitudinal factors of values and human cognition, and household and property structure (household scale). While Cook et al. (2012) focus on residential landscapes, they suggest that the framework could be applied more broadly (p. 40). We do that here by including parks and conservation areas. Our interviews with individuals at the local level are most relevant to understanding the household scale, though responses also touch upon elements at the neighborhood and municipal-regional scales.

The second framework we use is that of plant traits, which help us integrate and categorize respondents' stated reasons for plant selection. In ecology, traits have been defined as the physical characteristics of organisms that affect individual fitness and impact ecosystem processes, functions, and services[1] (Violle et al., 2007; Díaz et al., 2013). Traits have been suggested as a useful approach in comparative ecology, as they enable comparisons beyond taxonomic classifications to discern differences in functions within ecosystems (Díaz et al., 2002; Kohsaka et al., 2013). While traits have a long history of being linked to ecological function, this has recently been extended to social function in connecting the framework to ecosystem services (Díaz and Cabido, 2001; Díaz et al., 2007; Luck et al., 2009; de Bello et al., 2010; Lavorel, 2013). Though it has been suggested that people act as a distinct filter of urban vegetation by selecting for traits according to their attitudes and preferences (Williams et al., 2009; Aronson et al., 2016), the connections between traits and cultural ecosystem services have been less well-documented and may require an expansion of the organismal characteristics considered (Goodness et al., 2016). Few empirical studies have attempted to explicitly examine the relationship between human preferences with traits and connected ecosystem services, though see (Kendal et al., 2012), who found preferences for specific visual as well as non-visual traits; we build upon this by examining preferences in a novel geographic setting. In this paper, we use a definition of traits as characteristics linked to ecological and/or social function; these are elements identified by our respondents as reasons for plant selection.

Our study combines these two frameworks and serves as an exploratory study of what social factors influence plant selection in Cape Town. It (1) examines the reasons behind plant selection (with particular attention to plant traits) at the household scale, (2) identifies additional structural and institutional factors that shape plant selection at the household, neighborhood, and municipal-regional scale, (3) compares these results to other studies, (4) explores the potential impact on provisioning of ecosystem function and ecosystem services, and possible implications for environmental management, and (5) provides suggestions for future research. Ultimately, this investigation seeks to develop the growing literature on how humans influence urban ecosystems, and provides novel insights to a rapidly urbanizing global south city in a biodiversity hotspot.

2. Study area

The city of Cape Town, South Africa, occupies an area of 2, 461 km^2 (City of Cape Town, 2012b) on the southwestern tip of the continent, and has a population of 3.7 million people (City of Cape Town, 2012a). Located within the Cape Floristic Region, the smallest and most diverse floral kingdom on the planet, Cape Town is home to exceptional biodiversity, and is characterized as a biodiversity hotspot (Myers et al., 2000; Holmes et al., 2008). The city supports 3, 350 plant species that are indigenous to South Africa, and 190 of these species are found solely within the city boundaries (Raimondo et al. 2009; Rebelo et al. 2011). This biodiversity is at risk; 450 of the indigenous species in the city are listed as threatened or near-threatened, and 13 as extinct (Rebelo et al., 2011; Golding, 2002).

The city faces expanding urbanization pressures, with an annual population growth rate of 3.2 % (between 2001 and 2007, City of Cape Town, 2010), which is higher than the national average for South Africa

(Mieklejohn and le Roux, 2008). The legacy of apartheid, which disenfranchised and spatially segregated people along racial lines, is still ingrained, persisting in a spatial form of low-income, black informal settlements of high density on one extreme end of the spectrum, and high-income, white areas of low-density housing with spacious yards on the other (Turok, 2001; Lemanski, 2007; Goodness and Anderson et al., 2013). This significant economic disparity is reflected in comparative global measures of inequality including the Gini coefficient (UNDP, 2006), and the UN City Prosperity Index value (UN-Habitat, 2013). In this study, we focused our interviewing efforts on a transect along a socio-economic gradient in a specific part of Cape Town, stretching from a high-income, low-density residential area through to a low-income, high-density area. The aim of drawing upon this transect was to capture a diverse set of respondents across socio-economic conditions in the city.

3. Methods

3.1. Data collection

We interviewed stakeholders managing and/or planting across three different land use types in our study transect: private residential gardens, public open space/parks, and public conservation areas. For parks and conservation areas, we contacted four City of Cape Town government officials who are responsible for landscaping care and management of these areas. For private gardens, we visited five plant nurseries located within our study transect and interviewed customers (i.e., residential gardeners) as they walked by a central point. We utilized plant nurseries as they provided rapid, easy, and concentrated access to residential gardeners (rather than walking door-to-door in neighborhoods, which might inspire less trust and only provide limited access to respondents). The five nurseries were selected across the study transect in an effort to capture the full spectrum of socio-economic conditions that characterize Cape Town.

Our approach consisted of a series of open-ended, semi-structured interview questions (see Appendix for each of the surveys for different land use types). The content of the questions focused on management practices (what plants people selected for and why, what plant traits were important to them, and other social factors that influenced management practices). Interviews were conducted by one author writing down responses, and took place during the spring to summer growing season, from November 2015 to March 2016. For residential gardeners, we obtained a random sample of at least 25 customers from each nursery; we visited each nursery up to 4 times for periods of 5 h each to obtain this number and included at least one weekday and one weekend visit. Only individuals living in Cape Town were included. In total, 157 nursery customers were interviewed.

In terms of other stakeholders, we interviewed two conservation area managers, and two managers overseeing public open spaces (Table 1) in the municipal government. Conservation managers were from Environmental Management Department's Biodiversity Management Branch, which is responsible for conserving and restoring biodiversity, and manages the nature reserves in the city (City of Cape Town, 2018a; 2016; 2001; 2003). Public open space managers were from the Recreation and Parks Department, which is responsible for maintaining recreational amenities, and manages parks, greenbelts, and road verges, as well as community centres and sports grounds (City of Cape Town, 2018b; 2015). Both departments are small, centralized entities, each adhering tightly to a specific mandate. Employees do not operate with high autonomy, and therefore our four interviewees were considered representative informants of how these spaces are managed throughout the city. Their statements are supplemented with additional evidence from department policies in Sections 4.2 and 4.3.

3.2. Data analysis

We used a qualitative approach to the analysis of our interviews; we applied a process of inductive descriptive or topic coding as outlined by Miles and Huberman (1994) and Saldaña (2003) to written recorded interview responses. In a first round of coding, we recorded in-vivo

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[1] Ecosystem services are broadly described as the benefits that people obtain from ecosystems; these are distinguished into four categories of provisioning, regulating, supporting, and cultural services (MEA, 2003; TEEB, 2010).