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Nature-Based Solutions in Environmental Planning: Ecosystem-Based Adaptations, Green Infrastructures, and Ecosystem Services to Promote Diversity in Urban Landscapes

by

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A dissertation submitted in partial fulfillment of the
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Abstract

Nature-based solutions encompass strategies that explore ecosystem-based adaptations, green infrastructures, and ecosystem services in environmental planning and landscape management. However, nature-based solutions do not always consider ecological values and perspectives from Black, Indigenous, and Global South population. This dissertation has three independent papers that explore the application of ecosystem-based adaptations, green infrastructures, and ecosystem services in communities unheard by environmental planning agencies. The first paper is a conceptual framework that used literature review and observations of current human-nature interactions to reflect how the criminalization, acculturation, and cultural appropriation of cultural ecosystem services have burdened Black and Indigenous identities. Recommendations for the inclusion of diverse cultural ecosystem services values in environmental planning include ecosystem-based adaptations and frameworks of reimagination. The second paper is a case study about urban mobility in the Southern Zone of São Paulo, Brazil. Using surveys, interviews, and spatial analysis, I explored mobility patterns for urban services in macro zones of social and ecological vulnerability. The clusters for urban services were in macro zones of complete infrastructure or close to vulnerable housing spaces, opening space for discussion of the use of green infrastructure to mitigate social and ecological vulnerability. The third paper is a case study in Portland, OR, that used surveys, demographic indicators, and spatial data to explore the sense of ownership and maintenance for urban forestry. The results indicated a significant

correlation among tree canopy, household income, and sense of ownership for urban forestry. The results suggested that Portland residents are aware of tree maintenance challenges and the values of cultural ecosystem services for ownership of urban forestry. The three papers contribute to including historically marginalized values in environmental planning and validating mixed methods that use spatial analysis and public perceptions.

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Chapter 1: Introduction to human-environmental systems

1. Introduction

Urban Studies is a field of study that explores aspects that contribute, impact, and constitute the urban development of cities. Technology, concentration of jobs, and higher availability of social resources lead to the increasing population in urban areas. In the urbanization process, landscape change is an inevitable outcome. Urban studies scholars investigate ways to find balance, reach for sustainability, and research the socioeconomic impacts of constantly changing landscapes. With a forestry background and a passion for socioecology, I decided to follow environmental justice and forestry research within urban studies - learning through environmental planning initiatives in Portland, Oregon.

During the Ph.D. program, I participated in the City of Portland Urban Forestry Commission and City of Portland Parks Board as an advisory board member. I also joined the board of Urban Greenspaces Institute, a local nonprofit organization that advocates for the conservation and expansion of green infrastructure in the Portland (OR) region. In addition, I did an internship at Green Lents, a grassroots nonprofit in East Portland. The internship explored how community-based learning, public administration, urban ecology, and public participation in geographic information systems could reduce social vulnerability in Portland. In my final year of the PhD program, I joined the Portland Community College faculty board to teach Geography courses full-time.

Teaching and co-teaching environmental planning and GIS classes were inspiring to observe the formation of new leaders, create assignments that mimic real case

scenarios, and support students with comprehension of urban studies theories. In advisory boards, I could participate in discussions about the future of green spaces, green infrastructure, tree canopy and understand the process of policy creation. Today, I believe that the existence of fair public policies relies on the work with multiple stakeholders, listening to community members, and including reparations measures to overcome the long-term inequalities toward vulnerable populations. Community leadership strategies require a hands-on approach to engage citizens and to educate future generations. It is also possible to learn from community practices that succeeded or failed along with local history. Research builds up scholarship to observe urban issues and find methods that explore how to improve the liveability of cities. These experiences complemented my positionality as an Urban Studies scholar, allowing me to participate in environmental policy review and community engagement.

The path of this dissertation allowed the exploration of topics related to environmental sociology, anthropology, geography, urban planning. Through classes, readings, mentorship, community engagement, and professional development, I focused on exploring literature review, qualitative research with interviews and surveys, quantitative statistical analysis, and GIS applications. The conceptual theories explored environmental ethics, foundations of ecosystem services, human and physical geographies in urban landscapes, and the public perceptions in urban planning. Altogether, they reflect the sense of belonging, interpretation, and identity with the natural and built environment. In the following subsections, I will introduce

socioecological theories explored through the dissertation chapters and my positionality as a scholar.

2. Nature-based solutions: ecosystem services, ecosystem-based adaptations, and green infrastructures

The four shades of green (4SG) is a conceptual framework from Pauleit et al. (2017). The model explores nature-based solutions (NbS), ecosystem-based adaptation (EbA), green infrastructure, ecosystem services. Each *shade* bears a level of operationalization ranging from operational to conceptual. Operational values are the closest to practical and feasible solutions, and conceptual values englobe the ideas for nature-based solutions. Figure 1 is an adaptation from the Pauleit et al. (2017) diagram, explaining the thematic scope and level of operationalization of the 4SG model, aligning environmental activities within the four models.

Nature-based solutions (NbS) propose the maintenance of biodiversity conservation to mitigate climate change, with conceptual theories that are either inspired, supported, or copied from nature. Following NbS concepts, humans need to adopt a lower anthropological footprint and mimic natural solutions. NbS has a large thematic scope, covering topics that encompass ecological solutions and the coexistence of nature and humans. However, NbS proposals, as policies to promote human-nature systems (Eggermont et al., 2015; Nesshover et al., 2017; Van der Jagt et al., 2017) and degrowth economy (Savini, 2021; Mastini et al., 2021), have an elevated conceptualization of ideas (Pauleit et al., 2017). Global environmental agendas need actions for the accountability of

agreements - and these actions happen through the operationalization of NbS ideas through ecosystem-based adaptations, green infrastructures, and ecosystem services metrics.

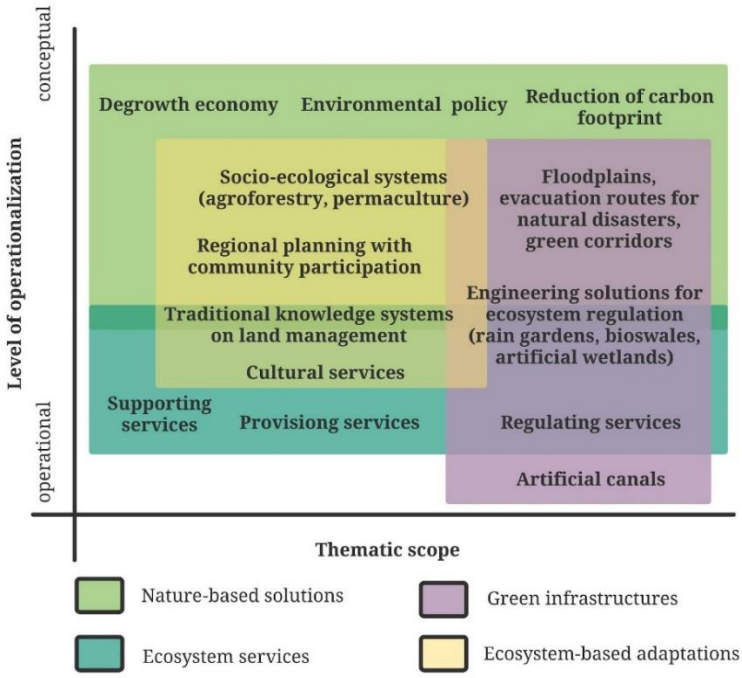

Figure 1. Level of operationalization in the 4SG model – adapted from Pauleit et al. (2017)

Ecosystem-based adaptations (EbA) are under the NbS umbrella, focusing on rural and forest landscapes. EbA promotes landscape adaptations for climate change, especially in restoring ecosystems through community knowledge systems. The initial application of EbA was for Global South economies, rural and forest communities, with the application of this model in regional planning. For example, EbA models can regulate traditional land use management, such as agroforestry (Vignola et al., 2015), *ayllu*

(Swiderska, King-Okumu, and Islam, 2018), and similar systems of non-surplus. The expected outcome of EbA goes beyond biodiversity conservation (the main focus of NbS), relying on a higher operational level of local knowledge systems and community participation. EbA models work well with local and regional communities, addressing the diversity of landscape values. Nalau et al. (2018) reviewed sixty case studies of EbA concepts in communities worldwide, concluding that application of knowledge systems counts with the participation of local leaders in the regulation of ancestral land-use practices, like crop rotation, rainwater harvesting, and traditional spiritual ceremonies.

In urban areas, green (trees, parks, bioswales, forest fragments) and blue (canals, artificial wetlands, floodplains) infrastructures can enhance and manage ecological processes and contribute to the public health of a larger population. Green infrastructures address areas with high population density and consequently the aggregation of resources. Green infrastructures have a high level of operationalization and create mosaics that combine both built and natural elements, using architecture, engineering, and landscape ecology concepts. Examples of green include green corridors, forest fragments, management of stormwater management, bioswales, floodplains, rain gardens, and artificial wetlands (Gordon et al., 2018).

There is a possibility for integrating EbA and green infrastructures in urban areas, considering cultural aspects of a local community through design and appreciation of traditional knowledge systems. The overlap of green infrastructures and EbA happens through ancient technologies with a lower footprint, such as aqueducts, rain gardens, and natural river dams, exploring traditional knowledge systems and engineering solutions.

There is a higher conceptualization in projects where the green infrastructures are green corridors implemented along urban, suburban, and rural areas to enhance biodiversity and facilitate wildlife transit. On the other hand, a bioswale in a sidewalk is a solution that uses more practical engineering techniques to reduce long-term flooding costs, capture stormwater, and diminish the risks of the flood - protecting humans and their properties. Indeed, green infrastructure overlaps with ecosystem services by regulating ecosystem functions, like local climate, air quality, water quality, waste management, erosion control.

Ecosystem services are natural benefits delivered straightforwardly to humans - a concept that started as a study from the United Nations to explore the recent ecosystem changes caused by humans (MEA, 2005). Ecosystem services are responsible for guaranteeing the ecosystem functions (soil formation, nutrient cycle), providing resources and raw materials (food, fibers), regulating the ecosystem design (climate, water, air, waste), and offering cultural services to support the socioecological expectations. However, urban areas have a higher anthropological influence on the landscape, impacting the availability and use of ecosystem services.

Green infrastructures and ecosystem services metrics are popular in Europe and the United States, leading to replication of projects in developing countries. However, in non-white communities of the United States, Europe, and the Global South, replicating green infrastructures and ecosystem services projects might not consider the local socio-ecological values. The richness of ancestral ecological solutions in societies labeled as vulnerable are excluded from traditional environmental conservation literature. Hence,

there is a disconnection between the expectations of environmental agencies that rely on traditional environmental conservation literature and the local socio-ecological knowledge and behavior on land use. In this dissertation, I explore semi-lost values from vulnerable communities for nature-based solutions in three independent papers.

3. Organization of dissertation chapters

Chapter 2, *Unfolding cultural ecosystem services from Black and Indigenous ancestrality for environmental planning,* is a conceptual paper that reviews Black and Indigenous values for cultural ecosystem services that are marginalized because they are not included in environmental conservation literature. Criminalization and acculturation impede the inclusion of specific cultural ecosystem services values in environmental planning and public policies. Omission and erasure of Black and Indigenous values related to medicinal plants, spiritual beliefs, traditional knowledge systems, and ancestral healing perpetuate environmental racism practices. As ecosystem services are a reference for landscape metrics in global environmental planning agendas, diverse values must be part of the conversation. Combining cultural ecosystem services and EbA is a path to introduce Indigenous knowledge systems on land management regulation.

Chapter 3, *Exploring urban mobility through interviews and social mapping in São Paulo*, is a case study that maps mobility for urban services in Sao Paulo, Brazil, through macro zones of vulnerability, ecological protection, and complete infrastructures. The macro zones are part of the Sao Paulo Strategic Master Plan that seeks the reduction of poverty, geological risks, and vulnerable housing. Green infrastructures, like parks, natural areas, bioswales, water canals, are part of Sao Paulo's master plan to mitigate

social and ecological risks. Through maps and interviews, I explored the relationship between humans and the expectations for land use in Sao Paulo Southern Zone. Sao Paulo Southern Zone bears macro zones of vulnerability and ecological protection, which is an interesting scenario to observe the application of nature-based solutions through green infrastructures.

Chapter 4, *Integrating Diverse Perspectives for Managing Neighborhood Trees and Urban Ecosystem Services in Portland, OR (US)*Portland, centered trees as green infrastructures that promote ecosystem services. Knowing that the urban tree canopy in Portland is concentrated in affluent areas of prominent geological formation, the analysis methods observed the statistical relationships between tree canopy cover, socioeconomic indicators (income, race, house ownership), and perception of ecosystem services through the city. I used an open-ended survey question to analyze the perception of ecosystem services (and disservices), creating space for popular knowledge systems and perspectives in environmental planning.

4. Frameworks of reimagination for nature-based solutions

Nature-based solutions include frameworks adopted by global humanitarian organizations and worldwide municipalities in environmental planning. However, traditional documentation for policy recommendations in green infrastructures and ecosystem services can exclude unheard communities because they rely primarily on values from environmental conservation literature. I am not the first to notice the exclusion of ethnic values, especially when using cultural ecosystem services as a metric in environmental planning.

Finney (2014) developed a framework of reimagination regarding the accessibility of African-Americans in outdoor recreational activities. Finney's framework of reimagination investigates the roots of the lack of Black representation in outdoor recreation. In the American context, the segregation roots are due to slavery, Jim Crow laws, and lack of Blacks in decision-making ecological agendas. Finney's framework of reimagination proposes that African-Americans reclaim natural spaces by bringing their knowledge, culture, identity, and interpretation of land use in green areas.

The purpose of this dissertation is to examine the possibility of expanding Finney's framework of reimagination to better align with Black and Indigenous identities in the American continent, including North, Central, and South America. I do so because they seem to convey the same roots of nature segregation caused by slavery, colonization, and genocides. After listing examples of criminalization, acculturation, and cultural appropriation of cultural ecosystem services values from Black and Indigenous communities, I suggested using frameworks of reimagination to rescue semi-lost values and reintroduce them in environmental planning. In the discussion, I compare the use of frameworks of imagination and ecosystem-based adaptations with radical proposals of excluding cultural metrics in landscape management or including new evaluation methods. Frameworks of reimagination applied to natural-based solutions expand the interpretation of landscape metrics value for Black and Indigenous identities and other unheard ethnic groups misjudged for keeping ancestral ecological practices in the Anthropocene.

5. Anthropocene and the extinction of experience

In the Anthropocene Epoch, humans are responsible for major and irreversible land changes; therefore, environmental ethics are constantly reviewed. Postmodern society's political, economic, and social aspects impact the interpretation of nature and expectations for natural environments. For example, the domestication of nature for food, minerals, and natural resources can reflect how humans are the central subject in the Anthropocene. Nature has geological forces, like waves, geysers, volcanos, storms, and earthquakes. Humans are rational creatures that developed technologies to normalize land changes for shelter, more accessibility to food, and comfortable modern lifestyles. The segregation from nature started as intimidation of natural forces (storms, fires, earthquakes) and led to domination - because humans as rational explorers can plan their actions on Earth. Rather than waiting for the next extreme natural event, humans adapt the physical landscape to maintain a more extended existence on the planet. After centuries of anthropogenic land change, greed and comfort became mottos for human existence. And if the Anthropocene is the culmination of irreversible land changes, today humans are concerned about the environmental changes because it can lead to their extermination. Thinking about environmental ethics that praise coexistence, solutions for climate change would come from non-segregation between humans and nature and non-segregation between humans.

The coexistence of humans and nature is the foundation of ecosystem services, such as clean air, clean water, flood control, natural resources, recreation, climate comfort, aesthetics, and spirituality. They are part of Earth's natural capital, and their

sustainability impacts the quality of life of present and future generations. Supporting, provisioning, and regulating ecosystem services refer to the physical balance of landscapes. In traditional environmental planning, scientists and policymakers use mostly quantitative analysis to monitor ecosystems by observing air, water, and soil quality. Environmental modeling can predict carbon sequestration per vegetation cover, soil response to natural disasters, and vulnerable areas to global warming. Cultural ecosystem services explore the socioecological impacts of landscape change and interpretation of nature values as natural and cultural heritage. In most urban environments, landscape change reduced human interactions with natural environments, causing the extinction of experience and missing values of nature (Soga and Gaston, 2016).

The *extinction of experience* (Soga and Gaston, 2016) happens in the Anthropocene due to a decrease in biodiversity, an increase in a sedentary life, and safety concerns. Observing the impacts of extinction of experience, Gaston et al. (2018) created the concept of personalized ecology, explaining that each individual has a single relationship with nature based on their background and life experience. However, nature also has a "reaction" when finding another organism. Therefore, the result of the encounter varies according to the intensity of the interactions and expectations for land use.

I expanded the concept of extinction of experience and personalized ecology to the context of Black, Indigenous, and Global South voices - their extinction of experience happened with slavery, colonization, and genocides before the Anthropocene epoch. The extinction of experience perceived as a burden in the 21st Century is an extra segregation

step that Black and Indigenous identities face regarding nature accessibility. Loss of land rights, traumas related to slavery punishment in the outdoors, and criminalization of natural entheogens are examples of extinction of experience in Black and Indigenous communities in the American continent explored in Chapter 2 of this dissertation.

In Chapters 3 and 4, interviews and surveys combined with GIS analysis supported personalized perceptions in landscape management, as proposed by the personalized ecology theory (Gaston et al., 2018). Intrinsic cultural ecosystem services values can be measured through qualitative analysis, as some cultural landscape aspects are difficult to measure through numbers. In participatory urban planning, mixed-methods approaches can communicate the population's needs on feeling accepted and connected in the urban space.

6. Positionality

Literature review in academia supports the finds of the research and avoids bias, but the scholar's motivations are printed on the dissertation DNA. As an AfroLatina exchange visitor scholar, my journey is also part of this dissertation. As my immigrant status states, I am an alien - someone who is not naturalized with the country that resides. Therefore, I have been inserted and actively participating in American society.

America, which leads to a common understanding of synonym for the United States, also means a continent that encompasses Latino identities. *Afrolatinida*des (IPEA, 2011) challenges traditional demographic values, advocates for indigenous land rights, and reclaims lost cultural values. *How many times could I not properly fill a demographic survey in the United States because my ethnicity is Latino but not Hispanic?* This fact

reflects an initial *Afrolatinidade* challenge: bring visibility to African-American Latinos. Today, I am an AfroLatina woman pursuing a doctoral degree.. When Chapter 2 highlights how traditional cultural ecosystem services for indigenous communities are marginalized and criminalized in Western society, I am bringing visibility to these identities in the American continent. Furthermore, I show that the criminalization and marginalization in cultural ecosystem services come from a broader segregation context.

Why are Afro-Brazilians segregated in their own country through the perpetuation of racist planning practices? This question displays a second *Afrolatinidade* challenge of overcoming segregation and participating in decision-making agendas in the American continent. In Sao Paulo, Afro-Brazilians and other vulnerable identities have less access to complete urban infrastructures, including green infrastructure. Segregation happens through race, income, and geography. Interviews and mobility patterns show that access to education and social resilience through the production of space are tools that populations in periphery zones explore to overcome segregation.

I am an Afro-Brazilian, dark-skinned, and I experience racial segregation in coexistence spaces during my youth in Brazil. Growing up in a middle-class family, I frequented coexistence spaces where several times I was the only Black person, or my family was the only Black family in the location. The presence of Afro-Brazilians in middle-class coexistence spaces brings an exchange of values, normalizing Black bodies, culture, and values in educational, recreational, and work environments. Through this dissertation and future scholarship, I want to normalize AfroLatino voices in academia and in environmental policy review.

Chapter 4 does not have the study area centered in Afrolatinidades but reflects the accessibility of ecosystem services through previous redlined regions of New Deal America due to the presence of African-Americans and immigrants. The chapter also discusses the expectations from neighborhoods with higher diversity towards cultural heritage in urban forestry.

This three-independent-paper dissertation has a modern and concise format that touches on topics I found relevant for my scholarship identity. My environmental ethics philosophy is expressed through recommendations to accept cultural ecosystem services values from Black and Indigenous identities. Methods exploring public input through surveys and interviews, spatial analysis, and the landscape interactions between humans and nature illustrated the case studies in São Paulo and Portland. Scholarship literature review, survey and interview coding, and spatial analysis are skills that I learned through this educational journey. My future scholarship starts from this dissertation base and expands to a path of policy-making, teaching, and constant review on environmental ethics. A conclusion chapter wraps the dissertation findings, reflects the lessons learned on the research process and explores future questions in socioecological systems. As mentioned, this dissertation developed skills and critical thinking; but there are more values to be explored and reclaimed regarding human-nature systems in urban environments.

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Chapter 2: Unfolding cultural ecosystem services from Black and Indigenous ancestrality for environmental planning

Abstract

This paper advocates for including Black and Indigenous cultural ecosystem services values as environmental planning metrics. Black and Indigenous communities had their interpretation of cultural ecosystem services (CES) compromised due to colonization, slavery, genocides, acculturation practices, and land segregation. CES provide metrics for assessing the effectiveness of urban environmental planning. The extent to which they incorporate perspectives from historically excluded ethnic groups are not just. I argue that doing so will improve the quality of programs and policies that seek conservation and preservation of the biophysical environment. The exclusion of ancestral Indigenous and Black CES in urban planning is well-established in the environmental planning literature. The insidiousness of exclusion opens space for the criminalization, marginalization, and erasure of Black and Indigenous practices in nature. In this paper, I propose a framework for reimagining ecosystem-based adaptations. Drawing on a review of ecosystem-based adaptations and frameworks of reimagination, I offer examples and directions for including missing Black and Indigenous values in environmental planning. Therefore, it becomes possible to avoid cultural appropriation and criminalization of specific CES practices. Ecosystem-based adaptations and frameworks of reimagination create means for addressing centuries of oppressive practices that have harmed communities.

Keywords: *environmental ethics, environmental justice, knowledge systems, spirituality*

1. Introduction

Ecosystem services (ES) is a well-established concept from environmental conservation scholarship and practice (MEA, 2005) that aims to designate, quantify, and classify nature's benefits to society. Municipalities worldwide use ES for environmental planning metrics (Krellenberg et al., 2021, Wilkerson et al., 2018), and scholars have explored ES values and costs (Szucs, Anders, and Burger-Arndt, 2015; Zoreder et al., 2015; Langemeyer et al., 2015; Stanik, Aalders, and Miller, 2018).

There are four major types of ES: a) supporting ES encompass the geophysical dynamics and natural interactions that support the existence of ecosystems; b) provisioning ES are natural products obtained from ecosystems; c) regulating ES are the interactions that maintain ecosystems and natural outcomes from best management practices; d) cultural ES are the interpretation of biophilia and intangible cultural resources from ecosystems. Intangible cultural resources are abstract concepts that bear complex anthropological metrics, such as spirituality, knowledge systems, and aesthetic values.

Cultural ecosystem services (CES) metrics situate norms, practices, and accepted behaviors that a community derives from nature. Often requiring a comprehensive analysis of the origins of specific classifications for culture, CES metrics in environmental planning can include regulation for recreation activities, like camping, hiking, hunting, horse riding) and landscape management for aesthetics. Many studies (Szucs, Anders, and Burger-Arndt, 2015; Zoreder et al., 2015; Langemeyer et al., 2015; Stanik, Aalders, and Miller, 2018) have explored the interpretation of CES for European

communities, while relatively few have applied this methodology for Black and Indigenous ethnic groups (Mowat and Rhodes, 2020, Pascua et al., 2017, Jaganmohan et al., 2018). Supporting, provisioning, and regulating ES often use quantitative indicators for soil quality, food production yield, water quality, and other commonly known environmental metrics to inform the physical conditions of an ecosystem. CES is rooted in cultural anthropology, social studies, and sociology that qualitatively assess humans' dependence on nature (Van Riper et al., 2017). Different groups that share the same ecological space can have different expectations based on their backgrounds, traditional behaviors, and familiarity with natural environments.

Perhaps due to the Euro-centric origins of ES, scholars in the field of CES had limited application to or interest in engaging with historically marginalized groups, including Black and Indigenous communities (Pascua et al., 2017, Jaganmohan et al., 2018). Moreover, without specific studies for evaluation of CES among such excluded groups, much of the known ways of nature interpretation rely on practices rooted in colonization, slavery, genocide, acculturation, and land segregation. The extant evidence also precedes present-day concerns about climate change, pandemics, and the extended inequality gap. These limitations, I argue, amplify harm to communities that have long-standing cultural practices that fall outside the dominant heteronormative, Euro-centric systems that have categorically dismantled ways of life that are in many ways sacred to Black and Indigenous groups.

2. Advocating for inclusion of Black and Indigenous CES in environmental planning metrics

Ecosystems services scholarship expanded worldwide, bearing metrics for environmental planning, biodiversity conservation, ecosystem restoration, and land-use management. Developing countries refer to international ecosystem services scholarship to mimic successful initiatives in ecological planning. For example, Brazil relies on international consulting to meet the conservational criteria of the Brazilian System of Protected Areas, a federal law that mandates strategic master plans for conservation units. A partnership between Brazil and Germany created and implemented forest management practices, including ecosystem services metrics in conservation units. For the Amazon rainforest, thirty-four insightful publications recommended best forest management practices, forest economy metrics, and community engagement strategies (MMA and GIZ, 2015). The documentation used the ecosystem services framework to address the conservation goals.

Other countries have adopted ecosystem services metrics in environmental planning in the Global South. African nations that rely on United Nations humanitarian support use ecosystem services and ecosystem-based adaptations as management models to mitigate climate change and promote biodiversity conservation (UN Environment Programme, 2017; Swiderska, King-Okumu, and Islam, 2018). The humanitarian support from developed countries can adapt metrics to meet the social and ecological needs of the population. Still, the realm of cultural ecosystem services has complex metrics which often exclude Black and Indigenous values.

Latin American countries suffered European colonization and the Black diaspora in the American continent started with slavery. Consequently, colonization, slavery, and genocides generated a historical trauma where cultural values were lost or semi-lost. DeGruy (2005) defines the post-traumatic slavery syndrome as an intergenerational trauma that Blacks experience over time with the perpetuation of structural racism. Centuries of oppression, human trafficking, and torture developed stressed behaviors for self-preservation and survival—the lack of reparation measures for post-slavery caused segregation and exclusion. In the Native American community, attempts for inclusion failed through boarding schools and inequitable land management (Belanger, 2020).

The segregation in Western society reduced representation in decision-making systems, such as environmental planning agencies. Environmental racism is the spatial mismatch between people of color and ecosystem services (Pulido, 2016). Clustering landfills, waste facilities, and highways in non-white geographies bring limitations for nature accessibility. To address these limitations, this paper frames practices of criminalization, acculturation, and cultural appropriation of ecological practices in Black and Indigenous groups.

2.1 Criminalization, acculturation, and cultural appropriation of cultural ecosystem services values in Black and Indigenous communities

Criminalization relates to practices or activities categorized as a criminal offense resulting in incarceration or legal penalty. Black and Indigenous people have been arrested or murdered by vigilantes for maintaining cultural-ecological practices, as recreational activities, spiritual rituals, and believing in sacred nature values.

Acculturation is the process of assimilating a unique culture to a dominant culture. Acculturation leads to generalization and erasure of values through time to *fit* in a dominant culture. Cultural appropriation is the adoption of values from unique cultures without proper acknowledgment or context. For example, cultural appropriation can happen with commercializing spiritual practices from a minority group by a larger ethnic group.

This study explicitly points to CES's criminalization, acculturation, and cultural appropriation problems that reflect inequitable environmental planning practices. I list CES that have been historically excluded in conservation practices and the consequences in environmental planning. Municipalities have used ecosystem services metrics (Krellenberg et al., 2021, Wilkerson et al., 2018, MMA and GIZ, 2015) to measure environmental justice goals. Therefore, it is important to discuss the possible implications of Black and Indigenous CES values resulting in crimes, acculturation, and cultural appropriation. If not discussed, criminalization, acculturation, and cultural appropriation will keep existing with the endorsement of governmental agencies.

This paper proposes an unfolding framework to identify semi-lost cultural ecosystem services in the American continent. Despite the diversity of Black, Indigenous, and AfroLatino groups in the Americas, they share slavery and colonial traumas that lead to ecological segregation from ecosystem services. The specific objectives of the unfolding framework are to a) normalize Black and Indigenous values marginalized in environmental planning scholarship, b) create an inclusion framework with reimagination to sustain discussions on the normalization of Black and Indigenous CES values; and c)

list and explain examples of criminalization, acculturation, and cultural appropriation to avoid the perpetuation of these practices in environmental planning.

2.2 Scholarship critique on cultural ecosystem services

Searching on major databases of environmental sciences (EBSCO Environmental Complete, ProQuest Agricultural and Environmental Science Collection, BioOne Complete, JSTOR), I did not find a study that used the proposed unfolding framework lists criminalization, acculturation, and cultural appropriation practices in environmental planning in the American

context of post-colonization and slavery. Instead, I found studies that pointed out criminalization on traditional practices of land management, such as Inuit food harvest (Snook et al., 2020), pasturing in Maghreb (Davis, 2004), and human-wildlife conflicts in Ghana (Ayivor, Nyametso, and Ayivor, 2020). The case studies explained how the criminalization of land management practices affects specific groups to have access to food, ancestral values, and spirituality.

I also found articles critiquing the massive representation of European and North American authors in ecosystem services scholarship (Milcu et al., 2013). The recommendations for researchers and managers are to include and identify diverse perspectives when creating policy based on ecosystem services metrics (Van Riper et al., 2017).

Kirchhorf (2019) suggested the abandonment of cultural ecosystem services concepts, arguing that the model does not cover the diversity of anthropological values in nature. According to Kirchhotf (2019), the current metrics consider individual

preferences, the model is rooted in scientific imperialism, and the term *cultural* is too broad to measure the intrinsic values of ecosystems. Agreeing with Kirchhorf, I add that the current evaluation of CES does not share significant values presented in Black and Indigenous communities. The consequences are criminalization and marginalization of certain socio-ecological cultural values.

Another critique of current scholarship suggests shifting from cultural ecosystem services to relational values (Chan et al., 2016). Relational values represent a collective perspective on socio-ecological systems instead of personal intrinsic values. Or the singular evaluation of natural values considering cultural externalities, as the sense of justice, belonging, and place. Coelho-Junior et al. (2021) conducted a case study in the Atlantic Forest of Brazil, observing public perceptions of socio-ecological values on environmental planning. The results indicated preferences for relational values that translate collective memories, behaviors, and willingness to perpetuate ecosystem services for future generations. Understanding the importance of combining relational values to evaluate ecosystem services, I unfold collective values of Black and Indigenous communities marginalized in environmental planning.

Turning cultural ecosystem services as metrics for environmental planning excludes identities that do not share the Western-centered vision of aesthetics, recreation, spirituality, and other intrinsic nature values as semi-sacred benefits. The frontier myth (Turner, 1935) explains the Western feeling of exploring an intangible land, facing wilderness, and changing the socio-ecological dynamics of Black and Indigenous societies, as happened in colonization and slavery. The concept of *settlement*,

expeditions, and discovery erases previous existing values. The frontier ignores the culture of indigenous communities, forcing adaptation to a new tradition so that white men can dominate the land and resources. Yet, the frontier is tied to masculinity, individualism, and moral values, implying wilderness is associated with physical strength, quietude, loneliness, and confidence. In this way, the wilderness ends up as an unattractive space for women, people of color, queer folks, people with disabilities, and other non-white male heteronormative identities.

Cultural ecosystem services metrics are problematic because the conceptualization of nature uses similar values encountered in the frontier myth. However, I disagree with the abandonment of CES metrics proposed in the current political ecology scenario. Cultural ecosystem services are existing metrics on international environmental planning documentation (Krellenberg et al., 2021, Wilkerson et al., 2018, MMA and GIZ, 2015). Therefore, I suggest the unfolding framework to review the current values and start a dialogue on flexibility, adaptation, and inclusion of semi-lost cultural values in environmental planning metrics.

Environmental conservation literature suggests an interdisciplinary approach between socio-ecological systems, focusing more on the diversity of natural landscapes than human diversity. The environmental justice movement broadly explores the concept of intersectionality (Crenshaw, 2017) to meet the ecosystem services available according to the needs, burdens, and privileges of groups based on their social identity, such as gender (Mortimer-Sandilands and Erickson, 2010; Hoover, 2018; Ducre, 2018), race (Pulido, 2016; Ducre, 2018), age (Schwartz et al., 2015), ethnicity (Hoover, 2018, Carter,

2014), class (Costa, 2020), mobility (Karner and Duckworth, 2019), among others. There are three waves in the environmental justice movement, starting with first-generation scholars focused on case studies of contamination sites, environmental risk tracking, and ecological reparation measures (Gibbs, 2010; Turner, 2014). The second wave of EJ scholars separated the movement into particular causes, such as food justice, public health in incarceration facilities, transit accessibility, waste management, air pollution, and other environmental issues. The autonomy of the new studies converged the minds of experts in food, transit, urbanization, public health with the much-needed justice change in multiple sectors. The interdisciplinary approach in environmental justice led to the final ripple of intersectionality with political ecology challenges. This fact pushed scholars to connect former social justice issues with the impact of urgent ecological disturbances on specific group identities.

Recent studies framed environmental racism in the Flint water crisis (Pulido, 2016), the imposition of federal land-use management over tribal ancestral traditions (Ranco et al., 2011, Hoover, 2018), and disaster management response (Turner, 2014) - these justice claims are related to regulating ecosystem services. With the unfolding framework for cultural ecosystem services, I want to introduce a path for arguing injustice environmental planning practices on cultural ecosystem services metrics. Pascua et al. (2017) created a framework to incorporate Native Hawaiian cultural values in local environmental planning, including spirituality and knowledge systems. Ducre (2018) and Finney (2014) inspired me to follow a path of reimagination of behaviors in nature, highlighting how Black and Indigenous values are excluded in environmental planning

metrics. I argue the excluded values are also criminalized and marginalized through acculturation and cultural appropriation. Strategies for inclusion (Pascua et al., 2017) are essential in environmental planning, and I point out the origins of exclusion and acts of normalization of marginalization. I frame the problems using criminalization, acculturation, and cultural appropriation to cultural ecosystem services values to avoid perpetuating white supremacist practices in environmental planning metrics. For example, African-Americans barely have their culture, behavior, and values associated with the outdoors due to the perpetuation of exclusively white values and behaviors on outdoorsy sports and activities, like skiing, hiking, and mountaineering (Finney, 2014). The lack of normalization of Black bodies in nature leads to fear and criminalization of their reclaimed spaces, with governmental agencies defunding environmental budgets and reducing green infrastructure management (Brownlow, 2006).

In the Anthropocene, the intense urban and industrial landscape change generates a loss of ecological values. Soga and Gaston (2016) name this process the *extinction of experience*. The lack of familiarity and contact between humans and nature results in the loss of traditional ecological elements that were once intrinsic values on socio-ecological relationships (Soga and Gaston, 2016; Gaston et al., 2018). I argue that Black and Indigenous communities already witnessed the extinction of experience through colonization, slavery, and genocides. Today, the Anthropocene and racist environmental planning practices amplify intergenerational traumas from the historical extinction of experience in Black and Indigenous communities. Therefore, without the proper inclusion of diverse cultural ecosystem services values in environmental planning, future

generations will not experience ancestral nature practices (acculturation), or descendants can suffer from cultural appropriation and criminalization of specific practices.

Navigating through the current scholarship critiques on cultural ecosystem services and environmental planning, I did not find a study that individually pointed out repetitive criminalization, acculturation, and cultural appropriation practices on different classifications of cultural ecosystem services. I also did not find studies that created a framework to list and explain the marginalization of cultural practices in Black and Indigenous communities in the American continent. Thus, this paper contributes to the cultural ecosystem services and environmental justice literature. My goal in this paper is to a) support the current critique of cultural ecosystem services, b) expand the intersectionality lens of environmental justice to environmental planning metrics, c) combine the diversity of ecological values with anthropological values in environmental planning, d) normalize cultural plurality in environmental planning, e) support reimagination of socio-ecological values from the perspective of AfroLatino scholarship, and consequently f) empower AfroLatino scholarship in environmental planning.

After unfolding criminalization and marginalization practices towards cultural ecosystem services, I discuss alternatives for including the semi-lost values in environmental planning. The strategies are the reimagination of values in cultural ecosystem services (Finney, 2014) and ecosystem-based adaptations (Nalau et al., 2018), which consist of local management of socio-ecological systems. To resolve, I reflect on how diversity and inclusion in environmental justice practices can enhance the comprehension of semi-erased.

3. Unfolding criminalization, cultural appropriation, and acculturation

The extinction of experience during the Anthropocene created awareness for preserving the remaining ecosystems - which relies on law regulation for land use control. Environmental justice movement and environmental conservation scholars support the decision-making process in environmental planning with studies that explore human-nature interactions, access to ecosystem services, and the protection of natural resources. Environmental planning agencies can regulate the accessibility and control of natural ecosystems that provide ES for the population. When environmental studies do not explore the intersectionalities of CES within Black and Indigenous groups, these identities can have ancestral practices treated as a crime or misinterpretation. Respectively, these are cases of nature criminalization and cultural appropriation/acculturation.

For this study, I selected four cultural ecosystem services that are quite distinctive from each other: a) recreation, b) aesthetics, c) knowledge systems, d) and spirituality. Recreation is the most explored concept in CES literature, but mostly in white American or Euro-centered contexts (Szucs, Anders, and Burger-Arndt, 2015; Zoderer et al., 2015; Langemeyer et al., 2015; Stanik, Aalders, and Miller, 2018). It is necessary to explore specific values of cultural ecosystem services, as besides recreation, they are set in a bundle without proper disclosure of cultural, social, and economic values (Constanza et al., 2021, Hernandez-Blanco et al., 2020). Therefore, I continued the CES list with aesthetic values associated with landscapes' harmony, balance, beauty, and symmetry. Landscapes that resemble elements of Black identities are often underrated. Knowledge

systems rescue ancestral nature lessons that are mostly not present in academia, not institutionalized, and on several occasions not documented. When intergenerational verbal communications about knowledge systems are not presented in Western scholarship, environmental planning agencies can question the validity of the methods. However, the publishing process of non-academic knowledge can result in acculturation and cultural appropriation. Finally, spirituality values reveal practices maintained through verbal language, ancestrality, and supernatural experiences. I created Table 1 to describe the four unfolded CES and explain the definition of criminalization, cultural appropriation, and acculturation in this context. I use the words criminalization, acculturation, and cultural appropriation because they are the consequences of environmental racism. Listing and providing examples of criminalization, acculturation, and cultural appropriation is an initial step to reclaim semi-lost values and avoid perpetuating environmental racism.

Cultural ecosystem services (CES)	**Description and examples of CES**	**Example of criminalization of Black and Indigenous CES**	**Example of cultural appropriation and acculturation of Black and Indigenous CES**
Recreation	Enjoyment in nature through activities that support human-nature interaction e.g., sports, trails, nature watching, camping	Violence and non-acceptance of Black and Indigenous bodies in nature	Capitalization and elitism in Black and Indigenous recreational traditions
Aesthetics	Pleasant landscapes that harmonize physical and biological components of an ecosystem e.g., scenic roads, ancient natural monuments, green infrastructures	Association of crime to landscape aesthetics of Black and Indigenous neighborhoods	Lack of aesthetics diversity in natural monuments and green spaces protected by law

Knowledge Systems	Lessons from nature that educate society to improve life quality and promote wellbeing e.g., ethnobotany, medicinal plants	Persecution and prohibition of entheogens for and from Black and Indigenous identities	Regulation and acceptance of ancestral knowledge only through Western values and parameters
Spirituality	Connection with natural elements to promote inner peace, self-knowledge, and discovery e.g., ancestrality, rituals, biophilia	Violence and punishment to Black and Indigenous for relying on ancestrality	Accommodation of ancestral Black and Indigenous spirituality to Christianity

Table 1. Description of cultural ecosystem services meanings and implications of nature criminalization, acculturation, and cultural appropriation in Black and Indigenous communities

3.1 Nature criminalization

Nature criminalization happens through the prohibition and regulation of entheogens, non-mainstream land-use behaviors, and spiritual practices. In postmodern democratic societies, law enforcement agencies should defend a non-secular and equitable state. However, the current nature criminalization of entheogen substances, cultural landscapes, and expected behaviors in nature occur due to a misinterpretation of cultural ecosystem services and who has access to them. Law enforcement and environmental agencies mostly used interpretations, expectations, and acceptance of nature access based on whiteness. The following subsections provide examples of nature criminalization in recreation, aesthetics, knowledge systems, and spirituality towards Black and Indigenous identities. The examples originated from recent news observations, participation in public policies events, personal experiences, and literature review on case studies.

3.1.1 Nature criminalization in recreation

At the beginning of the COVID-19 pandemic, Ahmaud Arbery, a 25-year old Black man, went for a jogging run on a high canopy street in Glynn County, Georgia. He was chased and shot by three white men who did not accept Black men running in nature. In Brazil, a country with half of the population descended from the Africa diaspora, there is a racist saying:

"Branco correndo é atleta, negro correndo é bandido"	"a white person running is an athlete, a Black person running is a criminal"

Black people can fear for their lives while going for a jog in nature surroundings. In the wilderness, the perpetuated scenario of the frontier myth, the risks are higher. When Black people go together (for their safety) for a hike, non-Black hikers would ask:

"Are you all from a church group?"

Why can a Black group in nature not be associated with adventurers, explorers, people with fitness lifestyles, or environmentalists? Why are wilderness spaces of adventure generally associated with ownership for white straight men? How can non-white and non-male identities reclaim and reimagine their values in recreation? These inflated questions reflect the lack of normalization for minority individuals accessing recreation services.

Criminalization might not be associated with committing a crime, but Western society fears and biases Black and Indigenous accessibility to nature as a crime or a

potential crime. The lack of normalization of non-white bodies in nature can lead to police brutality, vigilant brutality, and segregation. For example, in Rio de Janeiro, Brazil, the historical classism sets the accessibility to the recreational sites of Zona Sul - a traditional wealthy and touristic area of the city. Native residents from Rio de Janeiro can feel intimidated to access recreation sites due to *social apartheid* that excludes individuals based on their race and income. Excessive police and militia brutality towards poor Afro-Brazilian folks generate fear in recreation sites. Exorbitant prices for goods and services in tourist areas are evidence of social inequality. The contrast between luxury apartments and favelas on the beachfront illustrates the sense of non-belonging of Afro-Brazilians folks within their city (Costa, 2020). Nature criminalization for recreation works as a structure of power and belonging, translating that those who have access to this CES are superior in social *apartheid.* Figure 1 illustrates the case of Mateus Ribeiro, a Black surfing instructor, was falsely accused by a white couple of stealing an electric bike in Zona Sul of Rio de Janeiro. Blacks are not expected to own complex recreational gear in traditionally white recreational spaces (Geledes, 2021).

Figure 1. A case of criminalization of recreation in Rio de Janeiro, Brazil (Geledes, 2021)

The historical exclusion of Black identities in recreational sites contributed to civic intolerance of non-whites in recreation in locations where African diaspora happened. For example, in Rio de Janeiro, racial segregation follows geographic segregation between favelas and luxury apartments. Both locations can share beachfront views, but only whites identities are normalized on the beachfront spaces as recreational users. If a Black person is in a recreational space, their expected roles are servers or criminals instead of recreationists.

In Los Angeles, Willa and Charles Bruce had their Black-owned beachfront resort shut during the Jim Crow era (Jefferson, 2015). Their resort was an alternative space for swimming and celebration without fear of white supremacists. However, Manhattan City officials announced the resort needed to be shut for a park location. Despite the current conversations on reparations for Bruce's family descendants (NPR, 2021), the initial displacement diminished the possibilities of diversity in recreational spaces over the past century.

Racial conflicts in urban recreation areas happen with disputes for land use, white fear of demographic change, and disagreements on cultural heritage values and behaviors. Examples of cultural clashes are visible in community events, school systems, and commercial venues with the increase of ethnicities that do not have standard fluency in English and work in low-skilled jobs than the traditional white norms (Frey, 2015). These struggles are barriers to acceptance in recreation, which constitutes activities that bring joy and explore biophilia. Fear, insecurity, and trauma triggers are the opposite of recreational values.

The extinction of experience between humans and ecosystem services (Soga and Gaston, 2016) is a consequence of urbanization and land change. Rural and forest environments have more natural ecosystems, therefore, more outdoor recreation availability. However, forestlands and farmlands recreation practices are not always related to cultural ecosystem services that support environmental conservation. For example, case studies have explored the land conflict between motor vehicles recreation practitioners and land conservation advocators (McLain et al., 2017, Rosenbaum, 2013, Asah et al., 2012). Some groups believe that jeeps and off-highway vehicles are ways to explore adventures in nature and build values and experiences in recreation. Other groups complain that the noise and pollution from motor vehicles can disturb wildlife and create an unsafe environment for other recreationists.

In the United States, nonwhite ethnic groups have a lower representation in rural and forest environments. Overall, white identities comprise nearly 80 percent of the rural population and 58 percent of the urban population (USDA, 2018). In rural counties, the lower diversity allows heteronormative whiteness to erase and threaten the experience of queer identities who suffered violence and exclusion (Abelson, 2016). Case studies explored social issues with major Latino and Black communities in rural areas. For example, in Tulare County, CA, Mexican migrant farmworkers reported that the children do not have fair access to recreation. Playing outdoors is unsafe due to pesticide contamination or lack of playground areas (Schwartz et al., 2015). Parents concern about their homes being close to containment agricultural lands, pesticide application in proximity to schools, lack of environmental recreational areas for children, and air

quality, despite the struggles to access healthcare. Black identities in the rural South can bear landscape memories associated with slavery, segregation, and violence instead of only positive recreation and ownership experiences (Finney, 2014).

3.1.2 Nature criminalization in aesthetics

In the Southern Zone of Rio de Janeiro, the city's geography serves as boundaries to delimitate perceptions of class, sense of belonging, and social acceptance. The luxury apartments near beaches, natural areas, and touristic sites set the dress code, price, and social acceptance in recreational sites. The favelas are in the hilly regions and bear great ocean views from a further distance. The elites are the center of cultural services with instant access to upkeep aesthetics, defining the boundaries of *accepted and unaccepted geographies.*

Despite the scenic view, favelas, low-canopy areas, neighborhoods close to Superfund sites, and locations not in elite geographies might not represent aesthetic values from traditional environmental planning perspectives. These areas are more likely to associate crime and lower land value. Vulnerability indicators can be a synonym of socioeconomic divestment from governmental agencies. In the United States, several disinvested areas were former redlined districts (Digital Scholarship Lab, 2021). For example, the Fairmount Park System of Philadelphia, located between greenlined and redlined zones, registered increased crime, community fear of public green spaces, and reduced management budget with the shift in racial demographics. The maintenance budget left the park system along with white residents. The resulting overgrown

vegetation and vandalism diminished the potential for aesthetic values (Brownlow, 2006).

Presence of street tree canopy and tree crowns with proper pruning can reduce the crime rate. For example, a study in Portland, OR, concluded that criminals assume people appreciating traditional aesthetics can be eyewitnesses (Donovan and Prestemon, 2010). Therefore, criminals avoid neighborhoods with traditional upscale landscaping and pruned trees. Tree maintenance, including pruning and leaves removal, does not offer visual obstruction in single-family housing. Knowing that tree maintenance can be a financial burden in Portland (Alves Carvalho Nascimento and Shandas, 2021), white and affluent neighborhoods can be less likely to have high crime rates. Nationwide, non-Hispanic white and affluent neighborhoods have disproportionately more canopy and access to nature than areas with lower-income and more diverse populations (Schwarz et al., 2015). Standardization for aesthetics can segregate vulnerable groups from cultural ecosystem services and generate a sense of criminalization to areas that cannot afford canopy maintenance.

3.1.3 Nature criminalization in knowledge systems

Knowledge systems promote well-being by perpetuating cultural ecosystem values within a community. For example, ethnobotany explores education values from the ecosystem, which sometimes are only available through local experiences and intergenerational storytelling. Thence, regulation agencies for land management can exclude and criminalize knowledge systems from identities not included in scientific literature.

Entheogens are natural substances, mostly plants (cannabis, peyote, coca leaves, ayahuasca), animals, fungi, and natural chemicals. In Western society, these substances are primarily seen as recreational drugs and targeted in the drug war (Blainey, 2015). However, these entheogens can build community bonds, serve as natural medicine, heal intergenerational trauma, and support religious rituals (Blainey, 2015). Unfortunately, with the criminalization of knowledge systems, Black and Indigenous folks are stigmatized for using entheogens, experience police brutality, and get arrested in a higher percentage for entheogen possession than white users.

Even when governmental agencies accept knowledge systems, there are few reparations to previous system transgression. In the example of the legalization of cannabis, many who were previously providing access cannot join the billionaire industry due to previous arrests and criminal backgrounds (Harris and Martin, 2021). Reparation measures are necessary to include knowledge systems through entheogens substances. Reparations can include dropping charges for minor drug possession, reducing police racial persecution, and reintegrating people seeking psychedelics access (Oregon, 2020, Dilley et al., 2017, Harris and Martin, 2021).

3.1.4 Nature criminalization in spirituality

Spirituality is a CES with intrinsic, personal, and subjective values that challenge traditional academic concepts. The validation of spirituality can occur with experiences that bring transformation to the inner-self, community development for spiritual support, and supernatural sensations. In general, communities surrounding nature have a higher sense of spirituality, reducing the influence of modern technology. Colonization, slavery,

and genocides judged spirituality and assaulted the spiritual knowledge and technology of Black and Indigenous in the American continent.

In 2014, while visiting the rocky, hilly, and earthy landscapes of the Sacred Valley of the Incas in Peru, I saw ruins of stone houses, sustainable irrigation systems, and ancient rocky foot trails in Pisaq. Ollantaytambo is an ancient city in the middle of the mountains with a god representation carved in rock (Figure 2). The archeological site bears structural pillars established on a deadly cliff, monuments with rectified stones, and a trail system connecting with other parts of the Inca civilization. Surprised with the impossibility of that architecture, a local Inca guide told me one unforgettable sentence:

"Cuando llegaron los españoles, nuestra gente dijo: démosles todo el oro, pero no les demos nuestra tecnología."

"When the Spanish arrived here, our people said: permit them to access the gold, but not our technology."

Figure 2. Ollantaytambo, an ancient city in the Sacred Valley of the Incas.

In the modern world, mysteries from ancient architecture are still unknown, such as the foundations of the Inca civilization, the Egyptian pyramids, and the Rapa Nui

statues. These structures likely explored spiritual technology that relies on knowledge systems and aesthetic forces to design infrastructures.

The violence that Black and Indigenous groups suffered through colonization and slavery impacted their future generations. Indigenous groups struggle to have land rights to maintain original ecosystems; 40% of environmental activists murdered in 2019 belonged to Indigenous communities (Global Witness, 2020). Slavery practices prohibited and persecuted descendants of the Africa diaspora from practicing their spiritual rituals. The spiritual centers and practitioners that perpetuated ancestral faith are constantly victims of racism and religious intolerance combined (Mahoche, 2021).

3.2 Cultural appropriation and acculturation

Cultural appropriation and acculturation are consequences of colonization and slavery that repressed Indigenous and Black cultural practices in society (Jackson, 2021). Therefore, reviewing cultural appropriation and acculturation is relevant to unfold cultural ecosystem services values properly.

Cultural appropriation happens when an empowered ethnic group uses cultural elements of an oppressed ethnic group out of context or cultural meaning (Jackson, 2021). For example, dreadlocks are part of several cultures, such as Rastafari. Black Rastafaris can suffer discrimination for using dreadlocks, implicating their ability to find jobs, being misjudged by authorities, and not fitting into socially accepted aesthetics. Dreadlocks inside a whiteness context miss the association with Rastafari culture and eliminate the social prejudice.

In cultural ecosystem services, acculturation happens through the erasure of ancestral values that differ from the culture that colonized them. Boarding schools for Native Americans are an example of acculturation, as they proposed the erasure of traditional behaviors and cultures for integration on Western society through an education system.

The following subsections will review cultural appropriation and acculturation in cultural ecosystem services.

3.2.1 Cultural appropriation and acculturation in recreation

Before colonization, Indigenous communities were fishing, *camping*, building trail systems, hunting, and foraging in original ecosystems. The concept of Western recreational activities mimics Indigenous traditions. However, Indigenous groups were displaced, killed, tortured, and acculturated to place recreational sites and other developments. For example, industrial installations diminished Mohawk tribes' recreation rights due to pollution in local rivers. Fishing is an activity that supplies multiple ecosystem services for Mohawks, such as food, spirituality, cultural heritage, and recreation. Pregnant Mohawk women have their traditional diet compromised without proper access to fish; fathers are discouraged from fishing in polluted waters; and intergenerational storytelling activities of tying nets weakened among the community (Hoover, 2018).

Another barrier to access recreation values is classism. Outdoor recreation sites have accessibility regulations (limited hours, limited capacity, fees) to minimize the impacts of the anthropological activity. These sites are often further from urban centers,

public transit, and within rural or forest zones with a majority white population (USDA, 2018). Black families are more likely not to have access to a car when compared to white, non-poor, and US-born (Klein and Smart, 2017).

Outdoor recreation activities build memories, connections with a place, and a sense of ownership. However, the segregation from recreation services diminishes memories, experiences, and cultural values, leading to exclusion and acculturation.

3.2.2 Cultural appropriation and acculturation in aesthetics

Prominent landscape sites, such as Yosemite, Grand Canyon, and Yellowstone, enhance aesthetic values. In the famous essay *The trouble with wilderness*, Cronon (1996) questioned why vast areas of grasslands are not traditional candidates for national parks. Although biodiversity, stratification, and geological formation are essential criteria for choosing a preservation area, extravagant sites can have accessibility barriers. Kirchhorf (2019) mentioned that aesthetic values could be as simple as observing wildlife and natural landscapes, and the current scholarship might not recognize simplicity in aesthetics.

Worshiping extravagant wilderness sites is reminiscent of the frontier myth, implying the conquest of complex landscape aesthetics. Historically, *settlements* and *discovery expeditions* extinguished Indigenous values for aesthetics, as observed in Mount Everest and Mount Rushmore. Mountaineers worldwide spend fortunes to challenge themselves to reach the top of Mount Everest, bringing a land-use conflict with the local Sherpa community that believes Sagarmatha is a sacred landscape (Mu, Nepal, and Lai, 2019). Similarly, Lakota Sioux tribe members face the symbolism of the white

freedom of Mount Rushmore carved on the sacred Black Hills (Belanger, 2020). Changing mountain names and values is an example of cultural appropriation and acculturation in aesthetics.

In urban green spaces, acculturation of aesthetic values happens through green infrastructures. A potential negative impact of green infrastructures can be green gentrification, with greening strategies enforcing displacement through increased property values (Gordon et al., 2018). In addition, if not respecting knowledge systems design, green infrastructures can use a repetitive architecture that causes placelessness - a sense of non-belonging and loss of aesthetic values (Relph, 1976).

3.2.3 Cultural appropriation and acculturation in knowledge systems

Maria Sabina, a *curandera* from Sierra Mazateca in Oaxaca, Mexico, was a pioneer in the contemporary use of entheogens, such as psilocybin mushrooms. She shared ancestral Mazatec practices and knowledge in ethnobotany and the use of entheogens. The merge of Western and Mazatec cultures in the comprehension of psilocybin had illuminated psychedelic science studies but resulted in cultural appropriation of Mazatec values (Dawson, 2015). Cultural appropriation is a persistent problem in knowledge systems because Western medicine sets rules for dosage, and law enforcement regulates cultivation and commercialization. Regulation of commercialization and accessibility to entheogens can have a higher cost and exclude populations from their own traditional medicine.

Ancestral knowledge systems also apply to ecosystem management, allowing hereditary values for land management that mitigate land degradation. For example, in

Spring Mountain, Nevada, Nuwuvi's practices for wildfire prevention that used patch burns, fuel reduction, and protection of fire-resilient trees had been more effective than the recommendations from the US Forest Service. Adopting ancestral land management practices into contemporary land-use planning can incorporate traditional knowledge systems values (Spoon et al., 2015).

3.2.4 Cultural appropriation and acculturation in spirituality

Colonization and slavery demonized spiritual practices that differed from Christianity. Recently, Catholic leaders have supported environmental rights and political activism in Amazon (Espinosa, 2015), but historically, several Christian missions promoted spiritual acculturation and genocides. Thus, religion can merge into politics, cultural norms, and environmental regulations, facilitating social control through acculturation and criminalization.

Afro-Brazilian religions, such as Jurema Sagrada, Umbanda, and Candomblé, explore spirituality through natural elements and ancestral values. Without preserving nature and accessibility to plants, animals, waterfalls, and beaches, there is no connection between the practitioners and the ancestral spirits - called orixás (*orishas*). According to the Brazilian Census (IBGE, 2010), 0.3% of the population identifies as Afro-Brazilian religion practitioners. A private demographic institute estimated that practitioners correspond to 2% of the population (DataFolha, 2020). There is an estimated increase of over 500% in adepts in 10 years, and some studies predict a higher percentage of practitioners. Because of the extensive history of discrimination toward Afro-Brazilian

religions, some practitioners would not declare their faith as this identity can impact their sense of social belonging in white cultures (Mahoche, 2021).

Candomblé, umbanda, and jurema sagrada provide services for communities through natural medicine, herbal baths, and teas. The *terreiros* are often open and welcome people from other religions. Treatments for insomnia, depression, chronic pain, and inflammation are available free or at a low cost (Braga et al., 2018). People seeking spiritual treatments are often deluded by Western medicine doctors, without access to public health, or practitioners of Afro-Brazilian religions.

The perpetuation of ancestrality in Afro-Brazilian religions happens through oral tradition, spiritual experiences, and spiritual mentoring. However, neo-charismatic church leaders use books, television, radio, and other media sources to reframe Black spiritual values. Furthermore, neo-charismatic leaders promote acculturation through defamation, intending to erase traditional spiritual values using mass media. Despite the religious intolerance, neo-charismatic churches include common spiritual practices from Afro-Brazilian religion in their ceremonies, such as spiritual incorporation (Barbosa, 2010; Silva, 2007).

4. Integration of lost CES values in environmental planning

The previous section unfolded criminalization, acculturation, and cultural appropriation in cultural ecosystem services towards Black and Indigenous groups. Radical scholars suggest the exclusion of cultural ecosystem services concept can avoid burdens in vulnerable and misrepresented groups on environmental planning and failing metrics for cultural values (Kirchhoff, 2019). Other scholars propose using relational

values to expand ecosystem services evaluation and suggest integrated landscape management (Pascua et al., 2017, Chan et al., 2016, Coelho-Junior et al., 2021). After unfolding the marginalization of cultural ecosystem services values, I propose two alternatives for continuing cultural ecosystem services in environmental planning: ecosystem-based adaptations (EbA) and frameworks of reimagination. The following subsections will review possible applications of EbA and reimagination through case studies and concepts of reimagination.

4.1 Ecosystem-based adaptations

Environmental planning agencies, such as the United Nations Environment Programme, recognize the use of EbA in association with ecosystem services and green infrastructures to mitigate climate change using a people-centered approach (Pauleit et al., 2017). Applying EbA to integrate cultural ecosystem services in environmental planning has the advantage of considering the social-ecological values of the studied community. Environmental planning in modern society represents anthropocentric and weak-anthropocentric views exploring the domestication of resources and the protection of ecosystem services for the perpetuation of humans (Norton, 1984, Epting, 2017). On the other hand, Indigenous communities are generally ecocentric-oriented, seeking non-violent and non-domestication approaches through neutral footprints (Fay, 2015). Ecosystem-based adaptations can explore ecocentric solutions through ecosystem services and green infrastructures in environmental planning. For a fair cultural appreciation and remembrance, EbA proposals should be place-based to narrow the local cultural values (Pauleit et al., 2017). EbA in green infrastructures promotes the inclusion

of intrinsic ancestral values, reducing the risks of gentrification, acculturation, and a sense of non-belonging.

Case studies of EbA in environmental planning for accessibility promotion for recreation, aesthetics, knowledge systems, and spirituality include:

- Mesoamerica: Coffee production with local farmers using agroforestry systems, bioconstruction, and traditional agriculture practices (Vignola et al., 2015).
- Gambia: Support for small farmers and fishermen to adapt to climate change with meteorological stations and adaptation of traditional food systems, and restoration of forest ecosystems (UN Environment Programme, 2017).
- Potato Park, Peru: *Ayllu* concept to balance wilderness, land management, and spiritual traditions within the community (Swiderska, King-Okumu, and Islam, 2018).
- Vanuatu: Indigenous knowledge for coral reef and coastal management, gender equity in fishing activities (Swiderska, King-Okumu, and Islam, 2018).

Nalau et al. (2018) did a critical review about the application of EbA in environmental planning worldwide. Community participation is crucial for the successful engagement of EbA strategies in food security, climate change, land restoration, and other ecosystem stressors. Challenges for EbA include the regulation and reintegration of semi-loss of traditional indigenous knowledge. The rise of scholarship on knowledge systems, observations of traditional ecosystem management practices, and incorporation of ancestral technology in environmental planning are manners to support diverse comprehension of socio-ecological values.

4.2 Frameworks of reimagination

Finney (2014) introduced the concept of frameworks of reimagination to shift the narrative of Black identities in nature. Environmental justice uses procedural and distributive justice to seek environmental reparations on burdened populations (Walker, 2012; Young, 2011; Pellow, 2018). Environmental justice narratives expose the structural injustice factors in vulnerable communities. Finney explores lost socio-ecological values, creating alternative land use and management scenarios possibilities.

Reimagination is an approach that reviews values perpetuated and normalized by a dominant culture and opens space for marginalized voices to share their perspective of environmental ethics. The reimagination of narratives mitigates intergenerational and cultural trauma by exploring new memories, interpretations of landscapes, and sense of place (Finney, 2014; Lehrner and Yehuda, 2018; Eyerman, 2001). A reimagined narrative - other than the expected by environmental planning agencies - ignites Black and Indigenous groups to participate in land use and management decision-making actively. Instead of claiming access to mainstream services, Black and Indigenous can reintroduce values virtually lost during colonization and slavery.

Supporting, provisioning, and regulating ecosystem services have common values that meet environmental needs, human physiology, and physical health. For example, people from different identity groups need fair access to good air quality, clean water, fresh food, and shelter. However, CES relates to culture, which varies according to background, history, and ethnicity. There are infinite interpretations of the cultural

ecosystem services, but the ability to explore nature without violence, criminalization, and acculturation should be the minimum service.

Examples of frameworks of reimagination to abolish criminalization, cultural appropriation, and acculturation include:

- normalization of Black and Indigenous bodies and behaviors in green spaces
  e.g., not calling cops on a loud barbecue, including Black and Indigenous identities on environmental agencies;
- appreciation of less complex ecosystems for acceptance of aesthetics values
  e.g., wildflowers' fields promote pollination and can have much aesthetic importance as ridgelines;
- reparations for Black and Indigenous groups for previous entheogens criminalization
  e.g., participation of Black and Indigenous in decision making for drug policy;
- perpetuation and acceptance of Black and Indigenous ancestral values
  e.g., merging ancient diaspora values (spirituality, knowledge systems) with technology in the political ecology scenario of Anthropocene (Afrofuturism theory).

4.3 Recommendations for inclusion of Black and Indigenous values in CES metrics

Environmental planning exists to mitigate the impacts of climate change, and several municipalities use ecosystem services as metrics for sustainability master plans (Krellenberg et al., 2021, Wilkerson et al., 2018). Therefore, it is necessary to have more diverse values for CES from traditionally excluded groups. Otherwise, these groups will

continue to have a geography mismatch regarding ancestral cultural practices and access to nature. Table 2 suggests using cultural appreciation through ecosystem-based adaptations and frameworks of reimagination. In the previous section, I reflected on using ecosystem-based adaptations and frameworks of reimagination to include Black and Indigenous values in CES. I created Table 2 to recommend actions of inclusion and diversity in recreation, aesthetics, knowledge systems, and spirituality.

CES	Ecosystem-based adaptations	Frameworks of reimagination
Recreation	Inform ancestral cultural values of recreation in green infrastructures through informational signs, totems, and other landmarks	Normalization of Black and Indigenous bodies and behaviors in green spaces
Aesthetics	Low carbon footprint construction and use of renewable materials with bioconstruction	Appreciation of less complex and stratified ecosystems. And acceptance of *simpler* aesthetics values as sacred and protected landscapes
Knowledge systems	Land management practices using Indigenous knowledge values	Reparations on Black and Indigenous for previous entheogens criminalization
Spirituality	Incorporate traditional spiritual values of wellbeing to enhance ecosystem conservation and community equity	Perpetuation and acceptance of ancestral values in Black and Indigenous religions in the modern society (Afrofuturism).

Table 2. Use of frameworks of reimagination and ecosystem-based adaptations to integrate missing CES values in environmental planning.

Ecosystem-based adaptations rescue ancestral knowledge from ethnic groups and elevate values already known but not largely used. Frameworks of reimagination challenges society to integrate values not imagined or applied before due to the normalization of criminalization, acculturation, and cultural appropriation practices. Cultural appreciation is a practice that recognizes cultural values and inserts them into an appropriate context with the participation and leadership of identities from the observed

culture (Jackson, 2021). Cultural appreciation is possible with representation, proportionality, and equity in environmental planning.

Postmodern society is living on a trend of equity hiring practices (Lopez-Littleton et al., 2018) that impact the staff capacity of environmental planning agencies. Hiring for diversity means diversifying the ideas, perceptions of land use solutions and accepting new values that can be part of EbA and reimagination scholarship.

Diversity in environmental planning combined with public participation invites the community to create their own solutions rather than replicating planning models. Cultural ecosystem services are mostly landscape values, which have their interpretations based on history, memories, and traditions. Because of cultural differences, successful environmental planning strategies from one particular geography can fail overseas. Therefore, rescuing and creating values based on the community identity offer personalized solutions.

The conceptual frameworks explored in this paper can work for other ethnicities. The loss of the traditional knowledge systems happened worldwide with the standardization of values. The sensibility of EbA and frameworks of reimagination can revive the significance of ancient recreation, spirituality, aesthetics, and educational values. For example, Inuit wooden maps represented the coast of Greenland, challenging traditional mapping technology (Aporta, 2009). A study that combined ecological knowledge from Inuit hunters and geomatics engineers optimized land management and environmental monitoring in the Arctic (Gearheard et al., 2017). In England, Stonehenge ruins present a landmark of spiritual, cultural, and knowledge systems values (Pearson,

2013). The archeological conservation promotes astronomical rituals for solstice events through the perpetuation, inspiration, and appreciation of ancestral technology (The Journal of Royal Astronomy Society, 2010).

Reviewing semi-lost traditional values from multiple ethnicities does not mean sacrificing advances in technology. Ecosystem-based adaptations and frameworks of reimagination can challenge the uniqueness of ancestral ideas in environmental planning, especially observing cultures that had intrinsic connections with original ecosystems. The risks of standardization of environmental planning interpretations push responses based on diversity and inclusion values. The Anthropocene brought advances in technologies - it is possible to adjust technology to include Black and Indigenous values on planning tools rather than exclude these communities with acculturation and standardization. Digitizing ancestral tools, translating documents, restoring artifacts, and respecting ethnic values and memories are ethical approaches for inclusion and diversity in postmodern society.

5. Conclusion

This paper advocated for including diversity values in cultural ecosystem services metrics, especially from Black and Indigenous communities. Navigating through the current cultural ecosystem services scholarship, I was able to break down the values of recreation, aesthetics, knowledge systems, and spirituality. Diverse values are bundled into one major category of cultural ecosystem services without proper distinctiveness and examples, leading to the marginalization of non-white values. Explaining recreation,

aesthetics, knowledge systems, and spirituality values from diverse communities enriches cultural ecosystem services scholarship.

As reviewed by other CES scholars (Kirchhoff, 2019, Pascua et al., 2017, Chan et al., 2016, Coelho-Junior et al., 2021), the current ecosystem services literature needs to expand the metrics standard for cultural-ecological practices. Cultural aspects can have multiple interpretations, therefore the urgent call for flexibility on environmental metrics that regulates human-nature interactions.

Ecosystem services as metrics in environmental strategic plans of worldwide municipalities are a trend. However, replicating metrics that have succeeded in Global North might not be the best fit for places with most Indigenous populations and Black diaspora. Nevertheless, using ecosystem-based adaptations and frameworks of reimaginations can open conversations for solutions that include the participation of traditional unheard voices in environmental planning.

The lack of equity, representation, and proportionality in decision-making agencies that regulate ecological interactions reflects CES values' criminalization, acculturation, and cultural appropriation. Recommendations for future research include case studies in Black and Indigenous communities that have marginalized cultural-ecological practices. Listening to community members and understanding the ancestral values in CES can aid the inclusion of semi-lost values on environmental planning metrics.

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Chapter 3: Exploring urban mobility through interviews and social mapping in São Paulo

Abstract

São Paulo is the largest city in Brazil and has an urban complexity that includes unregulated forms of transportation, housing, and commerce. São Paulo Strategic Master Plan (SMP) aims to improve urban landscapes, green infrastructures, and urban mobility to enhance accessibility to social welfare, jobs, housing, education, economic development, community development, and other opportunities. SMP uses macro zones to define target areas to reduce urban and ecological vulnerability, promote environmental protection, metropolitan structuring, and infrastructure improvement. The study area of this study is São Paulo's Zona Sul, which translates to Southern Zone (SZ), located in the south region of the municipality. Southern Zone is a periphery area with neighborhoods that fall within SMP macro zones of reduction of urban and ecological vulnerability. The demographic indicators show large cultural, ecological, and economic diversity. This research used data from a socioeconomic mobility research project with thirty-eight interviews with residents from Southern Zone regarding urban mobility for urban services. Urban services included education, work, shopping, leisure, community engagement, among other services. The methodology explored social mapping to assess the distribution of destination points and urban mobility and the connection to the land use proposed by master zones on SMP. The results informed clusters for urban services within the SZ neighborhoods or in São Paulo downtown.

When leaving the origin neighborhoods for services, the destinations are in economically developed zones. The urban services in the Southern Zone were in areas closer to the housing space, with proximity to public transit, and in commercial strips. Observing individual mobility maps, participants indicated that when leaving the neighborhood for work, school, and leisure services, there is a sense of non-belonging in downtown. The factors that influence social segregation and acceptance are associated with the racial, economic, and geographical aspects of the subjects' identities.

Keywords: PPGIS, urban planning, urban vulnerability, socio-economic behavior

1. Introduction

Like other urban areas in the Global South, São Paulo has substantial complexity regarding urban mobility. As the largest Brazilian metropolis with 12 million inhabitants (IBGE, 2021), São Paulo has a diverse landscape with unique socioeconomic aspects. An economic elite developed during Brazil's colonial coffee market concentrated wealth and power in the city. Industrialization caused intense demographic growth through national migration seeking economic opportunities. The migration population landed mostly in periphery areas with unequal access to housing and job opportunities. The hip-hop movement gave voice to the periphery as a social response to urban vulnerability. The southern portion of Sao Paulo hosts rural zones with indigenous territories and protected natural areas (Caldeira, 2000; Marques, 2015; Kowarick and Frugoli Jr., 2016; Rosa,

2013). The city is a mosaic of land use, with inequality issues revealed in shared public spaces and accessibility to urban services.

We defined urban services as common destinations that support city residents' well-being, community development, economic development and contribute to the production of space. Henri Lefebvre (1974) developed the production of space concept, which consists of interaction between humans to construct a built environment and the sociological aspects of the area. Production of space encompasses personal and collective experiences, roles of individuals in the public space, and the sense of belonging. The state can set definitions, expectations, and limitations of space through land use. For example, planning agencies can set rules for constructing space in urban areas, challenging individuals to adapt the landscape to their needs and identity. Relph (1976) adds the idea of a sense of place to the production of space theory, highlighting that the architecture, the built environment, personal and collective experiences, memories, and expectations construct the individual identity and sense of belonging in the surrounding landscape. Kowarick and Marques (2011), Marques (2015), and Kowarick and Frugoli Jr. (2016) studied the production of space applied to São Paulo.

Sao Paulo's urban studies literature highlights segregation through race, income, and geography. Kowarick and Marques (2011) explored housing, working conditions, politics, social issues, and violence in the metropolis in the past forty years. Even with the increase of public policies in the 2000s, Sao Paulo peripheries still have lower accessibility to water services, education, and green infrastructures. Industrial facilities, technical educational institutions, and commercial centers have expanded through the

past years, but most services and resources are in structured and developed zones of the city. Peripheries are areas of geographic vulnerability that are more likely to stay apart from various urban services. To overcome vulnerability, civil society in Sao Paulo organize through local political movements, grassroots production of space, and informal jobs. The acceptance of informal employment, as street vendors, security staff, drivers, beauty technicians, increased over time with the support of public policies and local political movements. The inclusion of previously marginalized workers in the economy expands access to higher incomes, higher mobility, and higher access to various urban services. Hence, grassroots production of space from peripheries, as protests, street art, and reclamation of spaces, can impact more geographies of the city, including coexistence spaces that merge periphery and (upper) middle class identities.

In São Paulo, three definitions of *space* construct the sense of accessibility of urban services: a) housing space, b) coexistence space (*local de convívio),* and c) production of space (*tipo de produção de espaço*) (Kowarick and Marques, 2011). Housing space is where individuals live with relatives, friends, or solo. Ideally, housing spaces resemble a sense of safety, privacy, community, and belonging. In the Southern Zone, housing spaces can be unstable or substandard within social and ecological vulnerability zones. Housing spaces might not fully support the basic needs of the urban residents, such as employment, education, leisure, and other services.

Coexistence spaces are locations outside the housing space where people find urban services and social interactions. Coexistence spaces provide urban services for a broad population, such as employment centers (work), schools (education), restaurants

(food), parks (leisure), hospitals (health). Coexistence spaces offer cultural exchange, discovery, and creation of values among individuals of distinct backgrounds. In coexistence spaces, individuals can build their sense of place, explore the sense of belonging, and add their input to the production of space.

Production of space can be physical, with the impact of infrastructures, buildings, features of natural environments. Behaviors and activities also contribute to the production of space, such as artistic interventions and diverse use of public areas that collaborate with the social construction of the space. The subjectiveness of human activities on the space allows personalized urban destinations, where physical and behavioral landscape aspects meet with individuals' values. In São Paulo, examples of the production of space include housing *mutirão* (collective housing construction), collective comprehension of landscape change, protests, and the organization of grassroots hip-hop events (Kowarick and Frugoli Jr., 2016).

1.1 Brief history of Brazilian democracy

In the past fifty years, scholars analyzed the rapid landscape change in São Paulo, especially with migration from northeastern Brazilians that moved to the southern metropolis. Brazilian Nordeste (NE) suffered from a lack of infrastructure, economic development, drought, and lower educational attainment (Caldeira, 2000, Marques and Torres, 2005, Kowarick, 2000). Seeking industrial jobs and opportunities, northeastern migrants boosted population growth in São Paulo in the 70s and 80s (Caldeira, 2000). Southern Zone (SZ) is a southern portion of the city that historically bears NE migrants. The spatial segregation of SZ challenges governmental agencies to provide the same level

of infrastructure and services as São Paulo central business district (CBD) and affluent zones. The geographic mismatch of urban services lowered land value. Housing mutirao, grassroots organizations, and the hip hop movement built a path to the collective production of space. Other vulnerable groups clustered in the Southern Zone were Afro-Brazilians and low-income populations. Socioeconomic inequality in SZ reflects through the lack of proper housing, access to education, basic sanitation, and transportations services.

Along with national migration movements, Brazil faced major political changes, from dictatorship to democracy, during the 80s. The *Diretas Já* movement advocated for elections and social equity, connecting industrial unions, artists, soccer players, and popular voices. São Paulo was the scenario of several marches projecting the expectation of a fair Brazilian democracy that would alleviate the socioeconomic issues of the city and the country. Unfortunately, the reestablishment of democracy in 1985 did not immediately solve the socioeconomic problems of São Paulo.

In 1988, a new Constitution reaffirmed civil rights values lost during the dictatorship and created new reparation measures for social equity, such as the criminalization of racism, participatory planning measures, and public policies to mitigate poverty. Sao Paulo, that was a central stage of articulation for a social democracy (Marques and Kowarick, 2011), developed initiatives of grassroots production of space to promote change in areas abandoned by the state, as Southern Zone periphery (Klein, 2019). Although, the incorporation and acceptance of social equity in society is a slow process, with reminiscent practices of autocracy and impunity. Nevertheless, democracy

enabled *free speech* through cultural manifestations, especially hip-hop music with roots in Southern Zone (Kowarick and Frugoli Jr, 2016).

In the early 2000s, Brazil shifted socioeconomic classes, following a social-democratic agenda that invested in welfare programs, like Bolsa Familia, Minha Casa Minha Vida, and university racial quotas. The benefits ranged from income supplementation to social reparation projects, housing programs, affirmative acts at universities, food justice measures, and job opportunities. For example, the federal housing program *Minha Casa, Minha Vida* benefited 1.8 million families with household income lower than R$ 1,600 to buy their first property by 2014 (Ministerio do Planejamento, 2014). Between 2007 and 2012, there was an increase of 75% in the civil construction industry, generating 750,000 new jobs to build dams, railroads, oil refineries, and support watershed management (Ministerio do Planejamento, 2014).

1.2 Social mobility in the Southern Zone of Sao Paulo

Klein, Mitchell, and Junge (2018) studied households and individuals in tracts of economic shift, according to the Brazilian 2010 census. The subjects reflected if their income and quality of life have improved, decreased, remained the same, or had ups and downs during the social democracy. Using the term *previously poor* to define the study subjects, the research explored positive lifestyle changes, such as access to affordable housing, popularization of higher education, jobs creation, and buying power of the poor population (Klein, Mitchell, and Junge, 2018).

In São Paulo, the working class can find difficulties identifying which social niches they belong in coexistence spaces. For example, airports, shopping malls, public

parks, and universities were traditionally occupied by the (upper) middle class in São Paulo. The reclamation of the previously poor in these public spaces challenges the sense of belonging and accessibility for the diverse groups in the city. On the one hand, the previously poor feel intimidated by the lack of sense of place and production of space in their unoccupied spaces. Then, they visit these spaces in large groups to feel more empowered and represented. On the other hand, the upper-middle class feels an invasion of their sense of place and shift in the production of space values. Attitudes of the (upper) middle class toward the previously poor include segregation and exclusion in public spaces (Pereira, 2014; Marrara, 2015).

For example, between 2013 and 2014, *rolezinho* events were common among periphery youth in the metropolitan region of São Paulo (Pereira, 2014; Marrara, 2015). *Rolezinhos,* organized mainly by Facebook social media, connected large groups of teenagers to shopping malls or parks in affluent areas. The event's goals were to occupy public spaces where the traditional visitors were white middle class. *Rolezinho* participants scheduled dates and times through social media and confirmed their presence on the online event invitation. The event planning guaranteed that the periphery youth would be the majority demographic or a significant group on the destination. The presence of Afro-Brazilian youth in *rolezinhos* attracted the attention of the media, security guards, and (upper) middle class residents. Several *rolezinho* events faced police brutality from security guards, social segregation from the upper-middle class, and social exclusion from shop vendors. Common *rolezinho* destinations included Parque do Ibirapuera - known as the best city park in an affluent neighborhood that borders the

Southern Zone, and Shopping Interlagos in a high-income tract of the Southern Zone. Improvements in public transit, wages, affirmative acts, and greater accessibility to cultural activities supported the reclamation of spaces.

In this paper, we analyzed perceptions of accessibility to urban services through the experience of individuals living in the Southern Zone of São Paulo. The general objective of this study was to identify if there are common destinations for urban services from residents of the Southern Zone. Then, observe if there are clusters of destinations within similar demographic characteristics. The specific objectives were to analyze the physical aspects of the clustered destinations, find the cluster zones and possible reasons for the clusters.

2. Materials and Methods

2.1 Study Area

Southern Zone is located in the southern region of São Paulo and bears high diversity of socioeconomic demographics. Figure 1 shows three maps with income, race distribution, and population distribution in *areas de ponderação* (census tracts) and census sectors (block groups) (IBGE, 2010). The income distribution is quite diverse, with the lowest and the highest income classes neighboring each other. In the SZ study area, there is a corridor with the highest income on the upper tracts and clusters of the lowest incomes in the southern portions. High-income tracts are closer to the central business district of São Paulo municipality. The study area has a vertical hatch symbology and bear tracts from all income classes. For race, Figure 1 shows a map with Afro-Brazilian population clustering in the periphery neighborhoods, such as the

Southern Zone. The study area also bears racial demographics with different ranges of racial diversity, but most of the observed tracts have within 43% and 65% of Afro-Brazilians. The population distribution is higher in the census sectors within the case study neighborhoods in the Southern Zone. In Sao Paulo, population clusters are also in northern and eastern periphery zones.

Figure 2 shows the case study neighborhoods, according to the Geosampa (2021) boundaries. The neighborhoods of Campo Limpo, Vila Andrade, Capão Redondo, and Jardim São Luís have access to subway lines. Vila Andrade, Jardim São Luís, and Grajaú have access to the train line. Jardim Angela does not have access to subway or train lines. Other forms of transit, like bus stations, were not included in the analysis, but they are spread citywide. Comparing the maps in Figure 1 and Figure 2, all the tracts in Jardim Angela have between 53% and 65% of Afro-Brazilians. Capão Redondo and Campo Limpo tracts range between 43% and 65% of Afro-Brazilians. The other neighborhoods have more racial variation. The income distribution is a mosaic of social class, with a trend of higher incomes in the north tracts of the Southern Zone.

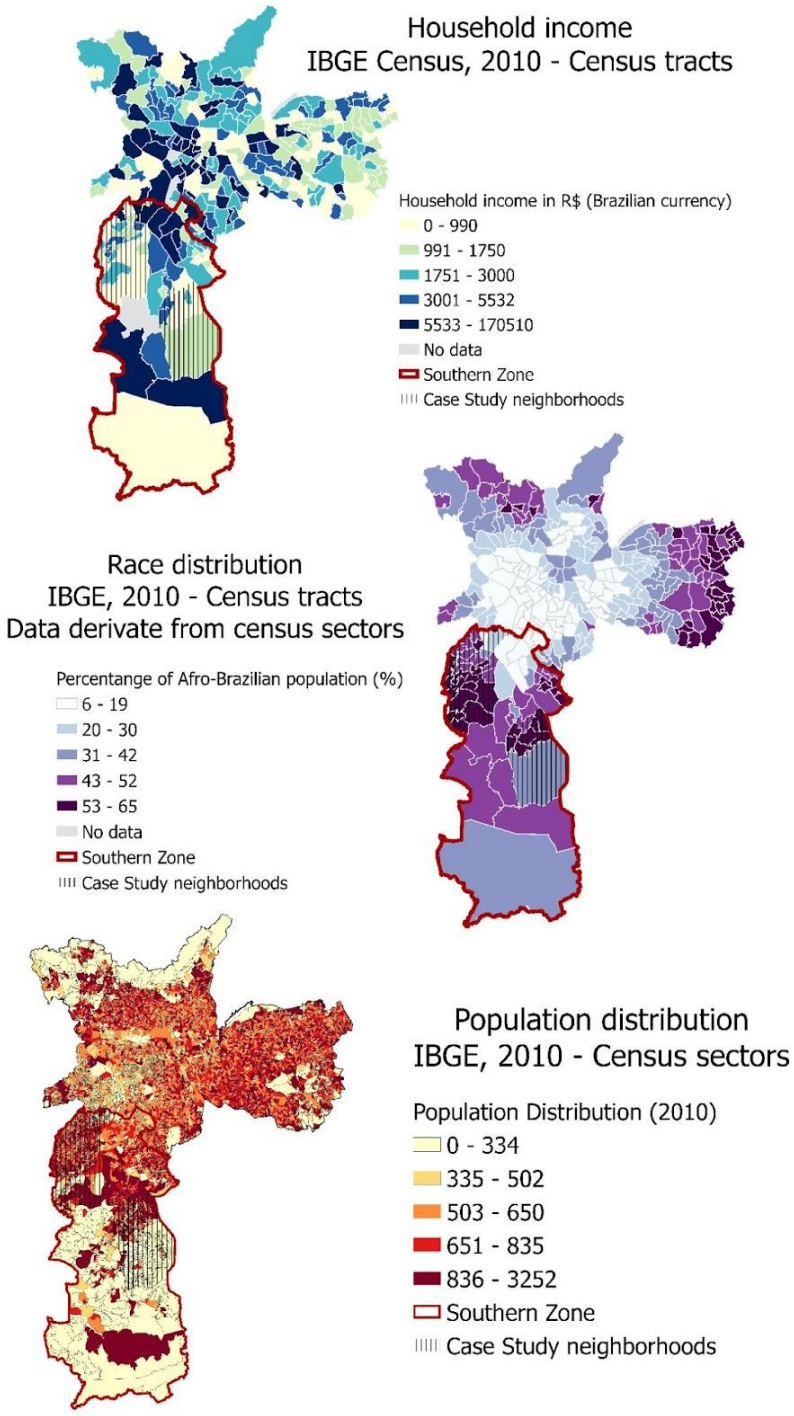

Figure 1. Income, race, and population distribution in São Paulo municipality using Brazilian 2010 Census data.

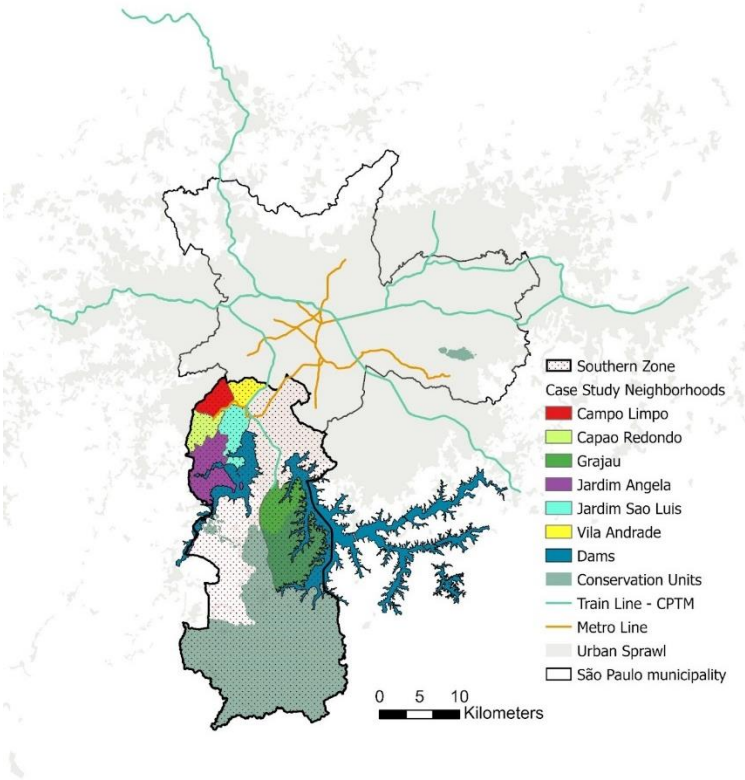

Figure 2. Southern Zone and the case study neighborhoods with trains and subway line

In Brazil, Article 182 of the Federal Constitution (1988) stated that cities with more than twenty thousand inhabitants must have strategic planning. The measures on strategic planning control city development, delimitate urban areas, and designate appropriate housing parameters. São Paulo has 12 million residents and approximately 2.6 million living in the Southern Zone (IBGE, 2021; Geosampa, 2021). Therefore, São Paulo municipality developed the Plano Diretor Estratégico do Município de São Paulo, translate as City of São Paulo Strategic Master Plan (2014). Released in 2014, SMP described multiple land use through eight macro zones (Table 1, Figure 3). The macro zoning strategy supports the urban planning process of a sustainable city, with priority

areas for housing improvements, job opportunities, reduction of urban vulnerability, and environmental protection.

The distribution of macro zones in São Paulo municipality has a balanced ratio, ranging between 10% and 16% of the city area, with the exemption of a completed urban area in the central business district (CBD) that corresponds to nearly 7% of the total city area. Environmental preservation zones without urban settlements are spaces designated for the protection of river springs, conservation of indigenous land, valuation of ecosystem services, and use of nature-based solutions for ecological restoration and purification. Zones for reducing vulnerability and ecological integration include implementing green infrastructures, reducing the susceptibility to natural disasters (floods, landslides), adequate housing, and collective production of space. In SZ, the combination of environmental preservation and reduction of vulnerability macro zones correspond to about 91% of the area. Rural zones of environmental preservation have lower population density (Figure 1).

In the Southern Zone, 57% of the macro zones encompass complete ecological restoration, including urban containment and sustainable use (34%) and preservation of natural services (23%). These areas correspond to, respectively, 99.7% and 62.4% of São Paulo municipality protection zones, which means that most ecological preservation zones are within SZ. Other critical zones in SZ are areas of reduction of urban vulnerability (7.5%) and reduction of urban vulnerability and ecological restoration (16%), which corresponds to respectively 27% and 55% of São Paulo municipality. Figure 4 illustrates the Southern Zone land use as a mosaic of vulnerable housing, areas

of geological risk, and census tracts of extreme poverty (less than R$ 70/month/per capita). All the neighborhoods in this case study had vulnerable housing and geological risks. Four neighborhoods, Campo Limpo, Jardim São Luís, Jardim Ângela, and Grajau, had census tracts in extreme poverty.

Number	Zone Name	Type	Zone Description	City area (km2)	SZ area (km2)	City portion (%)	SZ portion (%)	SZ/City Ratio (%)
1	Metropolitan structuring	Urban	High availability of infrastructure and mobility, but a spatial mismatch between jobs and housing	228.19	31.39	15.47	5.16	13.75
2	Completed urban areas	Urban	Major urban areas with complex transit and cluster of jobs and services.	103.13	7.46	6.99	1.23	7.23
3	Urbanization improvement	Urban	Combination of residential and non-residential land use, offering balanced services and infrastructure	204.79	18.67	13.88	3.07	9.12
4	Reduction of urban vulnerability	Urban	High index of vulnerable areas, including irregular and risk locations. Low availability of infrastructure, services. Mostly occupied by low-income population	167.09	45.93	11.33	7.55	27.49
5	Reduction of urban vulnerability and ecological restoration	Urban	Agglomeration of high index of socioecological vulnerability and irregular and precarious housing	177.67	97.94	12.04	16.09	155.12
6	Control and improvement of urban and ecological area	Urban	Empty of low-density areas with or without vegetation cover, reforestation, quarrying, industrial zones. Lower building stratification.	161.55	59.26	10.95	9.74	36.68
7	Urban containment and sustainable use	Rural	Large portions of natural vegetation in a mosaic with urban farms and agriculture zones. Integrated into protected	208.88	208.24	14.16	34.22	99.70

			areas, this zone does not have urban settlements.					
8	Preservation of natural ecosystems	Rural	Forest fragments with original ecosystem and high biodiversity. Does not include urban settlement.	223.88	139.62	15.18	22.94	62.36
			Total	1475.18	608.51	100.00	100.00	-

Table 1. Description and distribution of macro zones for land use planning in São Paulo and SZ, adapted from SMP.

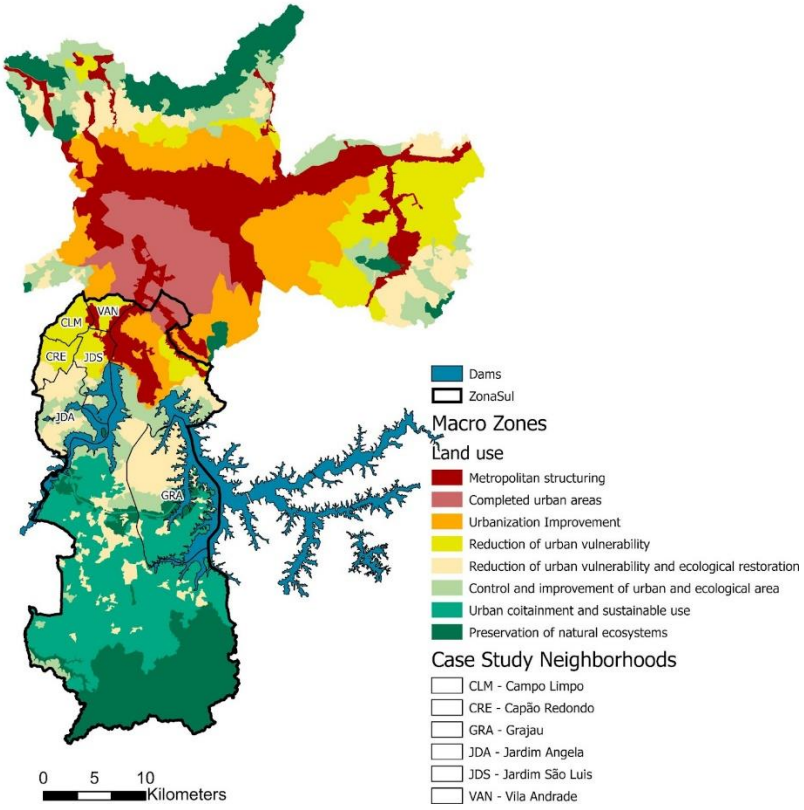

Figure 3. Spatial distribution of macro zones in São Paulo (Geosampa, 2021)

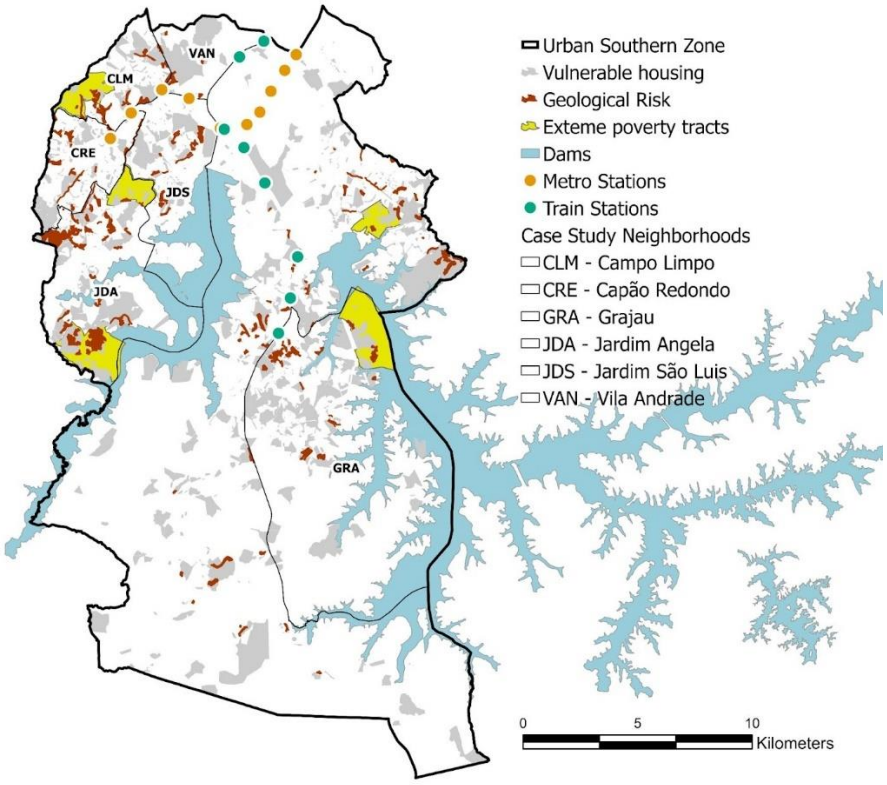

Figure 4. Urban and ecological vulnerability in the urban macro zones of the Southern Zone. (Geosampa, 2021)

2.2 Research Design

We used mixed methods to understand mobility patterns in accessing urban services, including surveys, interviews, and spatial analysis. The surveys provided an overview of perceptions of safety, sense of belonging, and satisfaction with local and city landscape management. Through the survey, we identified potential subjects for interviews. We also interviewed individuals from the same household or the snowball effect. Interviews and mobility mapping provided comprehension for mobility patterns

and preferred coexistence spaces. Spatial analysis displayed the proximity of urban services and public transit, destinations clusters, and individual mobility maps.

The increase of wages and improvements in transit infrastructure allowed Southern Zone residents to explore affluent areas of São Paulo and have access to *luxury* products for Brazilian society, such as high-tech electronic devices, home appliances, brand clothes, international traveling, car ownership, and homeownership. Thus, the identity of periphery individuals encompasses the class status, the geography they navigate, and their socioeconomic journey. The construction of identity and belonging build the individual role in the coexistence space (Klein, Mitchell, Junge, 2018).

This paper is a part of the research, focusing on mobility patterns in the Southern Zone of São Paulo. A National Science Foundation (NSF) collaborative research explored social mobility in individuals exposed to new social democracy policies in three Brazilian cities: Fortaleza, Rio de Janeiro, and São Paulo. Using surveys, interviews, and social mobility patterns, this research aimed to understand how forty million Brazilians left poverty during the years 2000 and 2018 in the social democracy of PT - Partidos dos Trabalhadores (Worker's Political Party).

2.2.1 Surveys

The data from this project was collected in 2017 as part of the NSF research grant. In São Paulo, a local team conducted the data collection led by Charles Klein, one of the authors. At least half of the team lived in Southern Zone neighborhoods.

The data included a survey with 401 Southern Zone of São Paulo participants about their sense of belonging in the city, sense of safety, and satisfaction with landscape management. The survey had 136 socioeconomic questions. We only used relevant questions to answer the question: *How do social mobility and the recent economic shift of the previously poor in the Southern Zone reflect their sense of belonging within the city?*

2.2.2 Interviews

To further explore urban mobility and personal socioeconomic journey, we selected survey respondents and used the snowball effect to select thirty-eight participants for semi-structured interviews. The interviews happened in São Paulo, in participants' housing spaces, between July and November 2017. Table 2 describes the socioeconomic characteristics of the selected participants and the neighborhoods they resided. For the data analysis in this paper, we used the Brazilian Institute of Geography and Statistics (IBGE, 2010) classification of race, including black and *pardo* (mixed-race, brown) as Afro-Brazilian. We asked participants to use self-classification of race during the interviews, including black, indigenous, white, and moreno (mixed race). To create two income classes, we used the median income of the sample. We interviewed cis and trans identities who used female or male pronouns, therefore the binary gender classification. Some participants used the sub-neighborhood reference, a smaller division into Geosampa neighborhood classification.

Socioeconomic indicators		Frequency	%	Total
Race	Afro-Brazilian	24	63	38
	Indigenous	2	5	
	White	12	32	
Income (Median income = R$ 3,200)	Lower -income (< 3,200)	19	50	38
	Higher-income (>= 3,200)	19	50	
Educational level	High school or less	22	58	38
	Higher education	16	42	
Age	Under 35	14	37	38
	Over 35	24	63	
Gender	Female	22	58	38
	Male	16	42	
Neighborhood	Capão Redondo	2	5	38
	COHAB Adventista (Capão Redondo)	4	11	
	Grajau	6	16	
	Jardim Nakamura (Jardim Angela)	6	16	
	Parque Regina (Campo Limpo) Parque Regina (Vila Andrade)	10	26	
	Jardim São Luis	10	26	

Table 2. Socioeconomic characteristics of the interviewees.

2.2.3 Public participation GIS and landscape value mapping

During the interview, participants indicated where they access urban services, shared their routine habits, and their perspectives of housing space, coexistence space, and production of space. Table 3 describes the typology of urban services, which include leisure, shopping, work, education. To collect the destination of the urban services, the participants marked points on a printed map with landscape references, such as streets, train lines, subway lines, dams, and landmarks. They could choose more than one point for the urban services categories but only one reference for the *home* category. The points from the printed map were digitized to a vector layer using the software QGIS. This data collection method relates to public participation GIS (PPGIS) and landscape value mapping (LVM). PPGIS uses the knowledge of the community to build maps, perform spatial analysis, and increase the collaboration of the people in the decision-making process (Brown & Weber, 2011). LVM is a branch of PPGIS that uses participatory methods to engage people to share their values regarding land use and landscape design through points, lines, or polygons on a map (Besser et al., 2014). Landscape values, such as preference for urban services, are challenging to measure in numerical units. LVM outcomes generate hotspots that indicate the concentration of points of interest. We used a facilitator to support the collection of destination points on printed maps.

Urban services	Description
Home	housing space
Work	work-related activities
School	education services, including universities and technical schools
Banking	banking-related activities
Eating Out	eating out sites, such as restaurants and food carts
Community Engagement	community activities, such as volunteering, neighborhood associations
Food Purchase	food stores, such as grocery stores, mini-markets, farmer's market
Shopping	purchase of items not related to food, such as clothes, consumer goods
Leisure	entertainment activities, cultural venues, sports venues, outdoor recreation, nightlife
Health	health services, such as hospitals, clinics, health centers
Religion	Faith expression, such as churches, temples, *terreiros*, spiritual centers
Social Services	social welfare benefits, mostly from governmental agencies or nonprofits, as food stamps, income support

Table 3. Description of urban services site destinations mapped by the participants

2.2.4 Spatial distribution of urban services

To analyze the distribution of points using LVM, we performed several analyses to find the spatial relationships between the destinations and the infrastructure and land use in São Paulo. We used referential data (macro zones, neighborhood boundaries, landscape marks) from the São Paulo GIS portal - Geosampa (2021). The measurements use the metric system and the spatial reference of SIRGAS 2000 UTM Zone 23S as standard from Geosampa sources.

First, we coded and summarized the interviews, finding relevant information regarding the participants' role in the coexistence space and their sense of belonging in

the physical landscape. Next, participants shared their socioeconomic journey, relevant life events, and mobility habits from housing to urban services. Participants' statements included thoughts regardings safety, access to public transportation, quality of urban infrastructures, satisfaction with their neighborhoods, and how these factors impact their mobility habits.

Second, we digitized the sketched destination points to a vector layer. We created a spatial database to connect the interviewees' socioeconomic indicators with the digitized vector layer. The following analysis used the software ArcGIS Pro 2.6. We observed the frequency of points in urban services categories, proximity to public transit, and existence in macro zones. We used infrastructure and zoning layers from GeoSampa spatial library. Intensity raster maps enhanced the destination clusters, and the Kernel Density tool populated the number of destination points in clustered areas of $100m^2$.

Third, we performed spatial statistics using the tool Average Nearest Neighbor to find if the spatial distribution of urban services had significant concentration, based on the significance of probability values. The Average Nearest Neighbor Tool calculates an NNR index based on the average distance from each feature to its nearest neighboring feature. For the values that had a significant spatial concentration of destinations, we did a second analysis of clusters, exploring the urban mobility within demographics. Finally, we used the Origin-Destination Link tool to find the average travel distance within the cluster demographics.

The research design approach uses a similar method explored by Garcia et al. (2017) and Burns et al. (2012), which used interviews, sketched maps, spatial

distribution, and intensity raster maps (Figure 5). The results and discussion are combined in the following section.

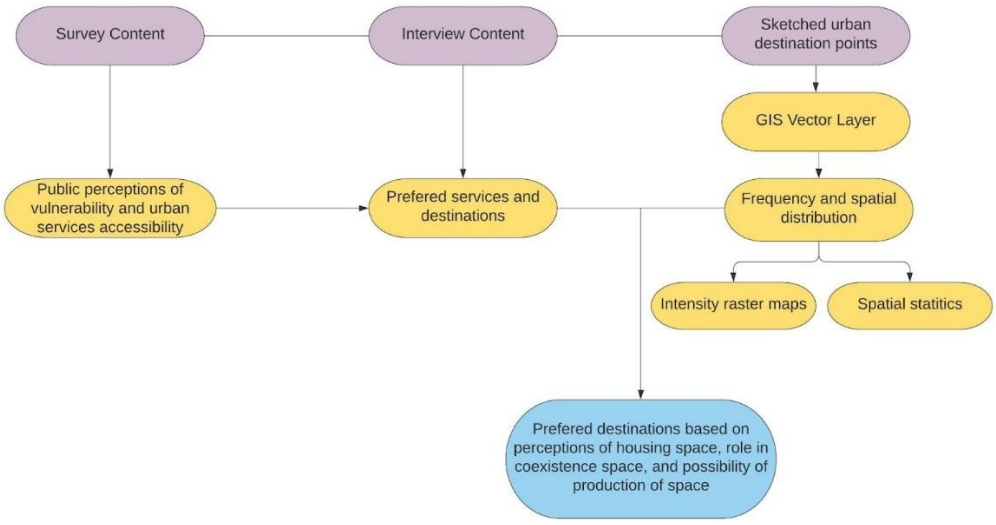

Figure 5. Research design and analysis flow

3. Results

The results include analysis that used a research design of survey answers, in-depth interviews, LVM, and spatial analysis to identify common destinations for urban services, observe the demographic diversity of the clusters, and analyze the physical aspects of the clustered destinations.

3.1 Survey results

The 401 survey participants answered questions about their mobility habits, satisfaction with the neighborhood, concerns about vulnerability, and preferred destinations. Not all respondents completed all the questions of the surveys; therefore, the results tables (Table 4, Table 5, Appendix A) show the percentage of valid answers.

Appendix A has all the survey questions and the expanded statistics for the selected questions. In Table 4, we selected the questions relevant to understanding the level of satisfaction with São Paulo and the Southern Zone.

When asked about their housing spaces, 63% of the respondents reported positive satisfaction with their residence. However, only 35% were happy with the neighborhood's appearance, a rate quite similar to the municipality's aesthetic satisfaction of 33%. The majority of survey respondents informed that if given a chance would leave São Paulo municipality and the Southern Zone periphery, with respective rates of 57% and 58%. Despite the satisfaction with housing, the rejection for city and neighborhood appearance and willingness to move to another place follow the same pattern.

Question	Validity	Answers	Frequency	Percent	Valid Percent
Level of satisfaction with the quality of residence	Valid	very unsatisfied	15	3.7	3.8
		unsatisfied	35	8.7	8.9
		indifferent	95	23.7	24.1
		satisfied	149	37.2	37.7
		very satisfied	101	25.2	25.6
		Total	395	98.5	100.0
	Missing		6	1.5	-
Level of satisfaction at the neighborhood level with neighborhood appearance	Valid	very unsatisfied	52	13.0	13.2
		unsatisfied	95	23.7	24.1
		indifferent	110	27.4	27.9
		satisfied	100	24.9	25.4
		very satisfied	37	9.2	9.4
		Total	394	98.3	100.0

	Missing		7	1.7	
Level of satisfaction at city level with appearance of city	Valid	very unsatisfied	54	13.5	13.7
		unsatisfied	86	21.4	21.9
		indifferent	122	30.4	31.0
		satisfied	94	23.4	23.9
		very satisfied	37	9.2	9.4
		Total	393	98.0	100.0
	Missing		8	2.0	
Would leave the city?	Valid	No	161	40.1	40.1
		Yes	229	57.1	57.1
		Don't know	11	2.7	2.7
		Total	401	100.0	100.0
Would leave the neighborhood?	Valid	No	160	39.9	39.9
		Yes	232	57.9	57.9
		Don't know	9	2.2	2.2
		Total	401	100.0	100.0
N = 401					

Table 4. Satisfaction levels with Southern Zone and São Paulo municipality.

Still observing the results that reflected the differences between housing spaces, neighborhoods, and São Paulo municipality, Table 5 shows the degrees of safety within these spaces. Participants feel safer in their own house than in their general Southern Zone or São Paulo. The answers informed that 61% of the respondents had a sense of safety in their own homes, contra 26% safety rate in the Southern Zone and 10% safety rate in São Paulo municipality. One fact that enforces the lack of safety is the finding of 35% of the sample informing that in the past 12 months, a household member was a victim of assault.

Question	Validity	Answers	Frequency	Percent	Valid Percent
Degree of safety felt in: Own house	Valid	very unsafe	36	9.0	9.0
		Unsafe	54	13.5	13.6
		Indifferent	65	16.2	16.3
		Safe	115	28.7	28.9
		Very safe	128	31.9	32.2
		Total	398	99.3	100.0
	Missing	System	3	0.7	
Feel safe in neighborhood?	Valid	No	297	74.1	74.1
		Yes	104	25.9	25.9
Feel safe in city?	Valid	No	362	90.3	90.3
		Yes	39	9.7	9.7
Last 12 months, household member victim of: Assault	Valid	No	260	64.8	64.8
		Yes	141	35.2	35.2
N = 401					

Table 5. Sense of safety in housing spaces, neighborhood, and city level.

In the interviews, we found statements that supported the comprehension of safety in their housing spaces. According to some participants, being familiar with the area, neighbors, and living longer in the region can increase the sense of safety. The fact that decreases security is drug trafficking and gang-related activities.

It is not a rich neighborhood, but it is also not miserable. People work and are happy. It is not violent, it is like everywhere else. Doors and windows can stay open until 11 PM. It is not recommended to show off possessions to avoid getting attention (of burglars). When we live here for a longer time, we feel safer.

Participant living in Parque Regina

"In my street, ten people were assaulted within a month. My backyard is in my safety zone. I don't want to live here. I was born here. In the past, there wasn't much infrastructure, and houses didn't have gates. All the houses were simple. Earth, trees. There were no schools, there were no technical schools, no Bolsa. We lived well." -

Participant living in Jardim Angela.

"There are organized crime activities in my apartment complex parking lot. (...) There is much inequality and corruption in Brazil. Poor and Black suffer more with inequality, especially those living in favelas. If people were more supportive with each other, there would be less inequality. (...) One unjust situation was when a doctor let my son die without hospital care. (...) I lost family members for police brutality. (...) I pity youth involved in criminal activities."

Participant living in Jardim São Luis

When asked about the major problems of Brazil, corruption was the first mentioned issue, with 46% of the answers (Appendix A). Regarding public safety and violence, 33% of the survey participants ranked this issue on the top three responses (Appendix A). In the interviews, there is a sense that corruption is the root of public safety and violence. Corruption deviates resources for socioeconomic initiatives and leaves vulnerable populations with fewer opportunities - opening a path to violence, organized crime, and segregation (Soares, Bill, Athayde, 2005).

Appendix A has the survey questions and results of questions related to safety in public transit, satisfaction with public transit on city and neighborhood level, satisfaction

with green infrastructures, and major social issues in Brazil. We will use these survey results in the following sections, referencing Appendix A, to support the spatial analysis findings.

3.2 Distribution of the urban services

The thirty-eight interviews generated 362 points of destinations. The average number of points per participant was nine, and the answers ranged from two to twenty destinations. The distribution of destinations located 282 points (78%) within the Southern Zone, 355 points (98%) within the São Paulo municipality, and 362 points in the State of São Paulo, including metro areas and coastal cities. Table 4 shows the frequency, percentage of points, average distance, maximum distance, minimum distance, and standard deviation for each category, from home to final destination. The distance units are in kilometers. Figure 6 shows the distribution of destination points through São Paulo municipality. Table 6 shows the descriptive statistics of destination points' distance in kilometers, and Appendix B has a table that breaks down the distance values per studied neighborhoods.

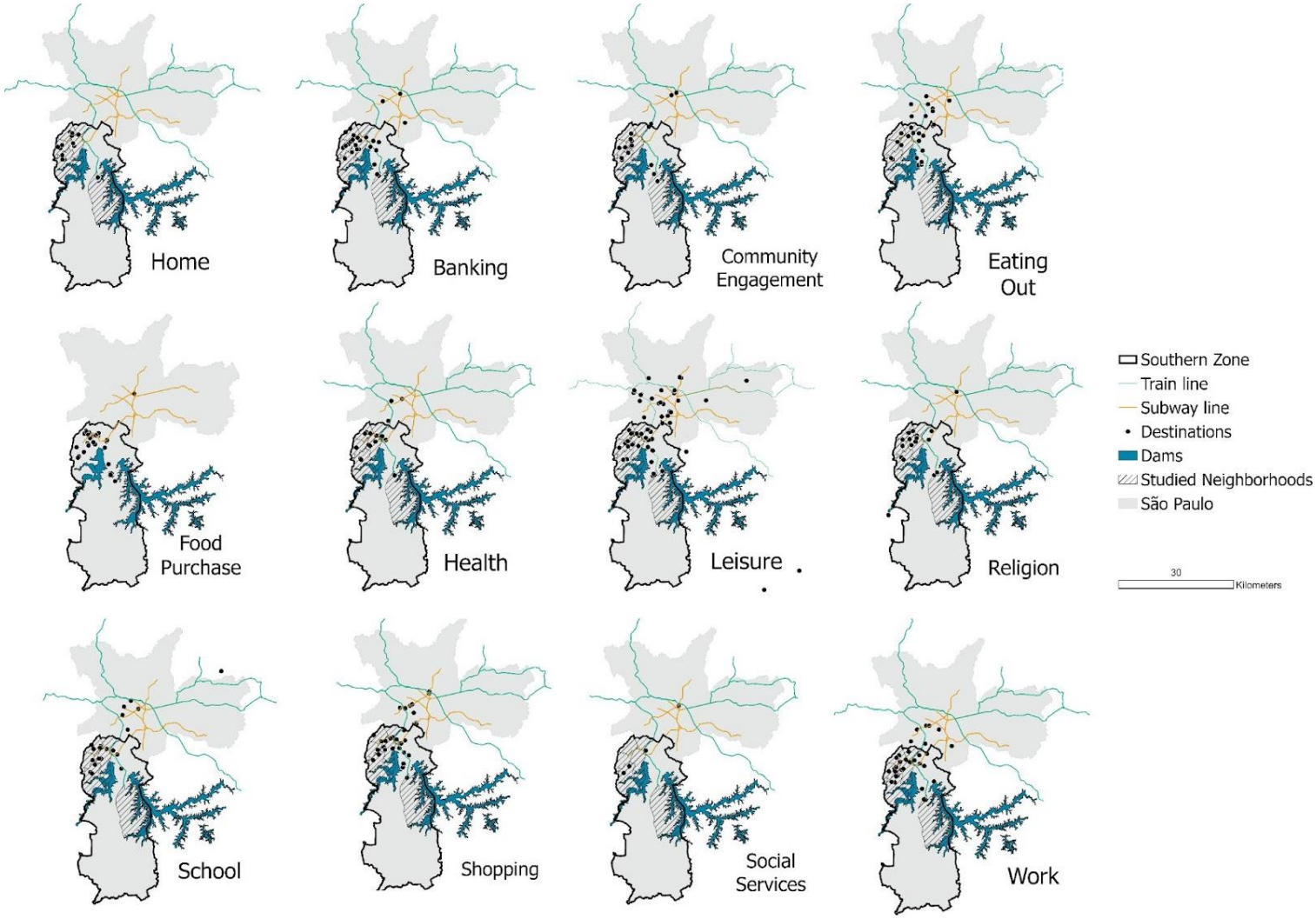

Figure 6. Distribution of urban services destination

Category	Frequency	%	Average distance	SD	Minimum distance	Maximum distance
Home	38	10	-	-	--	-
Banking	29	8	5.34	6.23	0.18	24.95
Community Engagement	18	5	4.59	6.76	0.15	21.12
Eating Out	29	8	7.85	6.11	0.10	23.35
Food Purchase	41	11	2.75	4.22	0.26	24.73
Health	19	5	5.36	6.21	0.21	16.62
Leisure	66	18	12.55	13.59	0.06	62.16
Shopping	41	11	7.39	5.74	0.51	23.51
Religion	21	6	4.28	6.75	0.05	24.76
School	20	6	8.95	11.28	0.16	43.90
Social Services	4	1	8.73	8.94	0.65	19.69
Work	36	10	6.91	9.43	0.17	50.96
Total	362	100	-	-		

Table 6. Spatial distribution of the points within categories and average distances.

The 38 points for home indicate the housing space of the participants. The categories with more destinations were leisure (66), food purchase (41), shopping (41), corresponding respectively to 18% and 11% of the points. Leisure had the highest average distance (12.55km), and food purchase is the category with minimum average distance (2.75km). Capão Redondo and Jardim Nakamura were the neighborhoods with the lowest mean travel distance for leisure, indicating the destinations are within the Southern Zone (Appendix B). The participants from Capão Redondo and Jardim Nakamura were from the snowball effect interview sample. The other categories of urban services had mean distance values ranging from four to nine kilometers. The higher

values for standard deviation translate variability in the destination distances among the participants. In all categories, but health and social services, the maximum distance was higher than 20km, reaching 62km for leisure, 51km for work, and 44km for school in destinations out of São Paulo municipality. We decided to maintain these outliers in the analysis because, based on the interviews and previous studies (Altieri, Silva, and Terabe, 2020; Silveira Neto, Duarte, Paez, 2014), a longer commute is a part of the routine of Southern Zone residents. In Grajaú, the furthest south neighborhood, school services had a mean distance value of 18km, and the minimum distance was 6km, showing that interviewed participants needed to leave their neighborhoods to find diverse educational services (Appendix B).

Most of the destination points were clustered within Southern Zone (78%), and the studied neighborhoods had 56% of the destinations; 15% in Jardim São Luís, 11% in Campo Limpo, 10% in Jardim Ângela, 9% in Capão Redondo, 6% in Vila Andrade, and 5% in Grajaú. In the interviews, eating out, leisure, shopping, work, and school were the entertainment urban services that mostly revealed interaction within mixed social classes in the coexistence space. According to the participants, leisure, shopping, and eating out services out of the Southern Zone offered an upper-scale quality with higher prices and more options, such as international cuisine and brand clothes. Participants from Grajaú (12.5km) and Jardim São Luís (8km) traveled further distances for eating out. Capão Redondo participants traveled an average of 13km for shopping destinations. And in leisure, Parque Regina (16.5km), Jardim São Luis (12 km), and Grajaú (12km) traveled

the furthest distance. The detailed distances for studied neighborhoods are in Appendix B.

3.3 Urban mobility and public transit

During the interviews, the participants consistently mentioned public transit, showing a preference for subways, trains, and satisfaction with the expansion of stations to the Southern Zone. Subways and trains provide a faster commute, with easier transfers between stations and lines, rather than other ways of transportations as buses or bicycles. The survey results showed that 55% of the respondents had positive satisfaction with neighborhood access to public transit, and 41% related to city level (Appendix A). However, there is still a high sense of unsafety in public transit, reported by 65% of the participants (Appendix A).

The subway line borders the metropolitan macro zones of Parque Regina (Vila Andrade and Campo Limpo) and the upper areas in Capão Redondo and Jardim São Luís in zones of reduction vulnerability (Figure 3, Figure 4). Grajaú has access to one public transit station, the last stop of the train line. Jardim Angela has no access to subway and train stations, only buses. Combining the subway and train layers from Geosampa, we calculated the frequency of points with proximity to public transit stations, using near buffers of 400m, 800m, and 1600m. These distances are respectively equivalent to 5, 10, and 20 minutes walking distances (Van Herzele and Wiedemann, 2003). Table 7 shows the frequency of points with proximity to public transit stations, subways, and trains, per urban service category. In the shopping category, 54% of the destination points were within a five-minute walking distance from a public transit station, while the other

categories had rates lower than 30%. Looking at destinations within a twenty-minute walking distance from public transit, shopping and leisure lead the ranking with 80% and 76% of destination distribution. Eating out, food purchase, health, and school has 70% or more destination points within 1600m of public transit stations. We can associate this fact with preferences for urban services close to public transit or with urban services being in commercial zones.

Category	Total points	400 (m)	%	800 (m)	%	1600 (m)	%
Banking	29	8	28	12	41	20	69
Community Engagement	18	2	11	5	28	10	56
Eating Out	29	8	28	11	38	21	72
Food Purchase	41	12	29	18	44	30	73
Health	19	2	11	7	37	14	74
Home	38	0	0	2	5	23	61
Leisure	66	16	24	32	48	50	76
Shopping	41	22	54	25	61	33	80
Religion	21	3	14	6	29	13	62
School	20	3	15	8	40	14	70
Social Services	4	1	25	1	25	2	50
Work	36	7	19	15	42	24	67
Sum	362	84	23	142	39	254	70

Table 7. Distribution of points with proximity to subways and train stations

3.4 Spatial analysis

3.4.1 Destination Clusters and macro zoning

To calculate the density of destination points, we used a pixel area of 100m^2. We used the macro zones as a reference to find the clusters on the development zones. Using

this case study to indicate the variation of urban services in the planning zones can indicate preferences for mobility within the macro zones.

Table 8 shows that the combined macro zones of metropolitan structuring, completed urban areas, and urbanization improvements are preferred for eating out (59%), leisure (63%), and shopping (63%). All the housing spaces and most essential urban services were in vulnerability zones. The majority of clusters of destinations are either on reduction of vulnerability (11.55points/m^2), metropolitan structuring zones (8.72 points/100m^2), and reduction of vulnerability and ecological restoration (8.54 points/m^2). None of the destination points were in rural areas, which indicates that these zones are not holding mobility referenced for urban services.

Figure 7 shows the clusters in the reduction of urban vulnerability are in Jardim São Luis (Parque Santo Antonio) and Campo Limpo (Parque Regina). Parque Santo Antonio and Parque Regina are subdivisions in the study neighborhoods, which have commercial centers with public transit, schools, small business, housing buildings, grocery stores, and civic services. The metropolitan structuring zones with more clusters were in Santo Amaro; a mixed-class upper neighborhood pointed as an area with better urban services. The neighborhood bears a recreational club (SENAC), an amusement park (Parque da Monica), and golf fields, malls (SP Market, Shopping Interlagos) that attract middle class and periphery residents. There are no large shopping malls in the study neighborhoods located in areas of vulnerability. Parque Brasil, a commercial area in Grajaú located by the last stop of the train line, had clusters in the macro zone to reduce urban and ecological vulnerability. The proximity to Grajau train station elevates

the commercial and economic importance of the area and marks the end of public transit accessibility and urban development. Further down Grajau, the macro zones are increasingly rural. Figure 8 shows the clusters in São Paulo CBD with destination clusters in Pinheiros, República, and Parque Ibirapuera, the last one a common destination past *rolezinho* events (Pereira, 2014; Marrara, 2015).

The intensity of clusters in SZ neighborhoods can be associated with higher satisfaction with public transit within the neighborhoods' area than city level (Appendix A). Although most of the structured zones with transit lines are out of Zona Sul, most destinations are within the Southern Zone and, therefore, the higher valuation of public transit in these areas.

Control and improvement of urban and ecological area	Reduction of urban vulnerability and ecological restoration	Reduction of urban vulnerability	Urbanization improvement	Completed urban areas	Metropolitan structuring	Macro zone
13.00	64.00	137.00	17.00	43.00	81.00	Total points
3.66	18.03	38.59	4.79	12.11	22.82	%
3.17	8.54	11.55	3.62	4.09	8.72	Maximum clusters (100m2)
3.45	17.24	48.28	6.90	3.45	20.69	Banking (%)
5.56	33.33	38.89	16.67	-	5.56	Community Engagement (%)
13.79	6.90	20.69	27.59	10.34	20.69	Eating Out (%)
2.44	24.39	58.54	14.63	-	-	Food Purchase (%)
-	15.79	47.37	21.05	-	15.79	Health (%)
-	31.58	68.42	-	-	-	Home (%)
3.23	11.29	22.58	29.03	6.45	27.42	Leisure (%)
4.88	9.76	21.95	43.90	2.44	17.07	Shopping (%)
5.00	20.00	45.00	25.00	5.00	-	Religion (%)
-	15.79	36.84	31.58	-	15.79	School (%)
-	50.00	-	50.00	-	-	Social Services (%)
2.86	17.14	34.29	14.29	17.14	14.29	Work (%)

Table 8. Distribution of destinations within the macro zones of São Paulo

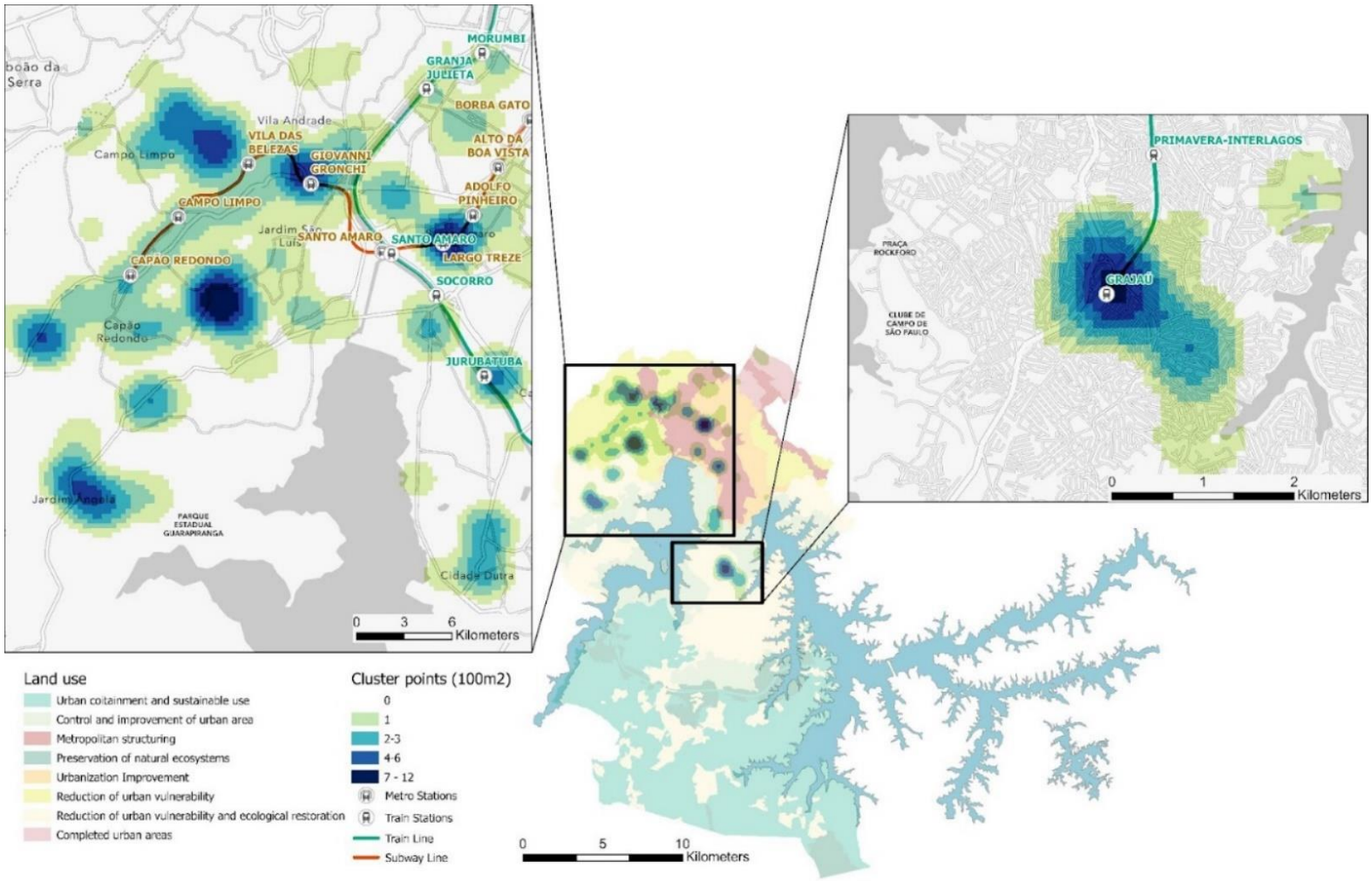

Figure 7. The concentration of destination points per 100m^2 in the Southern Zone

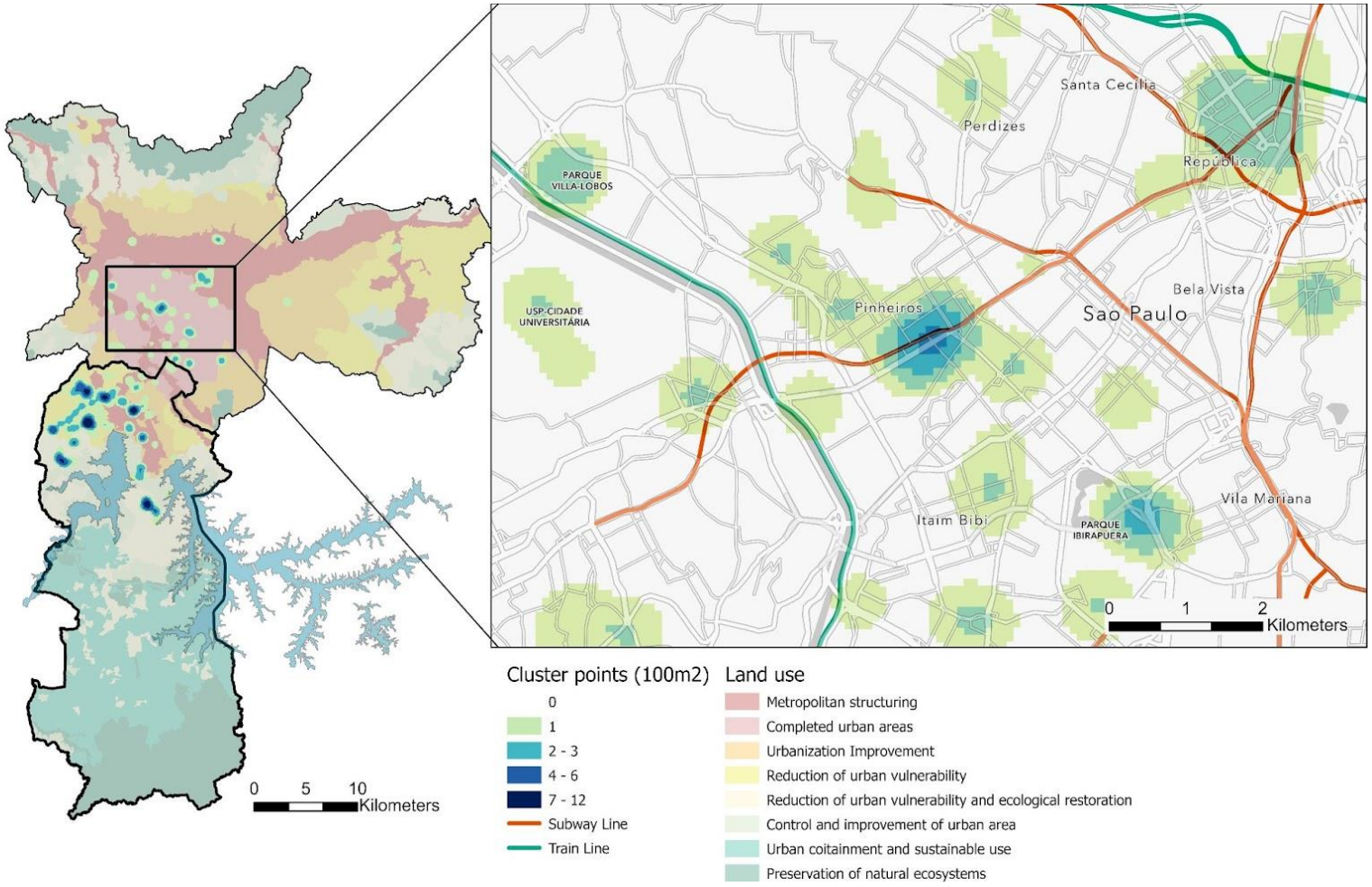

Figure 8. The concentration of destination points per $100m^2$ in São Paulo CBD

3.4.2 Destination clusters, urban service categories, and demographics

The density clusters displayed in Figures 7 and 8 show a concentration of essential services in vulnerable macro zones near housing spaces or entertainment services in economically developed zones. Further analysis using the Average Nearest Neighbor tool informed the urban services that had significant clusters, using the nearest neighbor ratio (NNR), z-scores (standard deviation), and p-value. NNR index uses the ratio of the observed mean distance to the expected mean distance. NNR values lower than 1 indicate clusters. We did not set a fixed area, using the standard minimum enclosing rectangle around the input features. Table 9 shows the results of the urban services categories for the average nearest neighbor.

Category	Frequency	Percentage (%)	NNR	z-score (NNR)	p-value	Pattern
Home	38	10.50	0.17	-9.75	0.00	Clustered
Banking	29	8.01	0.83	-1.76	0.08	Clustered
Community Engagement	18	4.97	0.57	-3.47	0.00	Clustered
Eating Out	29	8.01	1.01	0.11	0.91	Random
Food Purchase	41	11.33	0.61	-4.77	0.00	Clustered
Health	19	5.25	0.89	-0.89	0.37	Random
Leisure	66	18.23	0.64	5.60	0.00	Clustered
Shopping	41	11.33	0.62	-4.69	0.00	Clustered
Religion	21	5.80	0.99	-0.10	0.92	Random
School	20	5.52	1.11	0.95	0.34	Random
Social Services	4	1.10	6.01	19.16	0.00	Dispersed
Work	36	9.94	0.85	-1.71	0.09	Clustered
Total	362	100.00				

Table 9: Statistical significance and nearest neighbor ratio for urban services destinations

Eating out, health, religion, and school had random patterns. Social services had a dispersed pattern. However, the lower sample in this category of only four points can impact this result, with a low threshold for statistical analysis. Banking and work had a clustered pattern with a confidence level lower than 95%. As expected, the home category had a clustered pattern because all the housing spaces are within the Southern Zone study area. The other categories with more than 99% confidence clustered patterns were community engagement, food purchase, shopping, and leisure. Based on the interviews, we decided to explore shopping and leisure patterns within demographic categories. These two urban services represent a total choice of mobility and socioeconomic status, reflecting the role in the coexistence space. Therefore, we repeated the Average Nearest Neighbor analysis for shopping and leisure, separating the categories by socioeconomic indicators, as displayed in Table 10.

Variables		Leisure				Shopping			
Sociodemographic		Frequency	NNR	Pattern	p-value	Frequency	NNR	Pattern	p-value
Race	Afro-Brazilian	42	0.8	Clustered	0.00	24	0.7	Clustered	0.00
	Indigenous	3	4.6	Dispersed	0.00	2	173.7	Dispersed	0.00
	White	21	1.1	Random	0.17	15	0.9	Random	0.39
Income (Median income = R$ 3,200)	Lower - income (< 3,200)	26	0.8	Random	0.14	16	1.1	Random	0.43
	Higher income (>= 3,200)	40	0.8	Clustered	0.03	25	0.7	Clustered	0.00
Educational level	High school or less	22	0.8	Clustered	0.04	18	0.9	Random	0.45
	Higher education	44	0.9	Random	0.15	23	0.8	Clustered	0.10

Age	Under 35	27	1.2	Random	0.10	20	1.1	Random	0.60
	Over 35	39	0.6	Clustered	0.00	21	0.6	Clustered	0.00
Gender	Female	40	0.8	Clustered	0.01	25	0.9	Random	0.21
	Male	26	1.0	Random	0.72	16	1.3	Dispersed	0.02
Neighborhoods	Capão Redondo	0	-	-	-	0	-	-	-
	COHAB Adventista	6	1.9	Dispersed	0.00	5	0.5	Clustered	0.03
	Grajau	14	1.0	Random	0.82	4	3.9	Dispersed	0.00
	Jardim Nakamura	5	2.8	Dispersed	0.00	6	1.5	Dispersed	0.02
	Parque Regina	12	0.9	Random	0.74	8	1.3	Random	0.12
	Jardim São Luis	29	1.7	Dispersed	0.07	18	0.9	Random	0.42

Table 10. Statistical significance and nearest neighbor ratio for leisure and shopping destinations observed within socioeconomic indicators.

We found clustered patterns at a significance level higher than 99% in leisure for Afro-Brazilians and participants over 35 years old. For shopping, the most significant clusters were within Afro-Brazilians, higher income, and participants over 35 years old. In the Capão Redondo subdivision, there were no points for leisure and shopping.

Based on the findings, we explored individual maps and interview statements about mobility patterns from Afro-Brazilians over 35 years old using the Origin-Destination links tools to generate individual maps. However, the 362 destinations points from this study could have been a limiting factor for the Average Nearest Neighbor for

this tool. Observing other LVM studies (Garcia et al., 2017, McLain et al., 2017), the number of total collected points was higher.

3.4.3 Individual Maps

Using the Origin-Destination Links tool on ArcGIS Pro 2.6, we created four individual maps to show mobility patterns in São Paulo. The selected participants had different narratives, lived in distinct neighborhoods, and met cluster patterns of over 35 years old and Afro-Brazilians. The following subsections explored four individual maps, interview statements, and integration with the urban mobility explored on the results.

a. Parque Regina - Campo Limpo

Figure 9 shows mobility from an Afro-Brazilian male, over thirty-five, low-income. The participant has lived in the neighborhood for thirty-four years. The neighborhood change with the implementation of better schools, public transit, and green areas is an aspect that highlights his sense of place. He participated in a development project of a local park while working on a nonprofit.

All the urban services are within Southern Zone's boundaries and no further than three kilometers from his home. The person works as a driver for a mobility app now, therefore are no destinations for work. This mobility behavior also appeared in similar identities that live closer to metropolitan structuring zones of SZ, have lived long term in the neighborhood, and have a sense of belonging to the area. In northern regions of the Southern Zone, participants can find areas of economic development, better quality services, and a sense of place.

*"In Parque Regina, I am not considered Black – when I say this, they say 'you are not Black' – in Vila Madalena (*São Paulo CBD*), at the nonprofit, I was Black."*

The subject has a strong sense of belonging to the neighborhood and is politically aware of the socioeconomic issues of his area. In the interview, the subject mentioned his consciousness of class and race came with the lyrics of the hip hop movement and the work in the nonprofit, which allowed him to have overseas exchange experiences.

"The question of meritocracy, which totally annoys me – 'if I succeeded, anyone can'. But the math doesn't add up – with capitalism as it is, this doesn't work. Even if people want to, they all won't succeed. This doesn't all depend on the person."

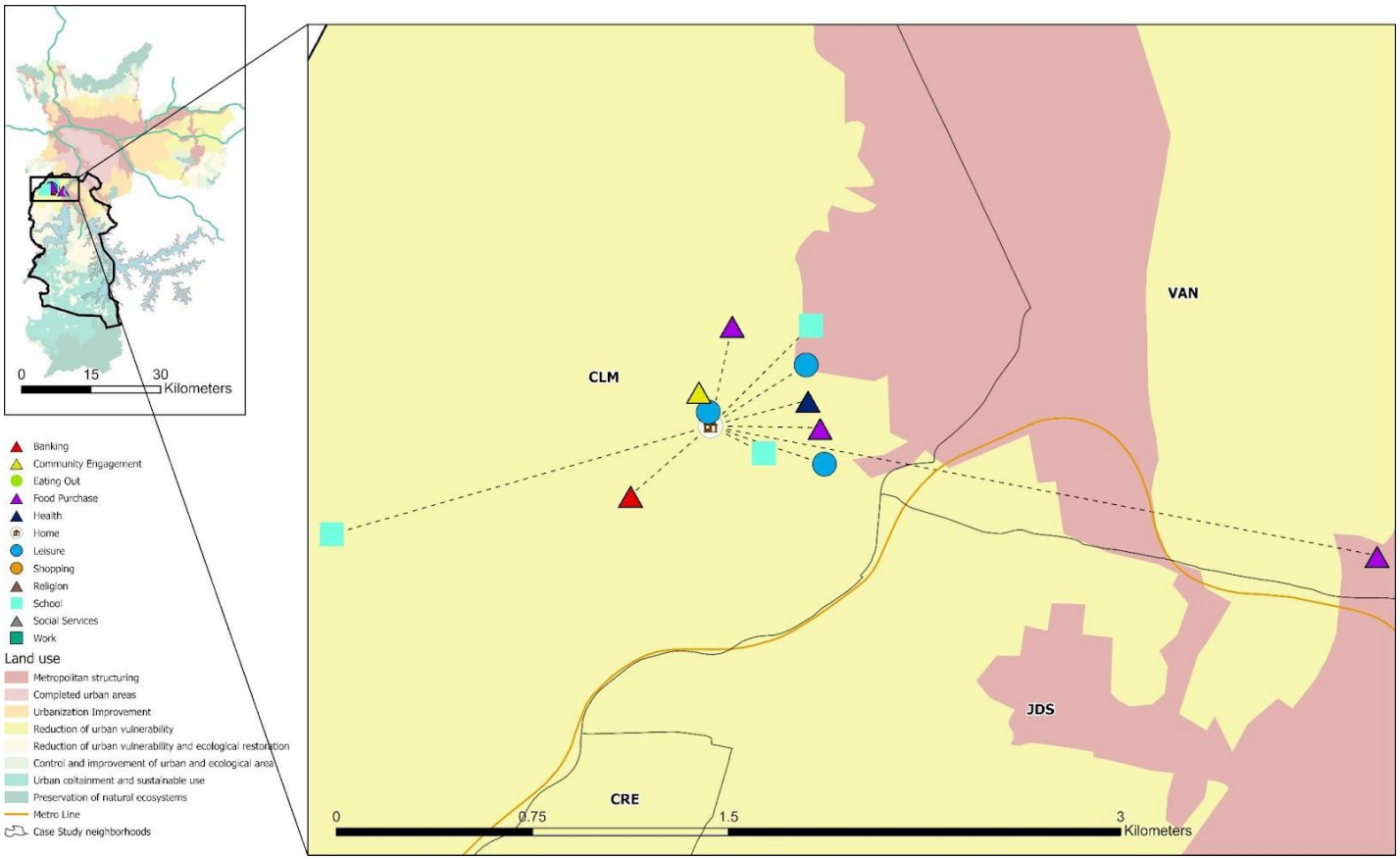

Figure 9. Individual mobility map from Parque Regina (Campo Limpo) participant

b. Jardim São Luís

Figure 10 shows a map from an Afro-Brazilian male, over thirty-five years old and with a high income. He is a long-term resident of the area and remembers the landscape change from rural to urban settlements. His map shows significant mobility with essential services (banking, religion, community engagement, health) in less than one kilometer. Then, leisure, eating out, and shopping services are up to fifteen kilometers from the housing space. Due to his job, the subject navigates in upper-middle-class coexistence spaces but feels displaced in these environments. As a result, he plans to move to a northern area in the Southern Zone, seeking better educational services for his children.

"I'm moving to Taboão to get more space, and not because of the neighborhood. I am friends with everyone here. I will rent out this apartment, as it is not good to sell patrimony. The new apartment is in a gated community and has three bedrooms, pool, gym, party room

playground, 24h security. It costs R$ 400,000, and I will pay R$ 1,600 per month for 30 years."

The urban services destinations within the neighborhood are all in vulnerability zones. The destinations out his neighborhood are in macro zones of metropolitan structuring, completed urban areas, urbanization improvement, and control and improvement for urban and ecological areas. The son of this participant is 21 years old

white, high income, and with higher education. He was also interviewed and had all destination points outside of the neighborhood and vulnerability areas. People in the neighborhood see him as a wealthy person. During the interview, he mentioned:

"I coexist with upper middle class people in my job. It is okay, I don't mind. But I would not bring anyone from work to my home, due to organized crime activities on my street. (...) I like the neighborhood, great public transit, but the violence is overwhelming. People from here think I am snob. I want to leave this neighborhood. (...)I'm afraid of me or my sisters being assaulted."

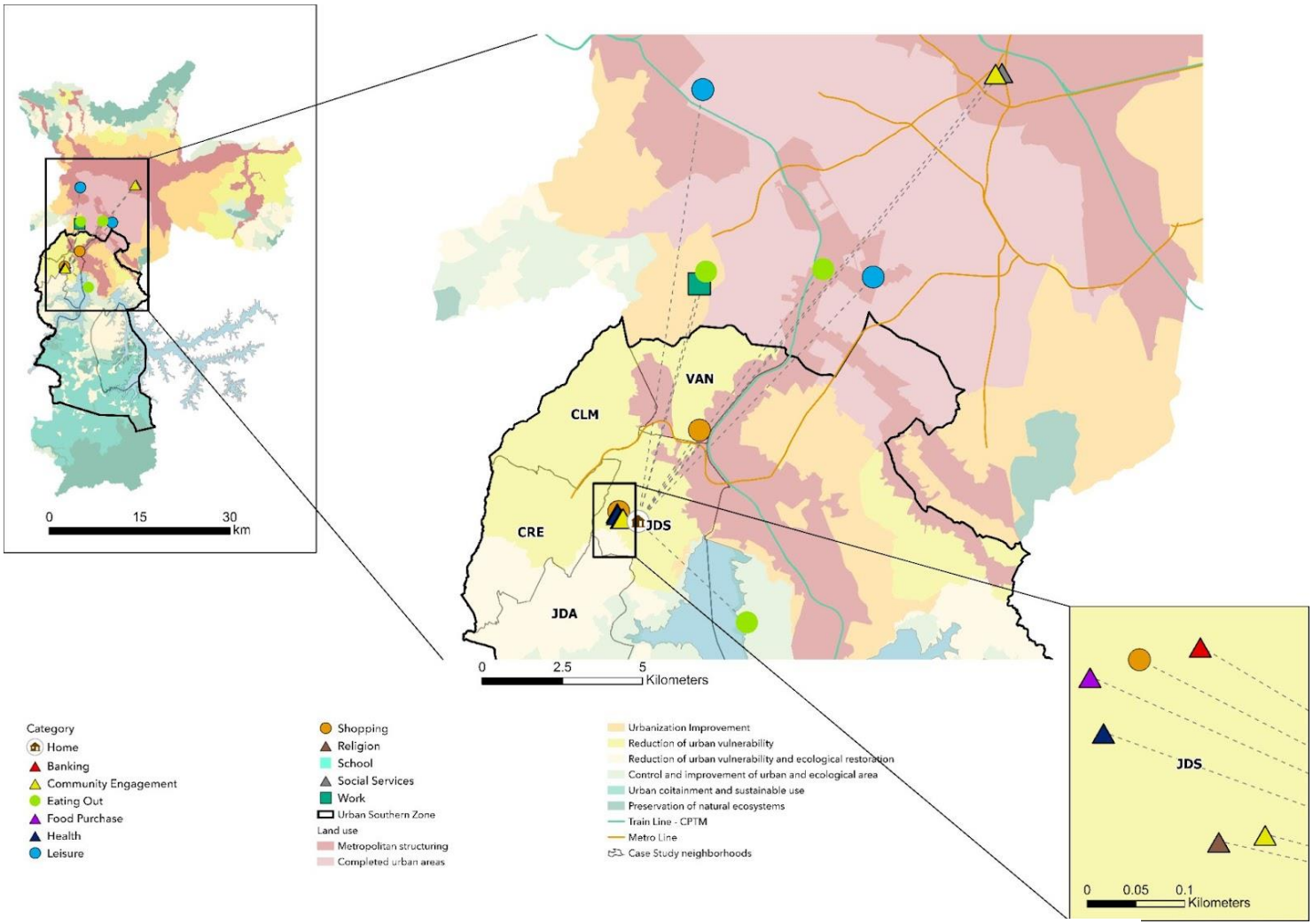

Figure 10. Individual mobility map from Jardim São Luís participant

c. Grajau

Figure 11 shows a map from an Afro-Brazilian woman, slightly older than 35 years old, with higher education and low income. Most urban services were within four kilometers of her neighborhood in Grajau, despite school, food purchase, and one leisure activity about twenty-five kilometers away downtown. She mentioned that racism and classism are evident in CBD through disdainful behaviors, inappropriate comments, and segregation.

*"My relationships at college are cordial and respectful, despite class differences. I'm busy, so I don't go out with classmates. (...) There is a classmate who always asks 'How is Grajau?' She said she couldn't go to see the event that I invited my college classmates to attend (*the subject is part of an artistic group*). She and her husband were afraid they would get lost. 'The probability of us going there and not coming back alive is great.' - she stated. She lives in Paulista* (São Paulo CBD)*, and asked 'Why don't you host an art event downtown?' My classmate is studying Sociology in theory, but not in practice."*

The subject sees her role in the coexistence space as a form of resistance, representation, reclamation of spaces, and to educate classmates about periphery culture.

"I went to Mexico for work and spent a week in Cancún with my "rich" white friends. They loaned me money. I would do it differently now, and not go to Cancún. Culturally, I was the only one who thought it was crazy to swim with dolphins or eat at a restaurant with sharks underneath. I had fun, but felt out of place."

Growing up in Grajau, the subject feels connected to the place through memories and art projects she has been engaged in for years. She mentioned the art projects brought production of space activities for youth, the LGBTQ community, and periphery identities.

"I like everything here, except violence. Grajaú is the chaos, but the culture movement has increased here in the past four years. (...) Impact art movements and LGBT presence is intense in Grajaú, and not in other periphery spaces."

According to the participant, the government does not support the community and can contribute to violence. Areas designated for cultural activities and environmental protection can be associated with violence and fear.

"The neighborhood is completely different than it was in the '80s and '90s when I would wake up with bodies next to my house, as was happening now in Jardim Ângela. I grew up in this context, losing friends when I was a teenager. The last one died from drinking, but it is all related to this tough life. The reality was like the music of the Racionais (influential hip hop group). Now, violence is now more at the hands of that State, whereas before it was between gangs. The police always killed – this isn't news – but it is more visible today. Along the dams, people used to dispose dead bodies. But people are still being killed, including one last year near areas of cultural activities. Violence spread out everywhere."

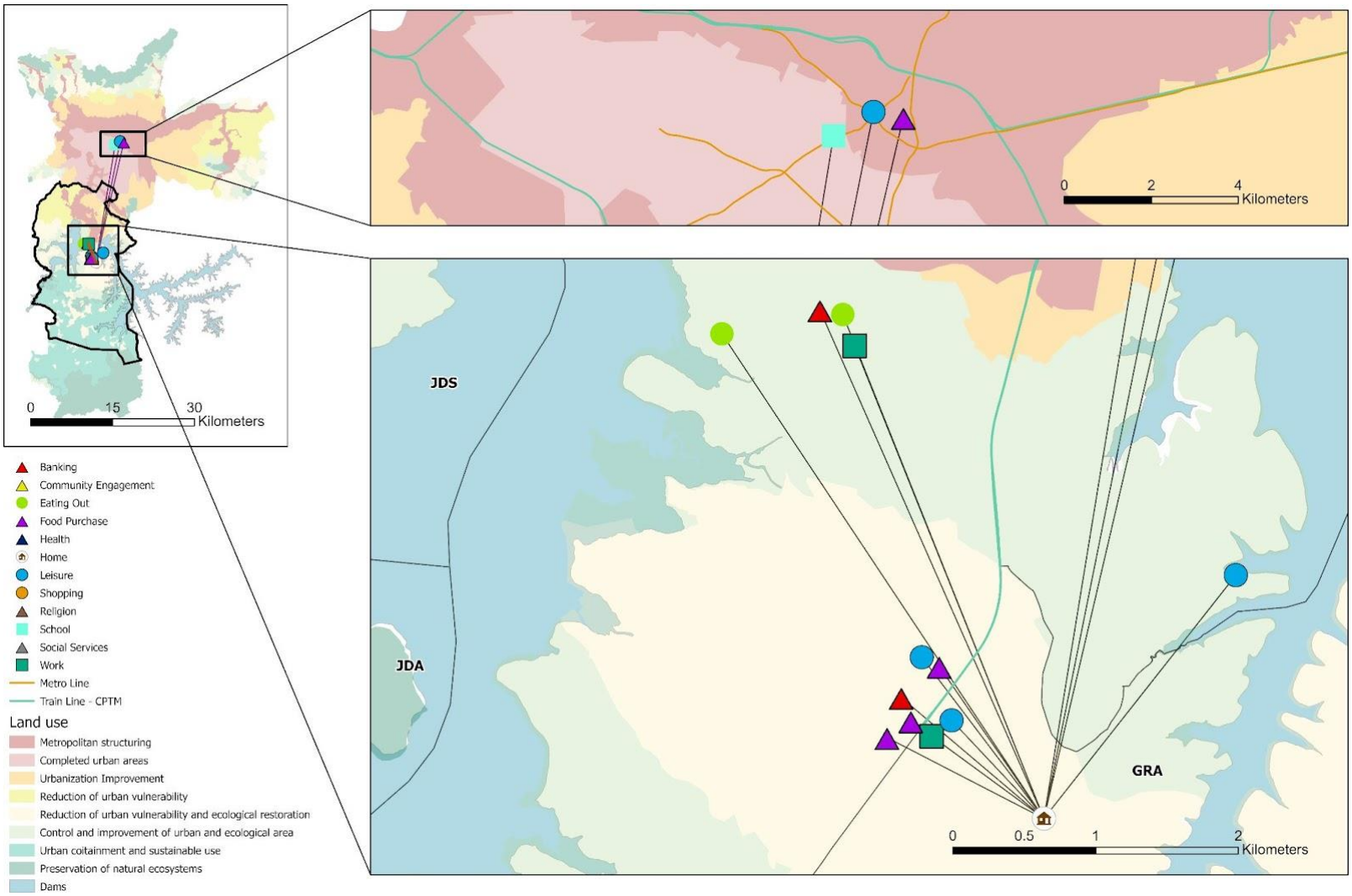

Figure 11. Individual mobility map from Grajau participant

d. COHAB Adventista - Capão Redondo

Figure 12 shows a map from an Afro-Brazilian woman, over 35 years old, low-income, and with low educational attainment. The destinations points for urban services were all within the Southern Zone, no further than six kilometers. The participant housing space was acquired in the ’80s through the *mutirão* collective construction. She was happy to be a homeowner and has a good relationship with neighbors. In her youth, she participated in community engagement activities.

“I participated in the mutirão movement, where most of the leadership and participants were women. I like politics and used to attend several city council, unions, and community association meetings. If I had more access to education, I would be a community representative.”

She is unhappy with racism and misogyny. She described situations in the work environment (she is retired now) where the boss was racist and benefited employers from the same social class and interests.

“It is an unequal country. Especially for women, who earn less than men even doing the same job. Blacks also suffer, because in the job market if there is a white candidate, even with lower qualifications, the Black one loses the position. (...) This country belongs to Black and Indigenous. If whites don’t like to see Blacks, go live in Germany.”

The participant reported being a past victim of domestic violence. In addition, other tragedies happened in her family, such as the imprisonment of a grandson, a son who is an alcoholic, and a daughter that has problems with drugs. Currently, she lives with one of the daughters and one of the grandchildren. The daughter, Afro-Brazilian over 35 years old, was also interviewed, and the destinations of the urban services were all within the Capão Redondo neighborhood. The daughter had a nursing degree, acquired with the support of a social welfare program for college funding and her church, but she was currently unemployed. Like the mother, the daughter was disappointed with violence and lack of opportunities in the area:

"The neighborhood is in a good location, close to commercial areas and public transit. However, with the economic crisis, there are many people unemployed and using drugs. The neighborhood is destroyed. Unemployed youth led to a path of drugs and violence. I learn how to live with people from different social classes, but it is unfair. I am dissatisfied with my economic situation."

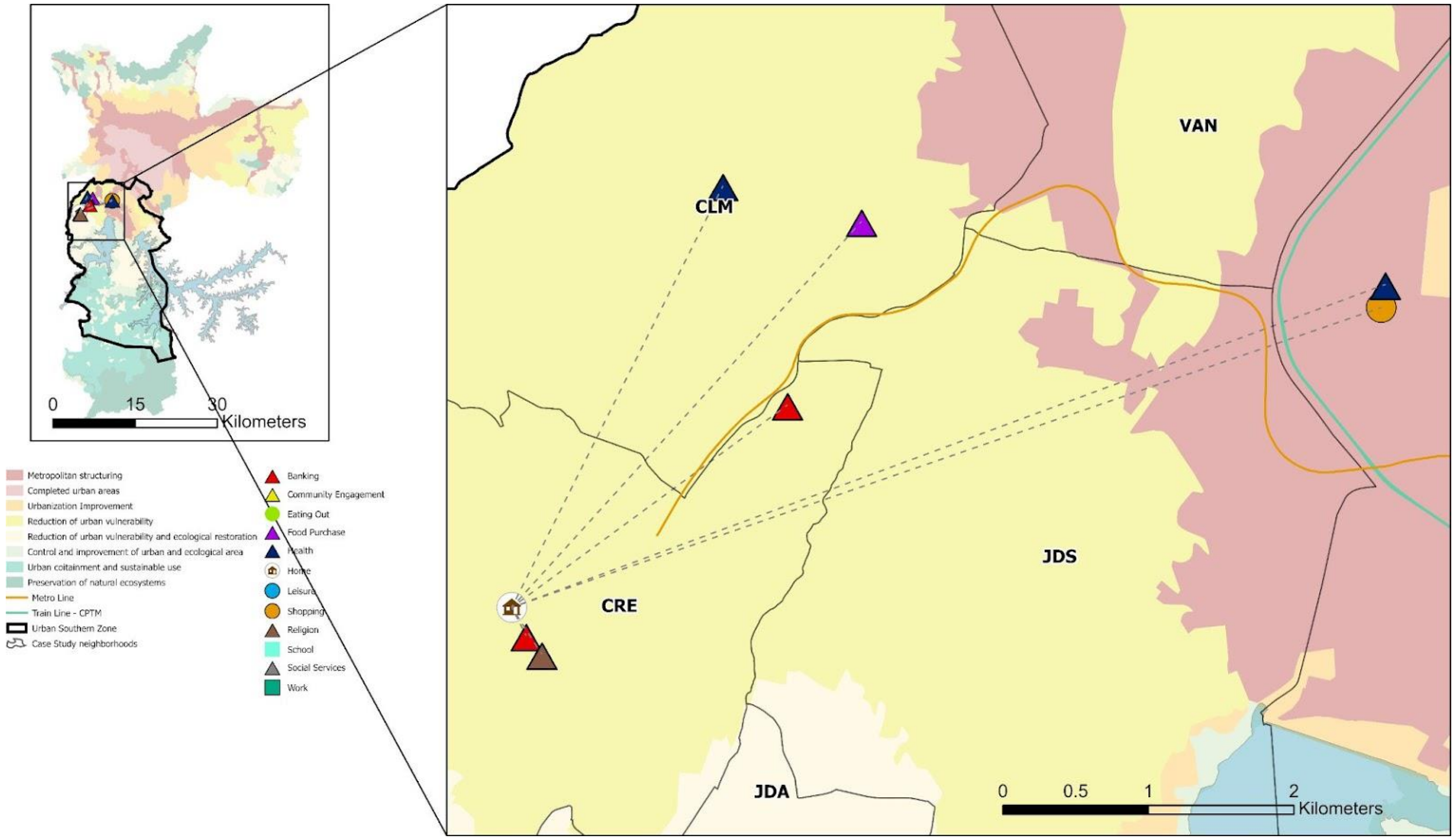

Figure 12. Individual mobility map from a participant in COHAB Adventista, Capão Redondo

The four observed maps show how geography, income, and race are the three major segregation actors in São Paulo (Kowarick and Frugoli, 2016). From São Paulo CBD, the perceptions of Southern Zone geography associate the area with violence, marginalized identities, and vulnerability. And as displayed in Figure 1, there are more population density, Afro-Brazilians, and lower-income identities in the periphery zones, such as the Southern Zone.

The Grajau participant mentioned being mocked by classmates on her SZ geography, especially with Grajau being a further south region. All the participants described good relationships with neighbors, identity with local geographic aspects such as the presence of family members, participation in associations, religious groups, connection with hip hop culture, and other forms of production of space. Most people from the center of São Paulo do not typically perceive these positive identity factors. And as mentioned by the subjects, most people living in São Paulo CBD are unwilling to visit the Southern Zone; therefore, the segregation continues. The mitigation for geography segregation can happen with the changing of the housing space, as the example of a family in Jardim Sao Luis. After navigating to destinations in São Paulo CBD with coworkers, the family decided to move to a safer region with more amenities in a closed condo.

The individual maps from COHAB Adventista and Parque Regina subjects show mobility only within the Southern Zone. In both cases, income was a limiting factor for the subjects, and staying in the neighborhood can save financial resources. The Southern

Zone offers basic services for affordable prices, and leaving the neighborhoods for services can be extravagant for a short budget.

Racial segregation can happen independently with structural racism; however, lower-income and periphery geography enhance the discrimination. For example, in COHAB Adventista, two generations of Black women faced racial discrimination, which impacted their ability to find steady jobs. The mother also highlighted the discrimination against women in work and leadership environments, even with qualifications and experience.

Education and stable jobs that can increase income are the keys to overcoming the geographic, economic, and racial segregation that follows residents from the Southern Zone. Education supports the consciousness of class and race, reclamation of spaces, and perspectives for better opportunities. Cultural initiatives, social welfare programs, and support of the third sector were other mentioned measures that mitigate segregation and promote the production of spaces in the Southern Zone.

4. Discussion

This section reviewed the results, the literature review on the Southern Zone, and the history of segregation and vulnerability in São Paulo to understand mobility patterns. First, we discuss aspects that influenced the preference for clustered destinations. Then, we observed how vulnerability, segregation, and urban planning impact mobility patterns and sense of belonging. Finally, we reviewed the LVM methodology, the potential impact of this study on the literature, the limitations, and recommendations.

4.1 Preferred locations

In São Paulo, social mobility through better wages, education, and cultural capital differ from belonging to a middle class. The geography of the housing space and coexistence space plays a big role in the sense of belonging for the individual perception and the social perception of the individual. The periphery geography impacts the identity and the interactions in the coexistence space. SZ residents' identities rely not only on their sense of place but also on how politics, intellectuals, and the traditional middle class perceive them. For most participants, education is the key to staying away from violence and finding better work opportunities.

Residents who commute to the CBD for education services, work, shopping, and leisure can contact the middle class and upper middle class population of São Paulo. However, the sense of belonging and acceptance in these downtown locations can be influenced by race, income, appearance, access to education, among other factors.

Living in a housing space in a periphery area impedes *social climbing* on the role of the coexistence space, despite educational attainment and higher wages. Educational attainment and better wages can allow urban mobility to expensive leisure and eating out venues and common goods but do not change the perception of social class due to the *trapped* geographic identity. Housing spaces in vulnerable zones offer limited access to *upscale* urban services. In the Southern Zone, the destination clusters were close to participants' housing spaces. In the interviews, participants informed that neighborhoods with proximity to commercial areas with public transportation favored destinations, such as Parque Regina and Grajaú.

Urban services out of the Southern Zone promote interactions with upper classes, fulfilling the experience for the more diverse services. Still, destinations in the Southern Zone accomplish belonging in the coexistence space and intrinsic relationships with neighbors. Moreover, the social resilience in finding a sense of place in an area the government targeted as vulnerable, challenges the state's expectation for the production of space and creates opportunities for bottom-up planning strategies.

4.2 Segregation and vulnerability

The state's abandonment of periphery neighborhoods results in uneven access to education, fair wages, and lack of support for family traumas, such as domestic violence, proximity to crime, and poor housing. Socioeconomic indicators as race, income, and education attainment can shape a sense of belonging and the role in the coexistence space. Furthermore, the Southern Zone geography significantly influences the sense of place. The subjects indicated that they could navigate to locations out of the Southern Zone for shopping, leisure, work, school, but because their housing space was in SZ, they were not totally accepted in these spaces. There is also a sense that further south locations have precarious urban services and more vulnerability. According to the interviews and the cluster analysis results (Figure 7, Figure 8, Table 8), there is a concentration of destination points in São Paulo CBD and the upper area of SZ. According to the initial vulnerability mapping (Figure 1, Figure 3, Figure 4), these areas have higher income, more infrastructure, and better access to public transit.

When asked about the critical problems of the neighborhoods, the top answers were the high presence of corruption, public safety and violence, unemployment, poverty,

social inequality, racism, and lack of access to quality urban services (Appendix A). The critical urban vulnerability issue is violence, displayed in many forms of domestic violence, drug traffic violence, robberies, and assault. Several participants have lost relatives to the drug war, witnessed dead bodies in nearby locations, and feared militia and drug traffic authorities.

Even though most of the Southern Zone bears critical ecological protection zones, most participants did not verbalize concerns about environmental degradation. Only 3% considered environmental issues as top priorities (Appendix A). Violence and social vulnerability issues overcome the concerns about ecological vulnerability. The environmental problems mentioned were high dissatisfaction with the maintenance of manholes, galleries, canals, and flood control (35%), preservation of public spaces (44%), amount of green infrastructures (45%), and public cleaning and waste service (46%). None of the urban services destinations were within environmental protection macro zones that are not easily accessible through public transit.

Abandoned green areas in vulnerable neighborhoods can generate fear, lack of sense of place, and discouragement to engage with nature (Brownlow, 2006). SMP aims to include collective actions for ecological restoration; however, there is a disconnection between the goals of the state and the community. All the green initiatives (tree planting, community gardens, ethnobotany studies, use of medicinal plants) mentioned in the interviews were from grassroots groups, independent local producers, NGOs, and schools. SMP describes complex environmental planning strategies, such as land use according to soil classification, reforestation on mining areas, universal access to basic

sanitation, and integration of public transit with bike lanes. These strategies resemble international scholarship of green infrastructures (Pauleit et al., 2017, Gordon et al., 2018) and combine ecological and social vulnerability mitigation. However, in the present study, periphery identities declared dissatisfaction with the existence and maintenance of green infrastructures.

Similar to the SMP proposal, other cities in Latin America have explored sustainable planning strategies to reduce vulnerability and promote ecological engagement with the population. For example, in Concepcíon, Chile, land suitability indicators analyzed critical areas for urban containment and nature conservation. The indicators included monitoring and protecting susceptible areas of natural hazards, calculating the risks of unstable housing in hazardous locations, and respecting the natural heritage values (Rojas, Pino, Jaque, 2013). Steinberg (2005) observed that strategic plans in metropolises of South America and Cuba are vulnerable to political changes, corruption, limitations of financial resources, and consequences of urban poverty. In the current political ecology scenario, poverty and climate change are urgent issues that impact the well-being of vulnerable populations. In regions that combine poverty, susceptibility to natural disasters, and environmental degradation, such as the macro zone of reduction of urban vulnerability and ecological restoration, where 32% of the participants have housing spaces, resilience measures should encompass social and environmental approaches altogether. Social issues, such as violent traumas, urban poverty, and food insecurity, immediately impact the subjects' routines. Environmental

degradation issues have a long-term impact on the landscape, require expensive engineering solutions, and are irreversible if not urgently treated.

4.3 Observations, limitations, and recommendations for LVM studies

This case study targeted previously poor participants of the SZ, and the mobility patterns represented public perceptions of recent political and economic shifts. Most subjects would not identify themselves as middle class individuals, arguing that the middle class is a social construction based on buying power, lifestyle, and sense of belonging in coexistence spaces. Future studies with the same sample or replication of the study in other areas of São Paulo could clarify broad mobility patterns and sense of belonging through the city.

Combining interviews, socioeconomic indicators, and landscape value mapping resulted in a technical challenge where not all variables (urban services, socioeconomic indicators) had the exact representation. Otherwise, we could have run a geographical regression analysis to find which variables could explain the mobility patterns. Observing the demographic variables' distribution allowed us to find vulnerability patterns for urban services within the socioeconomic indicators. Future analysis can compare the socioeconomic indicators from survey answers and mapping clusters to increase the validity of the research design.

In our study, the points were collected through printed maps (Figure 13), and there was a chance of data loss during the digitalization. As a collective paper, the conceptualization, the interviews, the digitalization of the points, and the data analysis

encompassed a team of scholars that were not necessarily working altogether during the whole research process. Our findings represent a case study in the Southern Zone and an alternative way to collect mobility data. The thirty-eight participants might not represent the mobility pattern of all SZ residents, but the statements obtained on the interviews and the clusters in either vulnerability zones or economically developed areas were consistent with the urban planning concerns on SMP. The findings on surveys, interviews, and spatial analysis corroborated that the geographic sense of belonging can impact mobility.

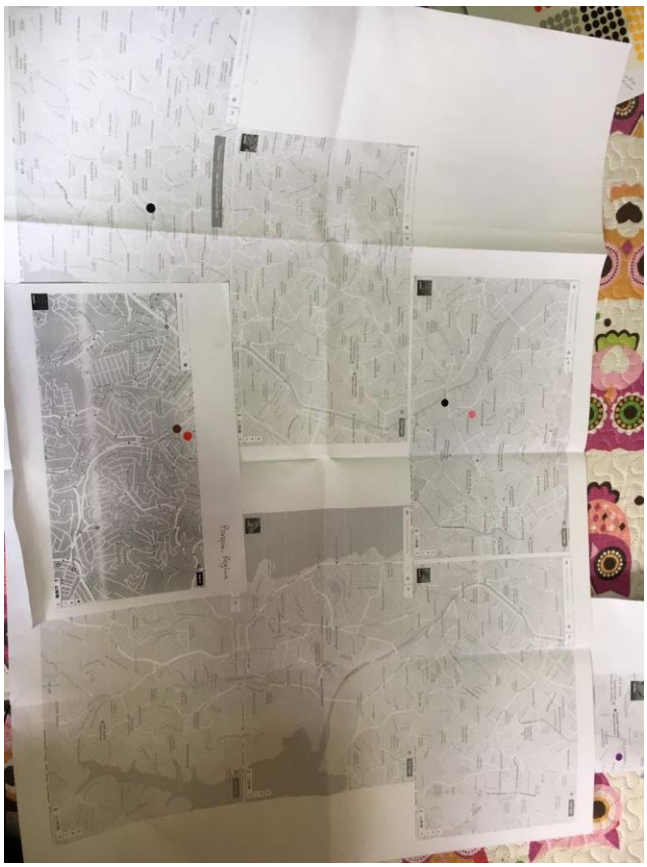

Figure 13. Printed maps, using color sticks points to represent the destinations of the urban services

5. Conclusion

Our findings align with previous research on São Paulo periphery ethnographies (Caldeira, 2000; Marques and Kowarick, 2011) and Southern Zone focused studies (Klein et al., 2018, Klein, 2019). Caldeira (2000) approached segregation through the landscape of gated communities, social exclusion through classism, and conflict of cultures. One way to overcome segregation was by producing art spaces that represented the sense of belonging or non-belonging in the coexistence space.

Marques and Kowarick (2011) and Kowarick and Frugoli Jr. (2016) explored the landscape transformations in São Paulo and the inputs of production of space in the changes in the housing space, coexistence space, and production of space. Over the years, public policies supported economic development by increasing income and the availability of jobs. Initially, income was not necessarily associated with an increase in education but with the strength of Brazil's economic development. Governmental planning agencies can develop measures to reduce vulnerability in coexistence spaces and support grassroots' production of space. Increase in income, access to higher education, and buying power allow residents to have more satisfaction with their housing space.

Marques and Kowarick (2011) also used mixed-methods with qualitative, quantitative, and spatial analysis to comprehend urban resilience and segregation in São Paulo. Segregation happens to three major identities: race, income, and geography. Therefore, Afro-Brazilians, low-income, and peripheral identities suffer triple segregation

forces. Corruption, abandonment of state, and lack of infrastructure push resilience forces through community support and grassroots initiatives.

The findings of this paper align with two other publications from the same research grant. Klein et al., (2018) explored how the socioeconomic shift during PT (Workers Political Party) social democracy impacted household income, access to production goods, education, housing, and other services. Before PT, the federal administration was following a neoliberal agenda. Klein (2019) navigated through the coexistence spaces and grassroots initiatives to produce space in the Southern Zone as a theater group and an environmental council. Integrating into community leaders' routine and political perspectives in the Southern Zone, he disclosed new positive intersected periphery identities that facilitated initiatives from a democracy that promoted social welfare programs.

In this paper, we reviewed and confirmed the existence of segregation and its impact on urban mobility and access to services. Including information about how segregated spaces are located in vulnerable zones through survey, interview, and spatial analysis data can supply materials for local planning initiatives in the Southern Zone. SMP used participatory planning to elaborate mitigation measures for urban and ecological vulnerability. The spatial analysis in urban mobility identified clustered areas for urban services, supporting future PPGIS studies in São Paulo and Brazil.

Today, Brazil has a government that aligns with neoliberal policies with quite different expectations from the data collection period for this project. Neoliberal policies promote economic competition, but the current socio-economic scenario of the country

shows a financial decline, inflation, high rates of unemployment, increase in poverty, and several environmental problems. Still, Brazil leads cases and fatalities in the COVID-19 pandemic, which aggravates the tragic scenario and expands the inequality gap.

This study found that power, class, and segregation are associated with geography in Sao Paulo. Despite the individual efforts for class mobility, periphery areas need more attention from planning agencies to reduce the burden of segregation. An urgent socioecological agenda could restructure identity values and promote sustainable empowerment of semi-lost community values, as proposed in frameworks of reimagination.

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Appendix A: Survey results

Biggest problem in Brazil

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Corruption	178	44.4	45.9	45.9
	Economic growth	19	4.7	4.9	50.8
	Unemployment	58	14.5	14.9	65.7
	Inequality between men and women	1	0.2	0.3	66.0
	Social inequality	24	6.0	6.2	72.2
	Homophobia	5	1.2	1.3	73.5
	Inflation	7	1.7	1.8	75.3
	The environment/ecology	1	0.2	0.3	75.5
	Urban mobility	1	0.2	0.3	75.8
	Poverty	16	4.0	4.1	79.9
	Social security	2	0.5	0.5	80.4
	Quality of education	14	3.5	3.6	84.0
	Quality of health system	22	5.5	5.7	89.7
	Racism	12	3.0	3.1	92.8
	Public safety and violence	28	7.0	7.2	100.0
	Total	388	96.8	100.0	
Missing	System	13	3.2		
Total		401	100.0		

2nd biggest problem in Brazil

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Corruption	35	8.7	9.1	9.1
	Economic growth	13	3.2	3.4	12.5
	Unemployment	85	21.2	22.1	34.5
	Inequality between men and women	3	0.7	0.8	35.3
	Social inequality	28	7.0	7.3	42.6
	Homophobia	11	2.7	2.9	45.5
	Inflation	26	6.5	6.8	52.2

	The environment/ecology	3	0.7	0.8	53.0
	Urban mobility	3	0.7	0.8	53.8
	Poverty	53	13.2	13.8	67.5
	Social security	4	1.0	1.0	68.6
	Quality of education	33	8.2	8.6	77.1
	Quality of health system	33	8.2	8.6	85.7
	Racism	15	3.7	3.9	89.6
	Public safety and violence	40	10.0	10.4	100.0
	Total	385	96.0	100.0	
Missing	System	16	4.0		
Total		401	100.0		

3rd biggest problem in Brazil

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Corruption	23	5.7	6.0	6.0
	Economic growth	10	2.5	2.6	8.6
	Unemployment	38	9.5	9.9	18.5
	Inequality between men and women	10	2.5	2.6	21.1
	Social inequality	22	5.5	5.7	26.8
	Homophobia	9	2.2	2.3	29.2
	Inflation	15	3.7	3.9	33.1
	The environment/ecology	7	1.7	1.8	34.9
	Urban mobility	4	1.0	1.0	35.9
	Poverty	35	8.7	9.1	45.1
	Social security	2	0.5	0.5	45.6
	Quality of education	43	10.7	11.2	56.8
	Quality of health system	58	14.5	15.1	71.9
	Racism	50	12.5	13.0	84.9
	Public safety and violence	58	14.5	15.1	100.0
	Total	384	95.8	100.0	
Missing	System	17	4.2		
Total		401	100.0		

Environment ranked in top 3 problems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	373	93.0	97.1	97.1
	Yes	11	2.7	2.9	100.0
	Total	384	95.8	100.0	
Missing	System	17	4.2		
Total		401	100.0		

Public Safety and Violence ranked in top 3 problems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	258	64.3	67.2	67.2
	Yes	126	31.4	32.8	100.0
	Total	384	95.8	100.0	
Missing	System	17	4.2		
Total		401	100.0		

Level of satisfaction at neighborhood level with maintenance of manholes, galleries, canals, and flood control.

			Frequency	Percent	Valid Percent
	Valid	very unsatisfied	61	15.2	15.7
		unsatisfied	76	19.0	19.5
		indifferent	81	20.2	20.8
		satisfied	111	27.7	28.5
		very satisfied	60	15.0	15.4
		Total	389	97.0	100.0
	Missing	System	12	3.0	
	Total		401	100.0	

Level of satisfaction at city level with public cleaning and waste service

			Frequency	Percent	Valid Percent
	Valid	very unsatisfied	100	24.9	25.4
		unsatisfied	80	20.0	20.4
		indifferent	73	18.2	18.6
		satisfied	87	21.7	22.1
		very satisfied	53	13.2	13.5

		Total	393	98.0	100.0
	Missing	System	8	2.0	
	Total		401	100.0	

Level of satisfaction at city level with amount of green spaces in city

			Frequency	Percent	Valid Percent
	Valid	very unsatisfied	71	17.7	18.3
		unsatisfied	104	25.9	26.7
		indifferent	84	20.9	21.6
		satisfied	87	21.7	22.4
		very satisfied	43	10.7	11.1
		Total	389	97.0	100.0
	Missing	System	12	3.0	
	Total		401	100.0	

Any civic participation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	368	91.8	91.8	91.8
	Yes	33	8.2	8.2	100.0
	Total	401	100.0	100.0	

Level of satisfaction at city level with system of public transportation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very unsatisfied	80	20.0	20.3	20.3
	unsatisfied	69	17.2	17.5	37.7
	indifferent	84	20.9	21.3	59.0
	satisfied	109	27.2	27.6	86.6
	very satisfied	53	13.2	13.4	100.0
	Total	395	98.5	100.0	
Missing	System	6	1.5		
Total		401	100.0		

Level of satisfaction at city level with preservation of public spaces

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very unsatisfied	67	16.7	17.2	17.2

	unsatisfied	106	26.4	27.2	44.4
	indifferent	117	29.2	30.0	74.4
	satisfied	72	18.0	18.5	92.8
	very satisfied	28	7.0	7.2	100.0
	Total	390	97.3	100.0	
Missing	System	11	2.7		
Total		401	100.0		

Table 11. Supplementary survey results

Appendix B: Distances (km) of destination points aggregated by neighborhoods

Neighborhoods	Category	Frequency	Mean	Median	Max	Min	SD
Capão Redondo (Capão Redondo and COHAB Adventista)	Banking	6	2.39	1.99	7.42	0.17	2.66
	Community Engagement	3	7.72	3.59	19.31	0.24	10.18
	Eating Out	0	0.00	0.00	0.00	0.00	0.00
	Food Purchase	4	2.28	1.91	5.04	0.24	2.42
	Health	4	4.41	4.82	7.69	0.33	3.30
	Leisure	6	3.75	2.99	7.27	0.20	2.91
	Other Shopping	5	12.77	7.71	21.49	6.32	7.79
	Religion	1	0.38	0.38	0.38	0.38	0.00
	School	2	11.92	11.92	19.44	4.41	10.62
	Social Services	0	-	-	-	-	-
	Work	5	5.03	7.04	10.01	0.31	4.45
Vila Andrade and Campo Limpo (Parque Regina)	Banking	5	1.34	1.37	1.97	0.40	0.62
	Community Engagement	3	2.18	1.69	4.72	0.14	2.33
	Eating Out	4	2.68	1.58	7.13	0.42	3.13
	Food Purchase	13	1.30	1.11	2.91	0.30	0.92
	Health	3	0.36	0.39	0.44	0.26	0.09
	Leisure	12	16.52	7.86	56.77	0.05	20.98
	Other Shopping	8	4.62	4.73	9.09	1.89	2.30
	Religion	12	4.93	2.35	22.56	0.04	6.52
	School	5	2.58	0.54	10.22	0.23	4.30
	Social Services	0	-	-	-	-	-
	Work	9	4.12	2.55	10.45	0.16	3.47
Jardim São Luis	Banking	6	8.40	12.99	13.98	0.48	7.17
	Community Engagement	4	5.31	1.46	17.85	0.49	8.38
	Eating Out	17	7.90	8.66	12.30	2.90	3.26
	Food Purchase	11	1.83	1.13	4.66	0.51	1.46
	Health	7	6.99	6.95	14.30	0.59	6.69

	Leisure	29	11.81	11.86	50.14	0.27	9.60
	Other Shopping	18	6.67	6.68	12.97	0.54	4.69
	Religion	4	4.99	0.83	17.77	0.53	8.52
	School	4	4.49	1.44	14.95	0.15	7.02
	Social Services	1	17.99	17.99	17.99	17.99	0.00
	Work	12	10.83	7.63	46.57	0.15	13.15
Grajau	Banking	9	7.42	7.42	22.75	0.98	6.93
	Community Engagement	4	5.09	2.46	14.44	0.98	6.35
	Eating Out	4	12.53	12.52	21.28	3.80	9.93
	Food Purchase	9	4.37	1.24	22.55	1.04	7.21
	Health	3	8.95	10.96	15.14	0.75	7.40
	Leisure	14	11.67	12.39	26.94	0.94	10.19
	Other Shopping	4	6.56	5.08	15.08	1.01	6.10
	Religion	1	1.19	1.19	1.19	1.19	0.00
	School	6	17.57	13.68	40.11	6.14	12.31
	Social Services	1	11.21	11.21	11.21	11.21	0.00
	Work	4	6.09	2.27	19.06	0.77	8.74
Jardim Angela (Jardim Nakamura)	Banking	3	2.27	2.51	3.93	0.37	1.80
	Community Engagement	4	1.05	0.75	2.27	0.42	0.84
	Eating Out	4	3.71	2.44	9.86	0.09	4.56
	Food Purchase	4	4.04	3.39	8.37	1.03	3.62
	Health	2	0.31	0.31	0.44	0.19	0.17
	Leisure	5	6.17	4.52	16.30	0.32	6.67
	Other Shopping	6	4.89	4.59	9.41	0.46	3.82
	Religion	3	0.48	0.39	0.84	0.20	0.33
	School	3	1.08	0.48	2.28	0.47	1.04
	Social Services	2	1.34	1.34	2.07	0.60	1.04
	Work	6	2.57	2.01	6.91	0.24	2.50

Table 12 – Distances (km) of destination points aggregated by neighborhoods

Chapter 4: Integrating diverse perspectives for managing neighborhood trees and urban ecosystem services in Portland, OR (US)

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Abstract

Municipalities worldwide are increasingly recognizing the importance of urban green spaces to mitigate the extreme effects of climate change and improve residents' overall quality of life. Yet, even with extensive earlier research examining the distribution of and implications of tree canopy in cities, we know little about the role of human perceptions of urban forestry and related ecosystem services. This study aims to fill this gap by examining the variations in socioeconomic indicators and public perceptions by asking *how neighborhood trees and socioeconomic indicators mediate public perceptions of ecosystem services availability?* Using Portland, Oregon (USA) – a municipality with extensive urban forests, including some remnant stands – as our case study, we assessed socioeconomic indicators, land cover data, and survey responses that focused on the public perceptions of neighborhood trees. Based on over 2,500 survey responses, the results indicated a significant correlation among tree canopy, resident income, and sense of ownership for urban forestry. We further identified the extent to which the absence of trees amplifies environmental injustices and challenges for engaging communities with landscape management. The results suggested that Portland residents are aware of the

challenges of tree maintenance and that including cultural ecosystem services – beyond only biophysical ones – we can better address existing environmental injustices. Additionally, our assessment of open-ended statements suggested the importance of conducting public outreach to understand management options, and describes a means for identifying specific priorities for supporting a community-based approach to urban forestry.

Keywords: urban forestry, cultural ecosystem services, public survey, tree maintenance

1. Introduction

By 2050, the United Nations suggests that the world human population will near 10 billion, with most living in urban centers. In the United States (US), eighty percent of the population already live in urban areas, which corresponds to only 3% of national land (US Census, 2020). The fast pace of urbanization and landscape change caused by humans are the major factors for transforming forests, urban and otherwise (Hall, 2016). Some have argued that the transformation of urban landscapes brings an 'extinction of experience' with nature (Soga and Gaston, 2016), which impacts the well-being, public health, and empathy for natural features. The management of urban areas requires the consideration of multiple land-use possibilities for conservation of built or natural environments. Roads, buildings, urban renewal, green infrastructure, and new developments compete for limited urban space. This fact requires municipalities to use strategic approaches to manage urban growth with civic services, including sewer, roadways, and other gray infrastructures. Often with priories of gray infrastructure, the

available locations for tree canopy is reduced, and existing tree canopy is removed – a phenomenon that has been well documented across the US (Nowak and Greenfield, 2018).

Several scholars have argued that urban tree canopy can be better managed by characterizing ecosystem services, which describes the benefits that trees and other natural landscape features provide to humans. For urban trees and tree canopy, these are often described as improvement of air quality, reduction of heat, filtering and infiltration of stormwater, and a host of cultural attributes that improve the overall quality of life for residents (Salmond et al., 2016, Wilkerson et al., 2018). Ecosystem services, in the form of tree canopy, come in three essential categories: (a) those in parks, schools, open spaces, and other natural areas; (b) those on private lands, owned by somebody other than a public agency; (c) those on streets and other public rights-of-way.

Municipal governments generally manage the urban tree canopy through a distributed model that embeds tree specialists in different public agencies or through a central division that works with other agencies. Few municipalities, if any, explicitly examine the host of ecosystem services that constitute the urban forest. We argue that urban ecosystem services as a management approach can help situate the urban forest within broader and potentially more inclusive management of natural features. The rationale behind our approach for ecosystem services lies in these three points: (a) they offer a cost-effective and functionally-based solution to major challenges facing urban areas, including rising temperatures, air pollution, and flooding; (b) when properly

applied, ecosystem services can support a more equitable distribution of canopy, which is currently highly centered on wealthy and white communities; (c) the consideration of ecosystem services can improve human-nature relationships, create a sense of ownership of places, and provide stewardship and community engagement opportunities. Together these functions of urban trees and forests compel their careful management, though the extent to which communities view or even understand these ecosystems services remains unclear.

This study examines the role of community perspectives concerning urban canopy management by assessing the relationship between the quantity of neighborhood tree canopy, public perceptions of ecosystem services, and socioeconomic indicators to support urban environmental planning. Many studies have found a positive correlation between tree canopy and residential income (Schwarz et al., 2015, Locke et al., 2016, Ramsey, 2019). However, few examine the extent to which public opinion about planting priorities, maintenance challenges, and the expectations for urban ecosystem services can be central to decision-making processes. We posit that engaging the public in myriad and creative ways in urban forestry efforts is increasingly essential. Planting and maintaining trees can promote a connection between residents and urban environmental services according to each neighborhood's needs, regarding socioeconomic, cultural, and historical aspects.

1.1. Background

The use of urban ecosystem services (UES) in describing trees and forests is a relatively new idea (Salmond et al., 2016, Wilkerson et al., 2018). Four categories of UES classify the services provided by the maintenance, preservation, and conservation of urban forestry. First, supporting UES contributes to nutrient cycling and soil formation through tree debris and habitat for decomposers. Second, provisioning UES for urban foraging of food and natural medicine (McLain et al., 2014). Third, regulating UES, as local climate resilience that prevents urban heat islands (Voelkel et al., 2018), air quality that mitigates respiratory problems (Rao, 2016), and stormwater catchment that controls flood and water flow (Kondo et al., 2015). Fourth, cultural UES bring socio-ecological values through self-actualization, esteem, and belonging (Wilkerson et al., 2018), connection with biodiversity, and personalized ecology (Gaston et al., 2018). The literature of ecosystem services (MEA, 2005) is gaining popularity, with research that includes public perception evaluations and how the ecosystem services adjust to reflect community identity.

UES relies on urban forestry and green infrastructure management, including public participation in strategic planning to recognize multiple ecological needs in diverse contexts. People's involvement in managing urban forests is often heralded as necessary for ensuring a just and equitable distribution of ecosystem services. However, communities' engagement may be mediated by intersectional factors that are often not considered in planning decisions (Wilkerson, 2018). For example, older adults and

children are more vulnerable to respiratory diseases and may be highly sensitive to degraded air quality; black communities have been historically excluded from desirable green areas (Kuthy, 2017); queer identities struggle to be accepted in heteronormative nature spaces (Mortimer-Sandilands, C., & Erickson, B., 2018); low-income residents have less canopy access (Schwarz et al., 2015).

Urban forestry scholars have already acknowledged the link between socioeconomic factors and access to ecosystem services in the municipalities. McPhearson et al. (McPhearson et al., 2015) called attention to incorporating UES into urban planning since cities globally are rapidly increasing in population. The persistent need for environmental justice and climate resilience created a framework for using ecosystem services as planning metrics. Wilkerson et al. (2018) developed an urban sociological framework to explain the intersectionality between UES planning and social demands because the variation of socioeconomic factors impacted the accessibility to green spaces. Empirical studies that measured urban accessibility based on socioeconomic indicators found geographic mismatches within vulnerable groups for the balance (demand/flow ratio) of ecosystem services of climate regulation (Voelkel et al, 2018), food supply, and recreation (Ortiz and Geneletti, 2018).

While these earlier studies call out distributional inequities, we need to establish programs and policies to ensure that historically underserved communities are at the center of urban forestry programs. We argue that urban forest planning needs to acknowledge and incorporate voices from diverse communities when managing

distributional equity. Moreover, we need to find effective and practical approaches for hearing voices from communities, especially about their perceptions of trees, and the factors that mediate the level of saliency for expanding tree canopy in historically disinvested neighborhoods. Since the fields of forestry, and more recently urban forestry, have been mainly heteronormative, white, and male (Mortimer-Sandilands, C., & Erickson, B., 2018), advancing a call for expanding the participatory process to include opinions that have not traditionally heard is instrumental to ensuring canopy equity in cities.

To provide a basis for our argument, we evaluated the presence of trees and public perceptions of ecosystem services through a community survey in Portland, Oregon (OR), US. The study aimed to understand what people expect about greening strategies, tree maintenance, and tree planting priorities. We specifically asked, *how do neighborhood trees and socioeconomic indicators mediate the public perceptions of ecosystem services availability?* We addressed this question through integrative analysis, involving a survey, socioeconomic indicators, and spatial analysis of neighborhoods in the study area. Portland has several advantages for a study of this kind, including an inequitable distribution of trees (Ramsey, 2019); historically unserved areas that reflect racist planning policies (Hern, 2016); and late incorporation as a city in the United States, leaving with its existing tracts of large trees, even today (Griffin-Valade, Khan, and Scott, 2020). At the same time, Portland's regional culture seems to have an explicit appreciation for urban forestry, as evidenced by establishing the first Parks Commission

in 1900 and green corridors West of Willamette River planned by the Olmsted Brothers in the early development of the city services (Hawkins, 2014).

2. Materials and Methods

2.1 Study Area

Located in the Pacific Northwest region of the United States, Portland bears the earliest and most preserved forest formations in the country (Robertson and Mason, 2016). Once called Silicon Forest (Gibson and Abbott, 2002), over the past 20 years, Portland attracts people looking for jobs in the tech industry and individuals seeking outdoor recreation and lifestyles. The physical geography has forest fragments in hilly areas to reduce the chance of landslides, as illustrated in Figure 1. Portland's canopy cover follows geological points of interest, like rivers, wetlands, and elevated formations.

Most of the city's canopy is west of the Willamette River in the Northwest (NW) and Southwest (SW) zip code sectors (Figure 1). Portland's western sectors also contain the most topographical relief for which trees protect from erosion, landslides, and riverbanks (Alberti, 2008, Turner, 2015). Western sectors of the study region had extensive early conservation policies by the Parks Commission, with the Olmsted Brothers' support. This landscape architecture firm promoted urban ecology practices, such as green corridors, large urban parks, wildlife habitat, and biodiversity in the early 20th Century (Hawkins, 2014).

Across the Willamette River, the eastern zip code sectors have flattened surfaces containing fewer trees than the western sectors. The eastern sectors are North (N), Northeast (NE), Southeast (SE), and East (E). The eastern sectors have a larger proportion of industrial and commercial areas and the largest percent of the city's population (Griffin-Valade, Khan, and Scott, 2020). The Columbia River, the second largest river in the United States (Wherry et al., 2018), surrounds North and East Portland. The high susceptibility to floods resulted in a 21-mile levee system created to allow urban development in areas along the Columbia River's riverbanks. Among the 654,741 people living in Portland (US Census, 2020), at least 25.6% live in the East sector (Griffin-Valade, Khan, and Scott, 2020), which is growing fast in terms of ethnic and income diversity. Still, Portland has a history of racist urban planning, redlining (Ause, 2016, Hughes, 2019), gentrification (Hern, 2016, Bates, 2013, Goodling, Green, McClintock, 2015), and late incorporation of eastern neighborhoods (Griffin-Valade, Khan, and Scott, 2020) that explains the separation between low-income communities and canopy abundance.

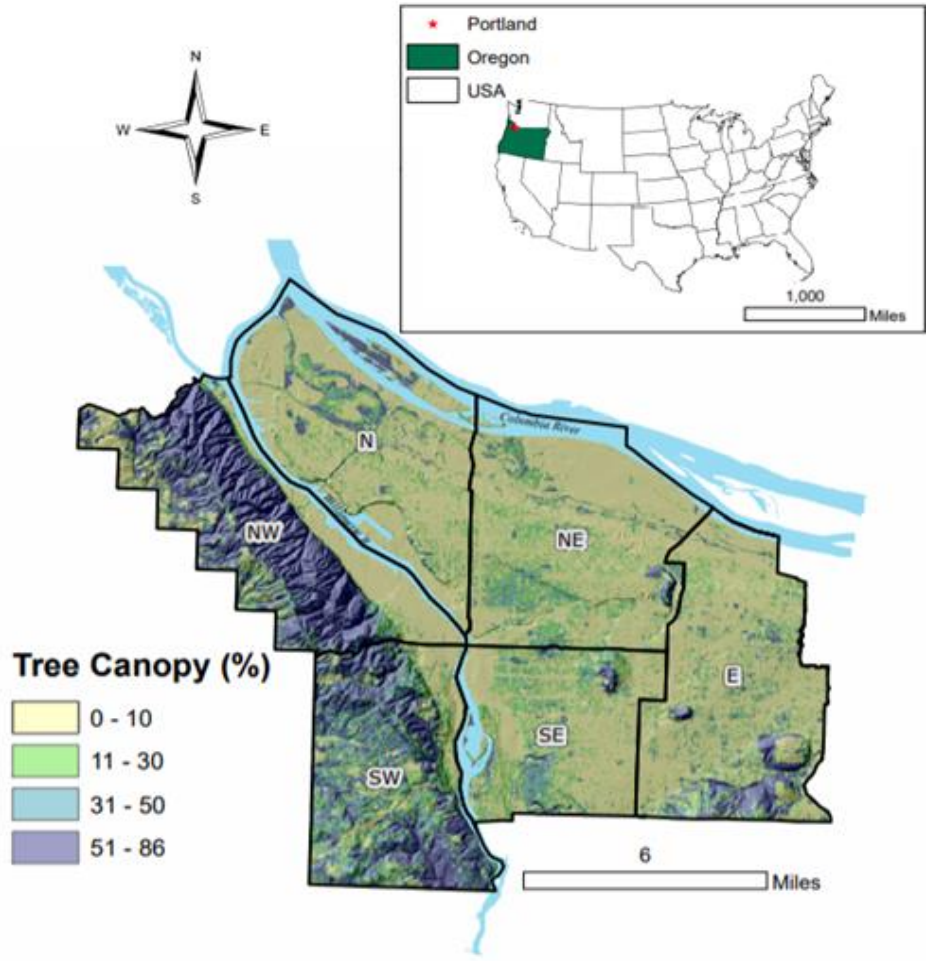

Figure 1. Map of Portland, Oregon, USA, with canopy distribution over the six zip code sectors: Southwest (SW), Northwest (NW), North (N), Northeast (NE), East (E), and Southeast (SE). The Willamette River divides Portland into East and West sectors, and the Columbia River embraces part of the North, Northeast, and East sectors. Sources: City of Portland, Oregon Spatial Data Library, USGS.

2.2 Research Design

We used a cross-sectional research design that applied satellite-derived measurements of the tree canopy cover, demographic analysis, and assessments about the public perceptions of the urban forest. This study used three parameters that encompassed

tree canopy measurements from the National Land Cover Database (NLCD), socioeconomic indicators from the US Census, and a public survey about urban forestry perceptions applied in Portland. The aim was to assess the extent of the connection between people and UES following the level of satisfaction and accessibility to urban tree canopy (Locke et al., 2016). By integrating the biophysical with survey responses, we argued that we were better able to describe how the presence or absence of neighborhood trees mediated differences in the perception of tree maintenance and tree ownership in the study area. Evaluation of public perceptions can offer insights, perhaps a first step, to understand the extent to which urban forest management can better support communities in the maintenance, ownership, and accessibility to trees among different socioeconomic groups.

2.2.1 External datasets for tree canopy cover and demographic data

US Census data from 2017 estimates (US Census, 2020) regarding income, race, and homeownership had two specific roles in this study. First, we wanted to note the fidelity of our survey sample. We compared the values of socioeconomic indicators from the survey and census. Second, we used census data as the parameters for socioeconomic indicators. The census data had higher representability and more complex data collection than the demographic questions from the survey. We aggregated the census data by zip code, following the delimitation of study areas from the survey.

The canopy cover percentage was obtained from the NLCD with 30m x 30m spatial resolution. The dataset informed the percentage of canopy per pixel (USGS, 2020,

Coulston et al., 2012). On ArcGIS software, we used the Extract by Mask tool to mask Portland boundaries and the Tabulate Area tool to measure the canopy area per zip code. Equation 1 calculated the average canopy percentage by zip code. The shapefiles for zip code and neighborhood boundaries were from the Portland Maps web library (City of Portland, 2020).

$$\text{Canopy cover (\%)} = \sum(ZA_i \times C_i) / \text{area}$$

Equation 1. Where ZA is the zip code area per canopy percentage, C is the percentage of tree canopy per pixel, and area is the total zip code area.

2.2.2 Survey data for public perceptions of urban forestry

To explore the public perceptions of UES, we used the results of an online public survey conducted between May and July of 2017. Portland is known for the neighborhood bonding and strong connection that residents have with their vicinities (Gibson and Abbott, 2002). Therefore, we used zip codes as the determinant scale and the unit of analysis. A total of 26 zip codes were large enough to have representative samples to assess patterns of responses and small enough to provide variations in our sample. We excluded zip codes from neighborhoods with less than fifteen answers for a better variability of answers and representation.

The survey had 26 questions that explored the views of Portlanders about the quality of the local urban forest, strategies for planting programs, possibilities for tree maintenance, and a socioeconomic questionnaire (Shandas, Boden, and Voelkel, 2017).

For this study, we combined 12 relevant questions that addressed: (a) the sense of ownership of trees, (b) the sense of maintenance for trees in public spaces, (c) the perception of UES on strategies to increase urban forestry, (d) and socioeconomic indicators.

The first six questions of our study encompassed the perceptions of tree ownership and maintenance (Appendix A – questions 1 – 6). Three questions about tree ownership asked the participants about 1) the importance of trees, 2) the satisfaction with the number of trees, and 3) the satisfaction with trees' health (Appendix A, questions 1 – 3). Three questions about tree maintenance inquired about 1) the maintenance of existing trees in the right-of-way, 2) maintenance of trees in the right-of-way in low-income communities, and 3) planting new trees in the right-of-way (Appendix A, questions 4 – 6). The participants used a Likert scale ranging between 1 and 5 to inform how much they agree or disagree with the six sentences related to tree ownership and tree maintenance. Table 1 shows the range of Likert scale values, tree ownership and maintenance questions, and multi-metric evaluation.

Instead of analyzing the six questions separately, we created two multi-metric indexes: Tree Ownership Satisfaction Index (TOSI) and Tree Maintenance Satisfaction Index (TMSI). TOSI combined the three questions about tree ownership and TMSI the three questions about tree maintenance. TOSI and TMSI also used a Likert scale, and we calculated them by finding the average values of the three questions of each index, as

displayed in Table 1. TOSI and TMSI resemble multi-metric indexes used in the biological assessment of watersheds (Atique and An, 2018, Yirigui et al., 2019).

	Likert-scale values					
Questions	Strongly Agree	Agree	Don't Know	Disagree	Strongly Disagree	Multi-metric Index
Q1: "Portland's trees are important to me"	5	4	3	2	1	TOSI = $\frac{(Q1 + Q2 + Q3)}{3}$
Q2: "My neighborhood has enough trees"						
Q3: "The trees in my neighborhood are in good condition and healthy"						
Q4: "The city should maintain all trees along the street"	5	4	3	2	1	TMSI = $\frac{(Q4 + Q5 + Q6)}{3}$
Q5: "The city should prioritize maintenance of trees along the street in low-income communities"						
Q6: "The city should plant trees in all available spaces along the street"						

Table 1. TOSI and TMSI indicators, where Q is the question number, TOSI is the tree ownership satisfaction index, and TMSI is the tree maintenance satisfaction index.

One open-ended question asked the participants about municipality strategies to increase tree canopy (Appendix A, question 7). After observing the responses, we coded repetitive values from the answers and created a typology based on UES and

management challenges. Table 2 shows the coded values that translated the public concerns about ecosystem services, tree maintenance, and financial concerns.

The last survey question about urban forestry asked if participants had trees on their property (Appendix A, question 8). We measured the answers per zip code, informing the percentage of participants that had trees on their yards.

Four questions explored the socioeconomic characteristics of the participants (Appendix A, questions 9 – 12). We asked questions about the participants' race, income, and zip code for the socioeconomic indicators. These indicators were traditional demographic parameters in other urban forestry and ecosystem services studies (Schwarz et al., 2015, Ramsey, 2019, Voelkel et al., 2018). We also asked about housing ownership, as house tenure is an indicator of membership and active participation in urban environmental planning (Arifwidodo and Chandrasiri, 2013). We compared the survey data's socioeconomic indicators to the census data to reinforce the survey sample's validity.

Type	UES	Typology
Regulation and Provisioning services	Climate	Support microclimate, provide shade, mitigate urban heat island
	Air Quality	Promote clear air, mitigate pollution on transit corridors and industrial areas

	Water flow	Encourage tree planting in water facilities, acknowledge that trees consume water, and support maintenance of groundwater
	Water purification	Improve watersheds and riparian areas, industries that pollute water should contribute to tree maintenance
	Erosion	Awareness that trees prevent landslides risks
	Natural Disaster Regulation	Flood prevention, stormwater mitigation in green infrastructures, reduction of impervious surfaces
	Pollination	Support bees and pollination
	Pest and disease	Physical and mental health, elders benefit from trees, industries that use pesticides should contribute to tree maintenance
	Waste	Pollution mitigation, energy savings, households with trees should have a discount on sewage bills, companies with more waste generation should contribute to tree maintenance
	Food	Encourage planting of fruit trees, urban agroforestry, mitigation of food deserts
Cultural services	Recreation and tourism	Recreation and relaxation, preference for trees over recreation facilities, canopy attracts tourists to the city
	Aesthetics and Inspiration	Inspiration, beautification, common appreciation for trees
	Knowledge Systems	Educate people on how to plant and maintain trees, partnership with education institutions, job creation, encourage workshops about the importance of trees

	Religious and spiritual	Biophilia, spirituality, partnership with religious groups
	Cultural heritage	Cultural values of trees, community bonding, civic engagement, diversity of cultures, and their interpretation of trees
	Natural heritage	Promote native trees, promote wildlife habitat, canopy preservation, encourage natural heritage stewardships
Management Challenges	Financial solutions	Tree giveaways, public/private/nonprofit partnerships, volunteers to reduce budget costs, use of taxes/donations/fundraisers resources
	Financial burden	Tree permit taxes, maintenance costs, other civic priorities over trees
	High maintenance	Right tree/right place, water and pruning care, public utilities, sidewalk maintenance, planning for climate change, regulations for trees in developed areas, tree maintenance strategies

Table 2. Survey coding: coded values from the open-ended question regarding strategies to increase tree canopy

2.2.3 Conceptual model

To integrate the analysis from the NLCD tree canopy, census, and survey datasets, we developed a conceptual model that described the analytical steps for addressing our research aims (Figure 2). The conceptual model contained, at its core, the research question: *How do neighborhood trees and socioeconomic indicators mediate the public perceptions of available ecosystem services?* The conceptual model also integrated the datasets vis-a-vie specific questions that reference each of the three datasets we employed:

1. Census data and socioeconomic survey questions: *Does the variation of socioeconomic indicators in the survey provide a good representation of the census data?*

2. Census data and tree canopy data: *Is there a relationship between socioeconomic indicators and tree canopy?*

3. Tree canopy data and urban forestry survey questions: *Does the presence of trees influence the public perceptions of urban ecosystem services?*

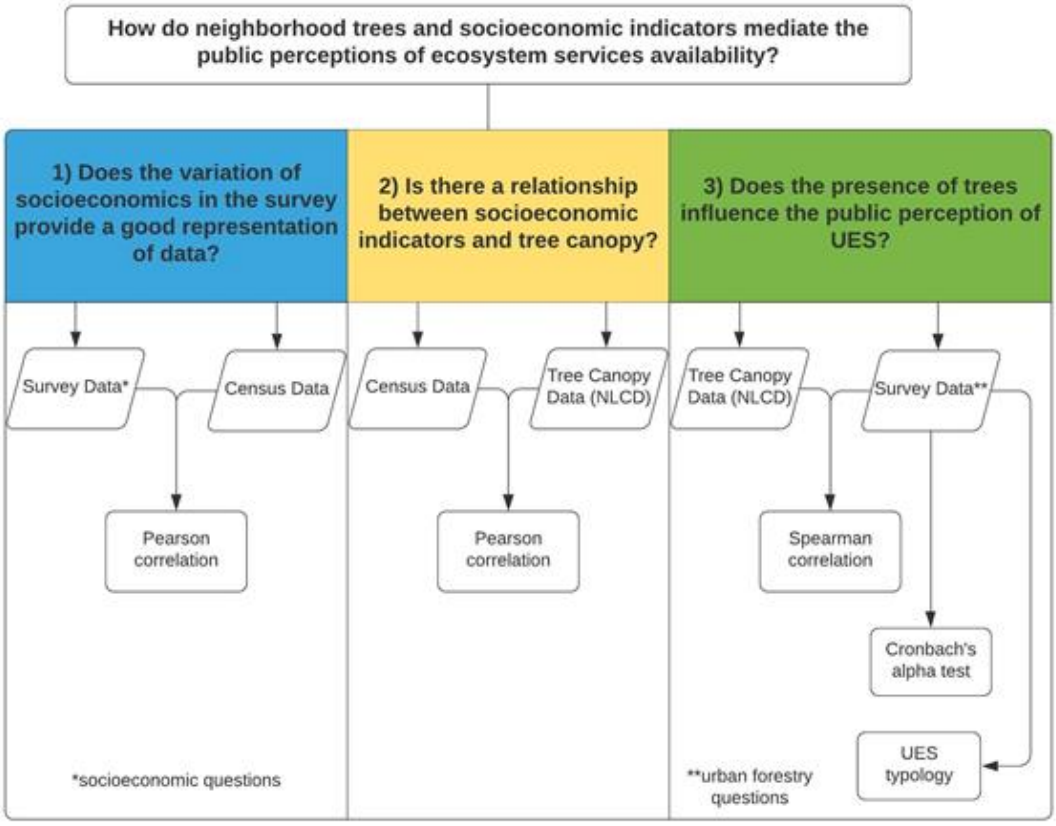

Figure 2. Flowchart with the research questions and research design

To answer the first two questions, we performed the Pearson correlation test between the socioeconomic survey questions and Census data, and between tree canopy data and Census data, as the variables were parametric. To answer the third question, we performed the Spearman correlation test between the tree canopy data and the survey urban forestry questions, as the variables were nonparametric. For both Pearson and Spearman correlation we considered the results that were significant with $p < 0.05$. For the urban forestry questions in the survey that used a Likert scale (Table 1), we performed Cronbach's alpha, which is a reliability test for the internal consistency of scaled questions and their variance. All statistical tests were performed with SPSS software v.26. Using the open-ended responses, we created a UES typology table (Table 2), which also served as additional data for evaluating and corroborating the statistical analysis.

3. Results

The survey for public perceptions of urban forestry and UES had 2,548 valid answers from 26 zip codes within Portland. The survey responses ranged between 15 and 249 answers per zip code (Appendix B, Figure 1; Appendix B, Table 1). As a voluntary online survey distributed in community engagement platforms (municipal listserv, Nextdoor, social media channels, focus groups, public meetings), there was a high chance that the participants had previous interests in urban forestry and city planning. We obtained completed answers and discarded those who did not complete the survey.

In the following subsections, we will answer the specific research questions regarding the correlation between the variables of census data, survey data, and tree canopy data. In the last subsection, we will summarize the core question "*how do neighborhood trees and socioeconomic indicators mediate the public perceptions of ecosystem services availability?"* using the open-ended statements and their associations with the statistical findings.

3.1. Does the variation of socioeconomics in the survey provide a good representation of the census data?

To answer this question, we compared the census data and survey's socioeconomic indicators, which were both collected in 2017 (Table 3). The correlation between survey answers and the number of households per zip code was moderately strong ($R = 0.554$) and significant ($P < 0.01$). This result suggested that the number of respondents reflects the total population size within the zip codes.

We found strong Pearson correlation values between the census and the survey for the variables of house ownership ($R = 0.796$; $P < 0.01$) and income ($R = 0.922$; $P < 0.01$). The percentage of house ownership was higher among the survey respondents (82.09%) than the values indicated by the census data (51.54%). We believed that our survey targeted participants aware of the local public budget (Arifwidodo and Chandrasiri, 2013), as property owners have more responsibility with taxes that support tree maintenance.

For the race variable, both data from the census and the survey showed that Portland has a majority white population in all zip codes. Due to this fact, we labeled all non-white races as people of color. People of color (POC) is a term commonly used in the US to describe a population that is not white. The correlation values between the census and survey data for the POC variable was moderate ($R = 0.402$, $P < 0.05$). The percentage between POC in the census (22.22%) and survey (23.29%) had similar values.

Overall, the results suggest that for the specific characteristics the survey contained a representative sample for the city as a whole, which provides support to address the remaining questions. Our survey had a consistent representation with the Census data, with significant values for population size, race, income, and house ownership.

Variable	Mean value per zip code	Pearson Correlation
Surveys (N)	98 ± 66	.554**
Households (N)	11318 ± 5076	
Housing ownership census (%)	51.54 ± 15.20	.796**
Housing ownership survey (%)	82.09 ± 12.87	

People of color census (%)	22.22 ± 8.56	.402*
People of color survey (%)	23.19 ± 7.26	
Mean income census (US$)	87813.04± 28397.40	.922**
Mean income survey (US$)	93319.65± 20275.61	

Table 3. Pearson correlation values between socioeconomic indicators from the survey and census*level of significance = 0.05; **level of significance = 0.01

3.2. Is there a relationship between tree canopy and socioeconomic indicators?

Earlier research from several studies across the United States)Salmond et al., 2016, Wilkerson et al., 2018, Schwarz et al., 2015) and Portland (Donovan and Prestemon, 2012) suggested that historically underserved communities are less likely to have immediate access to tree canopy. In contrast, white and wealthier populations have greater access, partly due to historical policies that segregated neighborhoods (Shandas, Boden, and Volkel). This study was no exception and corroborated previous findings. Using Equation 1, we observed that zip codes in NW and SW had higher tree canopy than zip codes in the eastern sectors (E, N, NE, SE) of the Willamette River (Appendix B, Table 2). NW and SW had respectively 42.5% and 37% of canopy cover and $125,739 and $100,696 of household incomes (Table 4). East had the lowest income ($57,104) and 12.4% of average canopy. The values of household income were obtained from the census data.

Variables	E	N	NE	NW	SE	SW
Canopy	12.39%	7.80%	7.30%	42.45%	10.24%	37.02%
Income	$57,104	$86,824	$95,714	$125,739	$93,200	$100,696

Table 4. Average tree canopy and income within the zip codes sectors in the study area

Pearson correlation values between tree canopy and census socioeconomic indicators for income, race, and house ownership (Table 5). The strongest correlation across all the sociodemographic was between tree canopy and income ($R = 0.625$, $P < 0.01$). This result supported the findings observed in Figure 1 and Table 4, with a high percentage of canopy cover in affluent neighborhoods of West Portland, suggesting that people with higher income in Portland have more access to the urban tree canopy. The results for the correlation between tree canopy with house ownership ($R = 0.206$; $P > 0.3$) and race ($R = -0.186$; $P > 0.3$) did not have significant values. As such, we conclude that income is the only significant (and positively correlated) variable in relation to the amount of tree canopy for the study area, as found in other urban forestry studies that used Portland as a case study (Ramsey, 2019, Shandas, Boden and Volekel, 2017; Donovan and Prestemon, 2012).

Correlation variables	Pearson Correlation
Tree Canopy and Income	0.625**
Tree Canopy and Race	-0.186
Tree Canopy and House ownership	0.206

Table 5. Pearson correlation values between tree canopy and census socioeconomic indicators **level of significance = 0.01

3.3. Does the presence of trees influence the public perception of UES?

3.3.1 TOSI and TMSI indicators

We combined three questions to build the TOSI, regarding (1) the satisfaction with the number of trees, (2) the good condition of trees, and (3) the importance of trees. The TMSI combined three questions about (4) the maintenance of street trees, (5) the maintenance of trees in low-income communities, and (6) the planting of new trees. Table 6 shows Cronbach's alpha results for the questions that encompassed the indexes.

While the Cronbach's alpha value of 0.490 can increase to 0.612 by removing Question 2 of the TOSI and TMSI multi-metric, we maintained the question because only 78.63% of respondents addressed all six questions, while 8.70% respondents answered five questions, 6.98% answered four questions, 5.61% answered three questions, and

0.08% answered two questions. While multi-metric methods (ecosystem services coding, Likert scale, TOSI, TMSI) are reduced by including additional questions, some of which may not be addressed, doing so also increases the diversity and reliability of responses. In addition, surveys about public perceptions of urban forestry are relatively limited, and the development of such metrics and observations, we expect, can contribute to further comparative studies.

Total statistics Cronbach's alpha = 0.490	Item Statistics		
Questions	Mean	Std. Deviation	Cronbach's alpha if item deleted
Q1: "Portland's trees are important to me"	4.81	0.49	0.502
Q2: "My neighborhood has enough trees"	3.07	1.26	0.612
Q3: "The trees in my neighborhood are in good condition and healthy"	3.39	0.91	0.505
Q4: "The city should maintain all trees along the street"	3.70	1.23	0.287
Q5: "The city should prioritize maintenance of trees along the street in low-income communities"	3.98	1.2	0.287
Q6: "The city should plant trees in all available spaces along the street"	3.61	1.32	0.340

Table 6. Cronbach's alpha for the Likert scale questions of survey

The variation of TOSI and TMSI answers are presented in a Likert scale across a series of maps (Figure 3). The Likert scale ranged from 1 to 5, where 1 represents strongly disagree, and 5 represented strongly agree. The TOSI and TMSI were the three questions' (Appendix A, Questions 1 – 6, Appendix B, Table 3) average values combined on the respective indexes.

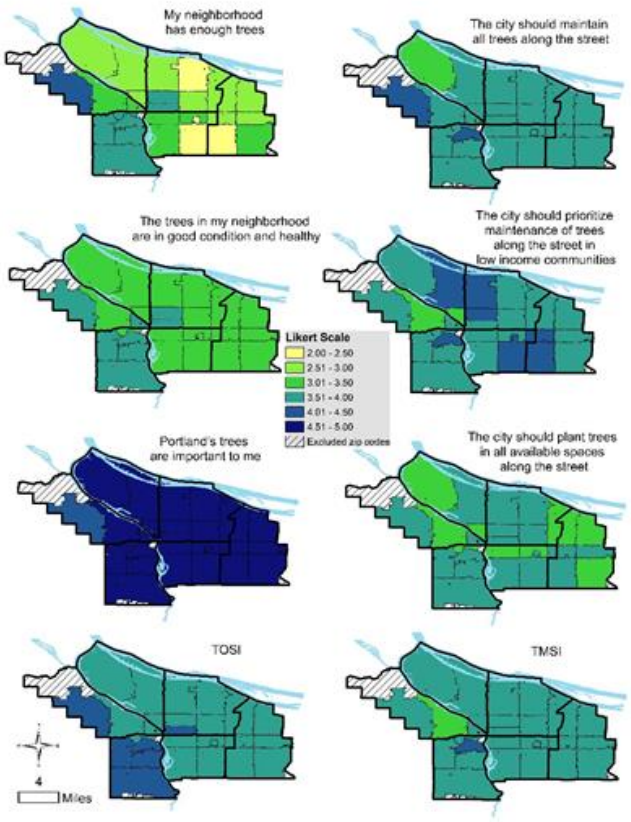

Figure 3. TOSI and TMSI indicators: range of answers to individual Likert scale questions that are used to generate the multimeric indices of ownership (TOSI) and maintenance (TMSI) for the study area.

In the questions associated with TOSI and TMSI, most of the answers per zip code were higher than 3 on the Likert scale, except for satisfaction with neighborhood trees. The eastern zip codes had lower satisfaction with the number of trees than the western zip codes. In the question about tree health, the western zip codes had a higher rate on the Likert scale. A zip code in NW, a high-income and high canopy part of the study area, scored the lowest value for trees' importance.

3.3.2 Public perceptions of urban ecosystem services

The results indicated that most of the participants had trees on their private property. The average percentage of participants that informed having trees on their yard was 94.2% [Appendix B, Table 3]. The lowest rate of private property trees was 75.8%, in the zip code 97209, an urban renewal area (redevelopment of industrial and low-income areas in inner-city) in Northwest Portland (Hughes, 2019).

The last question about urban forestry perceptions was open-ended, and we coded the answers using UES typology (Table 7). According to the coded answers, the strategies recommended a focus on urban forestry management (56.1%), cultural ecosystem services (31.5%), and regulating and provision services (12.4%).

Type	UES	Survey answers (%)	Survey answers aggregated (%)
Regulating and provisioning ecosystem services	Climate	1.67	12.36

	Air Quality	2.67	
	Water flow	2.02	
	Water purification	0.67	
	Erosion	0.19	
	Natural hazard	1.14	
	Pollination	0.16	
	Pest and disease	2.00	
	Waste	1.02	
	Food	0.81	
Cultural ecosystem services	Recreation and tourism	0.70	31.54
	Aesthetics and Inspiration	3.18	
	Knowledge	11.01	
	Religious and spiritual	0.33	
	Cultural heritage	9.55	

	Natural heritage	6.78	
Management Challenges	Financial Solution	33.59	56.10
	Financial Burden	4.53	
	High Maintenance	17.98	

Table 7. Public perceptions of relevant strategies to increase urban tree canopy

Within the management challenges, 33.6% of the answers suggested financial solutions. The answers recommended the municipality to seek partnerships with volunteer associations, donation of seedlings, and financial support for homeowners and renters, such as tax and water/sewage bill discounts. The second most mentioned typology was the maintenance of trees, with 18% of answers showing that respondents were aware of tree health and upkeep's essential requirements. The participants informed that proper tree pruning, tree species selection, tree debris removal, and regulation for trees in developed areas were their top priorities.

Among the UES, knowledge systems and cultural heritage were the most significant concerns, holding 11% and 9.6% of the answers, respectively. Knowledge systems associated with urban forestry solutions that educate the population on how to take care of trees. Connection with teaching opportunities through schools and training programs can prepare present and future generations to maintain trees and understand

urban ecology interactions. Awareness of cultural heritage indicated the respondents' related urban forestry to community development, community engagement, and neighborhood pride. The open-ended answers recommended tree planting events to promote activities that bring interaction among neighbors to praise trees' values for multiple cultures and ethnicities (Appendix B, Table 4).

As most of the answers indicated strategies using financial solutions and tree maintenance, we conducted a separate analysis only with the UES typology. Excluding the management challenges (Table 7), knowledge systems and cultural heritages lead the answers with 25.1% and 21.8% of the responses, respectively. Natural heritage was the third most important, with 15.5% of answers. Natural heritage responses concerned the loss of mature trees, biodiversity, and wildlife habitat. The respondents commented that small trees could take longer to provide the ecosystem services promoted by centenary trees susceptible to removal for new developments or infrastructure challenges.

The final analysis described the Spearman correlation between survey answers and the percentage of tree canopy per zip code (Table 8). The variables that had the strongest positive correlation with tree canopy were satisfaction with neighborhood trees (R=0.767), satisfaction with tree health (R=0.704), TOSI (R=0.758) in a 0.01 significance level, and aesthetics and inspiration (R=0.453) in a 0.05 significance level. Though these are general findings, we note that these levels of significance and strength of the relationship varied by zip code.

Public perceptions	Spearman Correlation (R)	Public perceptions	Spearman Correlation (R)
Climate	-0.136	Natural heritage	-0.191
Air quality	0.226	Financial Solution	0.039
Water flow	0.009	Financial Burden	-0.235
Water purification	0.194	High Maintenance	-0.162
Erosion	0.289	Food	-0.231
Natural hazard	0.034	Trees on property	0.048
Pollination	-0.233	Neighborhood trees	0.767**
Pest and disease	0.078	Tree health	0.704**
Waste	0.158	Importance of trees	-0.289
Recreation and tourism	-0.037	TOSI	0.758**
Aesthetics and inspiration	0.453*	Street trees	0.241
Knowledge	0.227	Trees in low income areas	-0.27

Religious and spiritual values	-0.149	Plant street trees	-0.104
Cultural heritage	-0.009	TMSI	0.005

Table 8. Correlation between tree canopy and survey answers about public perceptions of urban forestry*level of significance = 0.05; **level of significance = 0.01

3.4: How do neighborhood trees and socioeconomic indicators mediate the public perceptions of ecosystem services availability?

Seven out of eight zip codes in Portland's western sectors had a canopy rate higher than the eastern sectors. The justification for the uneven distribution is associated with the early conservation practices of urban forestry in the western zip code sectors (Hawkins, 2014), the hilly geological formation (Alberti, 2008, Turner, 2015), and the higher income [8]. Tree canopy had a significant positive relationship to TOSI indicators and cultural UES of aesthetics and inspiration (Table 8). However, the excessive canopy does not please everyone, as expressed in the following statements from participants living in high canopy areas (Appendix B, Table 2):

"Too many trees already. While they have benefits, the trees need to be healthy and co-exist safely with residents. This requires regular, vigilant maintenance, which a lot of people (...) fail to do. We've repeatedly witnessed the tragedy of human deaths and property destructions, especially this last winter. Even one death is too many! We need to

take better care of the existing trees before we consider adding more." (97221 – Southwest)

"I don't necessarily think the city should plant more trees. While the trees here certainly help relieve heat we need to be mindful of how little sun we get here (in Portland rainy weather). I think the city needs to maintain a balance between densely wooded areas (eg Forest Park) and highly exposed areas (eg central eastside). I think students and volunteers could plant lots of trees." (97221 – Southwest)

"(...)determine the most aesthetic and functional places to plant trees, and then only plant trees that make logical sense for the conditions present in the chosen locations." (97210 – Northwest)

"I think the city should plant fruit and nut trees when they plant trees. They grow just as easy as any other tree. Most have beautiful flowers and foliage. And better yet they make healthy snacks especially in low income neighborhoods and food deserts." (97236 – East)

"(...) I can't see cars coming at intersections because there are too many trees already in my neighborhood. There is a near miss almost every day at my house because people can't see the cars coming. (97212 – Northeast)

East of the Willamette River, five zip codes stood out with more than 10% of canopy cover (Appendix B, Table 2). The zip code 97236 had 23.5% canopy cover in the Pleasant Valley area, an early incorporated neighborhood near an affluent suburb, Happy

Valley. This zip code area also bears Powell Butte Natural Area, a remaining forest fragment. 97212 had 17% of tree coverage and the fourth largest average income citywide. 97202 had 13.8% of canopy cover and a protected riparian zone in the eastbound of Willamette River. 97215 had 13% of canopy cover and a preserved forest fragment on Mount Tabor Park. 97266 had 12.4% of tree coverage and was the third-lowest income zip code (Appendix B, Table 2). However, it bears a forest fragment on Kelly Butte Natural Area. These findings showed that tree canopy follows income and geological formation features, such as riverbanks, forest fragments, and hilly areas.

In low-income communities, trees' maintenance is observed as a financial burden, which can be classified as an ecosystem disservice (Speak et al., 2018). Two zip codes from the East sector answered that 8.3% and 7.7% of the increasing tree canopy strategies have financial burden as a management challenge. The average answer mentions for financial burden was 4.5% per zip code (Appendix B, Table 4). Seven out of eleven neighborhoods with answers above average are in the East, the sector with the lowest income and low canopy (Table 4). The following statements extracted from the open-ended question about strategies for increase tree canopy reflect the concerns for financial burden within residents of low-income neighborhoods:

"Offer to plant them (trees), offer low income solutions to families" (97233 – East)

"(...) lots of trees (are) in bad places and they die so better planning would do just fine and offering classes for ppl (people) who want to learn how to maintain the trees

better and if they have it why does low income not have access to the classes and knowledge of them?" (97233 – East)

"Don't charge for leaf cleanup. Offer a small tax credit for trees planted and maintained to property owner(s). Education regarding the importance of trees for everyone. Offer education to grow trees in a pot. Then everyone can grow a tree." (97220 – East)

"(...) more financial and volunteer support to groups like that (street tree planting nonprofit). Also when Portland had the ice storm this past winter, many residential trees came down. (...) people could bring downed trees and branches, maybe even for a donation. Free mulch for the city and donations! Tree culture need(s) to be supported in more ways than just plantings (...) to make owning trees easy." (97220 – East)

"I'm sure a lot of people are scared away from that program (street tree planting program) due to the need to care for the tree and the possible damage to sidewalks that they will eventually be forced to repair at their expense later on down the line." (97220 – East)

The answers for increasing canopy strategies also indicated concerns for other UES, such as climate change, knowledge systems, natural heritage, and cultural heritage. Excluding the answers about management challenges, responses about regulating and provisioning UES represented 28%, and cultural UES accounted for 72% of answers. We believed that people highly value cultural benefits from trees in urban areas due to the

"extinction of experience" (Soga and Gaston, 2016). Within cultural ecosystem services, we distinguished patterns in responses that seek environmental education, multiple ethnic values for forest biodiversity, and conservation of heritage trees. The answers associated with knowledge systems indicated that besides incentives for tree planting, people also need to know how to care for trees and their importance regarding ecosystem services. Public surveys assessing urban forestry and management of UES have suggested the enforcement of knowledge systems (Young, 2013). As observed in the previous statements, the survey participants repetitively suggested partnerships with education institutions, urban forestry jobs, internships, and free workshops. The responses indicated that the residents expect more personal accountability for ownership if they have access to knowledge, tools, and technical support from municipality and nonprofits.

In answers that mentioned cultural heritage, people requested more planting events to bond with neighbors and create a sense of community. The participants asked for multilingual tree support, public participation in urban forestry planning, and access to trees with ethnic values regarding inclusion and diversity measures. Natural heritage answers indicate the population's willingness to perpetuate biodiversity, urban ecology, and centenary trees. Together, cultural and natural heritage are UES that reflect landscape interpretations, which are individual perspectives of the environment based on personal background, memories, experiences, and expectations. In general, environmental planning bears management tools that can perpetuate systemic racism by restricting access to ecosystem services based on socioeconomic values, reducing maintenance costs in areas with low-income and people of color, and not acknowledging the diversity of

behaviors in public space (Brownlow, 2006, Schell et al., 2020). Surveys, interviews, and focus groups can collect ideas, perspectives, and expectations from historically unheard voices and open a path for public participation in urban forestry planning.

Portland had a complex history of gentrification that burdened the black community with displacement, loss of sense of spatial identity, and identity representation (Hern, 2016). The increase in population promoted real estate development for housing, business, and other civic infrastructures. In Portland, there is an inverse relationship between canopy cover and urban development indicators, as water pipers (Ramsey, 2019). The survey answers indicated that people are aware that new developments threaten trees, impacting their maintenance and natural heritage. The following statements are from the zip codes with lower housing ownership (Appendix B, Table 1) and most gentrified areas (Bates, 2013).

Yes, we need many more trees, but (...) focus on protecting the most mature trees as they have been shown to provide the greatest benefits. (97227 - North)

Demolition review to ensure maintenance of entire tree canopy as development can remove existing trees. The accelerated development in Portland has not been counterbalanced with a comprehensive plan to prevent tree removal and plant new trees. It has greatly reduced potential green spaces which could offset somewhat the unbridled concrete development (97232 - Northeast)

Trees are natural green infrastructures that support stormwater catchment, avoid erosion, and improve air quality. Other forms of green infrastructure such as rain gardens, green roofs, artificial wetlands, and parks can bring green gentrification – a gentrification process caused by the implementation of green infrastructures. The following Discussion section will explore how the results are associated with environmental justice and landscape management.

4. Discussion and Conclusion

This study aimed to address questions about the relationship between the existing amounts of neighborhood tree canopy with sociodemographic data and community perspectives. One of the explicit goals of the present study was to understand the relationship between tree ownership, maintenance, and the amount of tree canopy. We found that zip codes with higher tree canopy were consistent with greater sense of ownership and quality of trees, as measured by the TOSI. Specifically, the two TOSI questions about the number of trees and the good condition of trees had a strong correlation and high significance values with tree canopy. This finding is consistent with a low Cronbach's alpha, suggesting that this metric can be explored further, perhaps in a different setting.

Our findings also indicate that a sense of ownership comprises the importance and satisfaction with the quantity and the quality of trees in the neighborhood, including trees in private property, public spaces, and the right-of-way. Affluent zip codes had higher canopy cover had a higher correlation with public maintenance of street trees, as

measured by the TMSI. While earlier research suggests that tree canopy and income are correlated in the U.S. (Schwarz et al., 2015, Locke et al., 2016, Ramsey, 2019), the perception of tree ownership is a new concept that brings accountability of ownership and maintenance in relation to urban ecosystem services. We observed a lower correlation between the tree canopy and TMSI than with TOSI (Table 8). TMSI also presented a lower range of mean values on the Likert scale response (Table 6), suggesting a common concern about tree care citywide (Figure 3, Appendix B, Table 3). In the question about increasing tree canopy strategies, the responses about tree maintenance represented about 18% of the answers (Table 7).

Perhaps one of the most germane findings in our study is the fact that while a canon of literature describes the importance of trees in providing UES (e.g. pollination, air quality, climate regulation, etc.), our survey findings indicate that issues about management and cultural ecosystems services feature prominently among the respondents. This finding, while perhaps mundane, is significant for several reasons, including the fact that respondents seem to recognize the financial burden and maintenance when considering trees. If this finding is consistent across the city, then municipal goals for expanding tree canopy will face formidable obstacles if they present trees an important for traditional regulating ecosystem services. Rather, recognizing that communities are considering, perhaps less these regulatory services, than those surrounding maintenance and financing, may provide more effective.

Suitable messaging may not be the only implication of this finding. If aesthetics, inspiration, and level of ownership are correlated with the amount of neighborhood tree canopy (Table 8), then attempts to create distributional equity will require considerable recognition of the maintenance costs involved. Maintenance often includes the planting appropriate species, pruning of trees, watering, and a host of other monitoring to ensure healthy growth. Responses indicated the importance of maintenance, and also suggested that municipalities provide support to those communities how may not have the financial resources to address maintenance concerns. Currently the City of Portland requires adjacent property owners to maintain all public trees, which increases the level of inequity already experienced by lower income communities. Perhaps the positive and significant correlation between income and presence of tree canopy is because lower income community may not prefer trees due to the cost of maintenance, which the open-ended responses indicated. The development of trees in the right-of-way interacts with other infrastructure, such as sidewalks, residences, and transit features. Studies that observe the growth and health of street trees (Batala andTsitsoni, 2009), suggest regular monitoring and maintenance such as root pruning and interaction with underground infrastructures (Benson, Morgenroth, Koese, 2018, Kuliczkowska and Parka, 2017, .Ordonez, 2015) which can help to ensure a healthy and robust tree canopy.

While these findings offer a first step towards integrating community perspectives into urban forest management, the findings suggest the importance of engaging communities in the management of tree canopy. The open-ended results suggested that respondents genuinely understand the challenges facing urban forest management and the

importance of finding systematic ways to maintain canopy and provide equitable access to all residents. Our findings indicate, for example, that promoting financial solutions that optimize public and private budgets toward urban forestry, and cultural heritage practices that engage the community in participatory planning and empowerment are the priority strategies for increasing tree canopy. With the multiple goals for achieving environmental equity through urban forestry, these strategies must also include raising awareness about the inequitable distribution of existing tree canopy, planting more trees in vulnerable communities, exploring diverse perspectives about climate resilience, and exploring the role of trees among historically marginalized communities (Brownlow, 2006).

This study offers a means for understanding the importance of ownership and maintenance in addressing urban ecosystem services. While our survey can help to underscore some of these priorities, we recognize that engaging communities about urban forestry may pose several challenges. If employed effectively, other data collection methods, including listening sessions, focus groups, and interviews, can help to contextualize urban forestry within the broader set of community needs that may be priorities. The COVID-19 pandemic has made clear that priorities such has housing, food, and medical care are often front-and-center among POC and lower income communities, which may pose several challenges for discussions about urban forestry. Since POC and low-income neighborhoods have been excluded from planning for a healthy and abundant urban forest [8], a pattern that may be associated to redlining practices in the U.S. (Hoffman, Shandas, and Pendleton, 2020) perhaps the built and natural environment in neighborhoods can be a direct means for understanding other

pressing priorities. By engaging historically disinvested communities and address distributional injustices that have created current inequities in the distribution of tree canopy cover, municipal agencies may find creative solutions that 'multi-solve' the myriad pressing challenges.

Our study found that survey respondents seeks more measures and strategies to address cultural UES, such as cultural heritage, natural heritage, aesthetics, and inspiration. The gap of systematic descriptions for these cultural UES within municipal plans may require greater levels of public involvement, which would build on diverse perspectives (Schell et al., 2020). While government agencies are often responsible for the management of public spaces, the same agencies may not be trusted allies with communities that have been historically disinvested. As such, management options that engage community-based organization (CBOs) may be a more trusted and effective approach for soliciting plausible solutions. Such CBOs can work with community members to explore their expectations for land use, tree canopy, species selection, planting events, tree giveaways, and volunteer workforce.

Examples of such cross-sectoral urban forestry management are emerging. In Toronto, CBOs had a more diverse species list than municipal agencies, landscape architects, and nurseries (Conway and Vander, 2015). In Detroit, interviews with CBO staff and recipients of giveaway trees informed that the ability to choose the tree species is a fact that impacts the willingness of residents to care for private trees, as well as live in areas with lower canopy. In both cases, studies have found that the major challenges

are concerns with maintenance practices and costs, such as pruning, sidewalk damages, and tree debris removal (Carmichael and McDonough, 2019). Both studies suggested stewardships for a functioning and healthy urban forestry, where CBOs would have the goal to promote understanding while supporting cultural ecosystem services.

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Appendix A: Survey Questions

Survey Questions:

Tree Ownership Satisfaction Index (TOSI):

Q1 Portland's trees are important to me. Strongly Agree/Agree/Don't Know/Disagree /Strongly Disagree.

Q2 My neighborhood has enough trees: Strongly Agree/Agree/Don't Know/Disagree/Strongly Disagree.

Q3 The trees in my neighborhood are in good condition and healthy. Strongly Agree/Agree/Don't Know/Disagree/Strongly Disagree.

Tree maintenance Satisfaction Index (TMSI).

Q4 The city should maintain all trees along the street (in the public right-of-way, next to the sidewalk area): Strongly Agree/Agree/Don't Know/Disagree/Strongly Disagree.

Q5 The city should prioritize maintenance of trees along the street (in the public right-of-way, next to the sidewalk area) in low-income communities: Strongly Agree/Agree/Don't Know/Disagree/Strongly Disagree.

Q6 The city should plant trees in all available spaces along the street (in the public right-of-way, next to the sidewalk area): Strongly Agree/Agree/Don't Know/Disagree/Strongly Disagree.

Strategies for increase tree canopy:

Q7 How do you think the city should get more trees planted?

Presence of trees in private properties:

Q8 Do you have trees at the property where you live? Yes/No.

Demographic Questions:

Q9 What is your household income? Less than $10,000/$10,000–$19,999/$20,000–$29,999/$30,000–$39,999/$40,000–$49,999/$50,000–$59,999/$60,000–$69,999/$70,000–$79,999/$80,000–$89,999/$90,000–$99,999/$100,000–$149,999/$150,000–$199,999/$200,000 or more/I don't know.

Q10 Which best describes your race or ethnicity? Choose as many as apply:

❑ Alaska Native ❑ American Indian/Native American ❑ East Asian ❑ South Asian ❑ Southeast Asian ❑ West Asian ❑ Middle Eastern ❑ Black or African American ❑ African ❑ Hispanic or Latino ❑ Native Hawaiian or Pacific Islander ❑ Slavic or Eastern European ❑ White ❑ Other (please specify).

Q11 What is your home zip code?

Q12 Do you rent or own the place where you live? Rent/Own.

Appendix B: Socioeconomic indicators and zip codes areas

Zip Code	Area	Valid Survey Answers (N)	Population Census (N)	Households Census (N)	Housing Ownership Census (%)	Housing Ownership Survey (%)	Housing Ownership Census (N)	Housing Ownership Survey (N)	People of Color Census (%)	People of Color Survey (%)	People of Color Census (N)	People of Color Survey (N)	Mean Income Census (US$)	Mean Income Survey (US$)
97201	SW	50	17,566	9009	31.58	T52.00	2845	26	23.17	26.53	4070	13	92,276	88,666
97202	SE	211	42,189	18,135	49.68	81.52	9010	172	14.47	13.74	6103	29	92,391	96,865
97203	North	107	34,089	12,091	55.43	85.98	6702	92	24.2	21.5	8250	23	67,963	80,663
97205	SW	31	7122	4881	17.62	58.06	860	18	20.33	10	1448	3	61,537	81,087
97206	SE	249	50,655	20,100	62.83	84.34	12,628	210	19.94	34.94	10,102	87	71,658	83,602
97209	NW	33	16,507	11,376	25.58	60.61	2910	20	15.68	15.15	2589	5	82,582	100,645
97210	NW	35	11,676	6253	40.76	74.29	2549	26	9.76	25.71	1140	9	140,398	132,407
97211	NE	181	34,856	13,081	65.81	85.08	8609	154	27.21	19.89	9484	36	91,179	98,866
97212	NE	143	26,601	10,890	64.05	89.51	6975	128	15.81	11.89	4206	17	125,138	112,073
97213	NE	165	32,284	13,783	61.63	85.45	8495	141	15.98	17.58	5160	29	87,715	89,455
97214	SE	144	25,398	12,190	35.64	81.25	4344	117	12.91	22.22	3280	32	84,012	94,801
97215	SE	91	17,939	7802	63.86	92.31	4982	84	10.84	25.27	1945	23	101,953	97,530
97216	East	51	17,112	6530	46.66	90.2	3047	46	29.93	33.33	5122	17	53,870	70,306
97217	North	170	34,327	14,520	62.41	82.94	9062	141	22.34	25.29	7669	43	84,004	88,975
97218	NE	76	15,556	5543	59.1	90.79	3276	69	28.43	27.63	4422	21	68,539	73,450
97219	SW	202	41,534	16,561	70.32	90.1	11,646	182	13.05	17.82	5419	36	119,199	104,608
97220	East	93	30,374	11,488	56.27	91.4	6464	85	34.62	24.73	10,514	23	60513	80,632
97221	SW	41	12,363	5170	75.92	95.12	3925	39	11.79	34.15	1457	14	146,948	121,333
97227	North	15	4648	2259	31.03	86.67	701	13	24.94	26.67	1159	4	77,831	90,833
97229	NW	21	65,285	23,913	70.72	100	16,912	21	31.83	23.81	20,779	5	137,990	144,166
97230	East	77	39,884	14,967	56.97	93.51	8527	72	32.96	23.38	13,147	18	63,112	87,847
97232	NE	57	12,865	6641	31.86	56.14	2116	32	14.42	15.79	1855	9	86,325	104,727
97233	East	54	42,001	13,496	45.82	66.67	6184	36	35.16	37.04	14,767	20	49,769	51,875
97236	East	53	40,274	12,996	54.59	90.57	7094	48	36.56	30.19	14,726	16	60,022	69,200
97239	SW	67	16,682	8322	49.54	85.07	4123	57	17.89	14.93	2985	10	120,876	110,350
97266	East	131	34,757	12,280	54.24	84.73	6661	111	33.46	23.66	11,628	31	55,339	71,349

Table 9. Socioeconomic data from surveys and Census

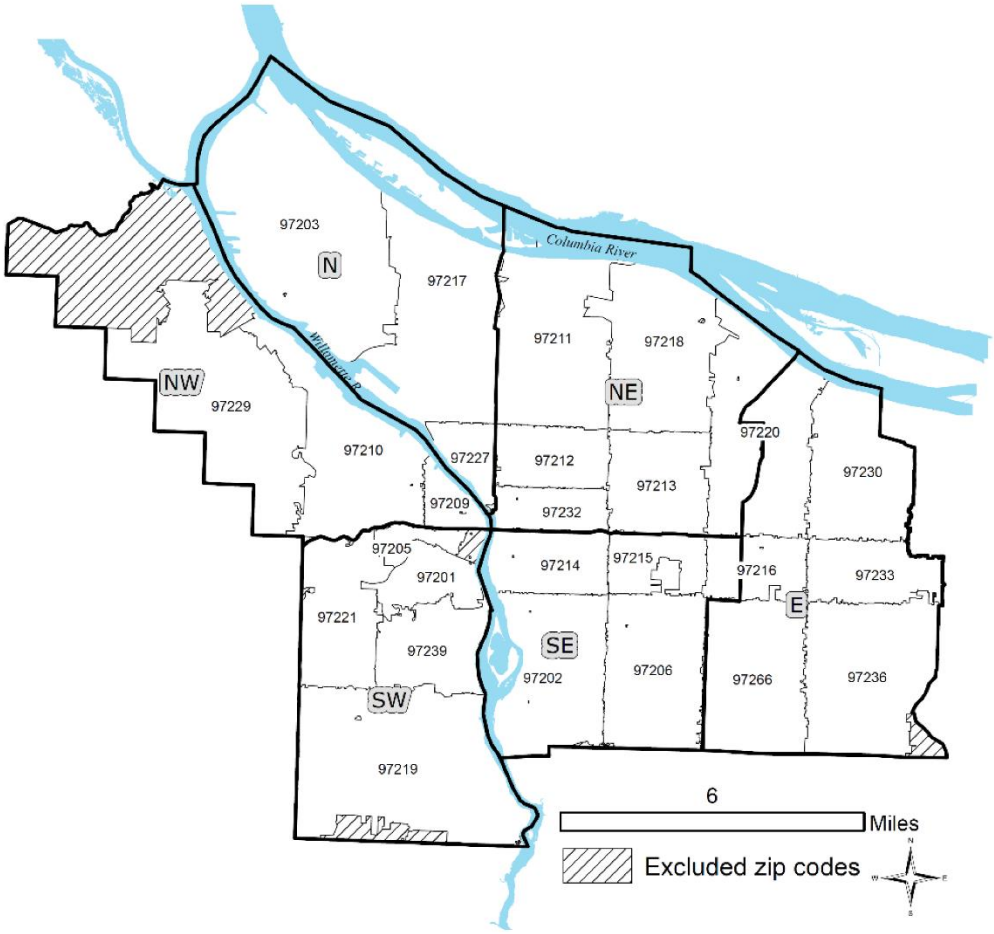

Figure 4. Zip codes in the study area

Chapter 5: Exploring nature-based solutions narratives for an inclusive ecological future

1. Public perceptions and environmental planning

Writing about humans and nature brings reflections on landscape ecology, environmental sociology, GIS analysis for geographic public perceptions, and urban vulnerability. Despite their independence, the three papers reviewed the elements of nature-based solutions theory, including the perpetuation of land use management inequalities endorsed by historical racist planning. In the introduction, I mentioned the existing frameworks of nature-based solutions, reimagination, and extinction of experience. Nature-based solutions comprehend operational actions through ecosystem-based adaptations, green infrastructures, and ecosystem services. Frameworks of reimagination applied to nature-based solutions prospect excluded landscape values, primarily from underrepresented groups in environmental planning. The extinction of experience that impacts the exchange of principles between humans and nature in the Anthropocene can be more intense in individuals not targeted in environmental planning.

I aim to advocate for inclusion and diversity in environmental planning as a researcher. Having my doctoral training in the United States while participating in advisory boards and community engagement allowed me to experience the creating process of public policies as a stakeholder. Growing up in Brazil, where there is lower community participation in creating public policies, I learned how to organize communities with flexibility and lower footprint. Therefore, I chose nature-based

solutions, reimagination, and extinction of experience to guide the dissertation path. These three theories recommend methods that aim to find answers through social participation. In nature-based solutions, ecosystem-based adaptations value systems that promote socio-ecological harmony to regulate ancestral practices. Several ecological practices rely on intergenerational conversations and empirical learning. Hence, listening to the local population allows the unfold of traditional knowledge.

Likewise, frameworks of reimaginations stimulate memory and future perspectives to shift a current struggle scenario with ancestral practices. Ecosystem-based adaptation literature backs up rural and small communities. In urban areas, where there is a large concentration of vulnerable populations, it is necessary to reimagine a future scenario with values that have been lost, stolen, or marginalized. For example, environmental planning can increase the number of urban parks in Black communities to promote ecosystem services. Still, most planning agencies do not accept that graffiti can improve the relationship of social belonging to a given park. Creating a park is a reparation measure for a Black community burdened by environmental racism, but graffiti is still a crime for planning agencies. In many Black communities, graffiti is not a crime; it is art. Without reimagination, the use of green infrastructures for Black communities is a void in the process of restoring values lost in the extinction of experience. In the Anthropocene, people living in urban environments lose familiarity with ecological education and ecosystem services. However, the population that is already excluded, whether by race, income, or geography, loses more. In addition to the landscape change, cultural intolerance impedes access to cultural ecosystem services.

Both case studies of this dissertation analyzed public perceptions of planning regulations agencies. In Portland, urban forestry, income, and satisfaction with trees are correlated values. These values were also found in other studies, but with qualitative data, I found what population expects from environmental agencies. In Portland, there is significant dissatisfaction with the distribution of trees in the city, as most of the trees are in Western areas. Geological formations, income, and early urban planning developed the canopy pattern. However, the city's expansion towards the Eastside, with large ethnic diversity, was faster than the tree planting policies. An open-ended question showed that even participants who live in high canopy areas understand the urgency for climate resilience lies in areas with less access to trees and other green structures.

In Sao Paulo, I also used qualitative data combined with social mapping to hear the periphery population. In São Paulo, peripheries are areas of high vulnerability and racial, economic, and geographical segregation. Because issues such as corruption, public security, and gang violence are glaring, environmental issues did not prioritize. However, the population is dissatisfied with the quality of water canals, sewage systems, and urban parks. Despite living close to areas of great ecological importance, such as indigenous reservations, waterfalls, and forest fragments within the municipality of Sao Paulo, participants do not visit those destinations. Desirable natural areas are a sixty-two-kilometer trip for leisure services within urban zones or on the coast. In my opinion, this finding shows the disconnection between the planning agencies and the public. Although there is a strategic planning plan to reduce ecological and social vulnerability, there are few accessible routes to access ecological and cultural values to the periphery population.

The conceptual chapter on the marginalization of cultural ecosystem services explains the roots and problems of environmental racism. Several planning initiatives are strategically functional but fail during implementation because there is not enough representation and participation of people in ecological and social vulnerability. Listing criminalization, acculturation, and cultural appropriation problems is an initial way to show how planning practices normalize the exclusion of non-white values. I suggest that reimagination is necessary to impulse more straightforward solutions and include ideas from unrepresented groups.

During my Ph.D., I had an internship role at a local NGO where I was supposed to facilitate the creation of an intersectional mural. In Portland, to paint a street, there is a series of administrative tasks: city permit, budget approval, meetings to discuss the mural design with the population. In Brazil, community leaders organize people, share the cost of the paintings, and do the mural without asking for permission. In Portland, the process is long and can exclude communities without leadership to fill the paperwork. When the population acts independently in Brazil, there are safety and liability risks. These are two extremes, and there can be a middle ground. Excessive bureaucratization can make simple solutions expensive, hinder urban participation, and keep more responsibilities on top-down management. São Paulo's strategic plan mimics sustainable cities initiatives, such as Portland. But when interviewing participants, it was challenging to find planned actions on the ground. Of course, engineering projects, such as the implementation of green infrastructure, need security and validation that public authorities must lead. But the population can also organize or have the autonomy to make decisions that apply to

their geographies, as grassroots production of space. These initiatives are observed in ecosystem-based adaptations in the periphery of São Paulo and through financial solutions for urban forestry proposed by Portland residents.

In the following subsections, I will review the findings and discussions of each paper and their contribution to the revision of urban studies literature.

2. Cultural ecosystem services, ecosystem-based adaptations, and frameworks of reimagination

Chapter 2, *Unfolding cultural ecosystem services from Black and Indigenous ancestrality for environmental planning,* listed forms of criminalization, acculturation, and cultural appropriation of cultural ecosystem services values from Black and Indigenous communities in the American continent. The marginalization of intrinsic cultural ecosystem services values happened because Black and Indigenous have been historically segregated from decision-making agendas through slavery, colonization, and genocides. Hence, the normalization of ancestral ecological practices was lost through history and not kept accountable in land use regulation. The loss of representation led to criminalization, fear, and acculturation of Black and Indigenous bodies, cultures, and behaviors.

Progressive environmental scholarship has criticized cultural ecosystem services metrics, which argues adopting mainstream Western values as cultural norms. My critique proposed combining cultural ecosystem services with ecosystem-based adaptation (EbA) for local and regional planning, where the accountability for diversity is feasible. Like cultural ecosystem services, EbA is also under the realm of natural-based

adaptations, with a similar goal to mitigate climate change, promote sustainable development, and restore ecosystems. EbA relies on using knowledge systems, including ancestral land-use practices, wildfire management, foraging non-commercial crops, and entheogens.

My critique put Black and Indigenous groups as generic unheard communities; however, I am aware of the diversity within these communities. The socioecological needs of Black and Indigenous groups vary according to their geography, ethnicity, origin, and expectations for land use. For now, my objective was to create awareness for the problems of marginalization of specific cultural ecosystem services values. In future studies, I want to explore the perceptions of cultural ecosystem services in particular geographies and ethnicities and their expectations for land use management regarding recreation, aesthetics, knowledge systems, and spirituality.

The other discussion point in this chapter was the expansion of frameworks of reimagination to create a possibility to overturn the portrayal of Black and Indigenous identities on the environmental justice scholarship. I struggle with the current approach of environmental justice and planning agencies towards Indigenous and Black communities. Terms as vulnerable, unheard, marginalized do not empower the values of non-white communities. In environmental planning, non-white communities are seen as target populations for inclusion programs, which should be synergic: inclusion of environmental justice practices to non-white community and normalization of people of color values to the white society. Reparations measures offer essential ecological services - clean water, clean air, access to green areas - to Black and Indigenous communities, but

I believe they need more. The ecological agenda should include the semi-lost cultural ecosystem services and lessons learned through social resilience to maintain these values. This liberation path is possible through reimagination for land use. Current equity measures mostly want to provide Western values to populations with no roots in whiteness. Rescuing semi-lost values brings the potential for a richness of normalized values and solutions in environmental planning.

Participating actively in environmental planning in Portland, I observed focus groups that listened to communities of color through facilitating events in vulnerable areas. The methodology of collecting qualitative data through public forums can disclose previously unheard cases of criminalization, acculturation, and cultural appropriation. Events that offer financial compensation, support (childcare, transit fare, parking vouchers, translations), and local facilitators can engage community members. I believe this is a successful strategy, with a two-way outcome: public agencies can understand the environmental expectations of the population, and the public learns civic commitment and responsibility.

3. Reimagining planning practices to mitigate urban and ecological vulnerability

Chapter 3, *Exploring urban mobility through interviews and social mapping in São Paulo,* mapped urban destinations of subjects in the Southern Zone of Sao Paulo. The results confirmed that segregation in Sao Paulo happens through race, income, and geography. In addition, the mapping ethnography revealed that participants living in a macro zone of urban and ecological vulnerability rely on social resilience to overcome the issues of public safety, corruption, and ecological vulnerability in Sao Paulo.

In the Southern Zone of São Paulo, the population uses their sense of belonging and collective efforts to transform urban landscapes and navigate socioeconomic changes, which resembles a framework of reimagination for vulnerability. For example, all the participants lived in zones of urban and ecological vulnerability, as Sao Paulo municipality labeled on the strategic master plan. Vulnerable areas bear geological risks, poverty, and high rates of crimes. The survey results disclosed that participants felt safer in their housing space and neighborhoods than in Sao Paulo municipality - even with indicators showing more vulnerability to crime in their homes and neighborhoods. There is a mismatch in perceptions of land use between planning agencies and residents. Trapped in geographies of segregation and exclusion, periphery identities use social resilience and reimagination to explore alternative space productions, including artistic interventions, reclamation of spaces, and collective support.

The study area for this research was in proximity of environmental protection zones, but the results did not show any destination for urban services in the forest fragments. The macro zones of environmental protection have urban containment, excluding housing and commercial zoning; therefore, retail destinations and activities. However, leisure is a recreational value that could have destinations in natural areas. Some participants traveled to the coast, but none visited local forest fragments for hiking, waterfalls, and other outdoor activities. Instead, Southern Zone residents go to Sao Paulo downtown to find recreation on Parque Ibirapuera, a structured urban park close to public transit and with several amenities, like museums, sculptures, running trails, and open areas.

Sao Paulo's strategic planning measures planned to use green infrastructures to mitigate urban and ecological vulnerability, such as improving water quality, investing in ecotourism, expand green areas and corridors. Green infrastructures can address the socio-ecological vulnerability, but the participants did not mention any strategic plan initiatives during the interviews and mapping. In the survey results, participants shared discontentment with the management of green infrastructures. From my perspective, these findings conclude that: a) environmental agencies rely on American and European models for green infrastructures, that might not represent the values of segregated communities; b) segregate communities do not have ownership of natural areas because the land use regulation is oriented for white recreationists; c) urban vulnerability (crime, corruption, irregular housing) represent short term urgent issues and are easier perceived by vulnerable residents; d) environmental agencies can have racist planning policies, prioritizing management of green infrastructures located in affluent areas.

I believe that combining frameworks of reimagination with green infrastructures is an alternative to engage the community in environmental education and increase the ownership of protected areas. The *rolezinho* events on Parque Ibirapuera were a form of reimagination, where the youth could experience high-quality green infrastructure without fear of segregation. Part of the urbanization of Sao Paulo Southern Zone happened in the 70s', 80s'and 90s'. There are long-term residents that have memories from a rural landscape scenario with more socio-ecological values. With reimagination and public participation, green infrastructures can restore values that promote cultural ecosystem services and bring aesthetic design that appreciates local ethnic and cultural

traditions, as hip hop culture, statues of periphery identities, graffiti art, and other historic aspects of the neighborhood.

Reimagination also applies in methods for data collection. With data ownership and accessible tools for data collection, as geospatial apps for smartphones and interviews through podcasts, it is possible to practice radical geography. Radical geography advocates for open data, solutions through social justice, activism, and geospatial technology accessibility. In scenarios of vulnerability, traditional planning practices might not reach the target population, as observed in Sao Paulo's strategic plan. Therefore, alternative solutions through reimagination and radical geography can be more feasible and operational.

4. Ecosystem services and perceptions of nature ownership

Chapter 4, *Integrating diverse perspectives for managing neighborhood trees and urban ecosystem services in Portland, OR (US),* explored the relationship between tree canopy, socioeconomic indicators, and public perceptions of urban forestry management. Portland has an experienced planning municipality, pointed as a sustainability reference worldwide. However, urban sprawl, racist planning, and late incorporation of periphery zones lead to an uneven distribution on the urban tree canopy. Affluent neighborhoods and areas of geological interest have more investments and a sense of ownership for urban forestry. On the other hand, displacement through gentrification and the increasing cost of living burden low-income residents to maintain private and street trees. To expand the accessibility to tree canopy, public perceptions expect more investments in cultural

ecosystem services of knowledge systems, cultural heritage, and financial assets for tree maintenance.

Portland has been investing in environmental planning policies for the past century, and the survey results showed awareness of urban forestry maintenance and ecosystem services values. The awareness of current ecological policies does not exclude the challenges for land use equity; contrariwise, the culture of tree appreciation elevates the conversation about urgent needs for landscape management. The sense of satisfaction for urban forestry follows the presence of tree canopy, pointing to the normalization of green infrastructures as a factor to enhance nature ownership.

Green infrastructures and ecosystem services have the highest level of operationalization in the nature-based solutions model. Thinking of trees as the simplest green infrastructure, planting and maintaining urban forestry can be an affordable and feasible solution to expand the accessibility to ecosystem services. Ecosystem services found in trees are tangible, have simpler metrics, and can developed cultural memories and associations to an individual tree. The major challenges for successful urban forestry systems are financial solutions for tree maintenance, optimization of planting programs, and equitable access to urban forestry.

The coding of public inputs generated a list of solutions from survey participants. Financial solutions include discounts on water and garbage bills for households that irrigate and prune trees to alleviate the maintenance costs. Technical forestry teams could follow-up support for tree care, such as educational materials about tree maintenance or online courses to optimize planting programs. Municipal planning agencies might not

have the capacity to design targeting programs; therefore, partnerships with startups, sustainable educational hubs, and local students can bring innovation through alternative stakeholders.

5. Future perspectives in urban studies scholarship

At the end of this graduate degree path, I have a better base to help with revising environmental ethics and ecological analysis from a perspective of an AfroLatina scholar. I want to keep working with community engagement, community participation, data empowerment. Growing up in a Latin country, I had a higher sense of belonging and social resilience. I believe that resilience without empowerment does not promote change - as resilience can be used against the community due to the high capacity of resurging. Resilience with empowerment builds stronger communities through education, training, autonomy, and representation. Today, data is power, and data ownership is a path to strengthen local independence, reasoning, and argumentation in decision-making agendas. With accessible spatial analysis tools, communities can collect their data, find spatial patterns, discover answers for local issues, communicate their findings, and actively participate in urban planning processes.

Currently, I am disseminating spatial analysis methods as an educator. Through teaching and consulting, I want to inspire communities and groups to collect their data and build their narratives. I completed the data analysis in Chapters 3 and 4, but I did not collect the data. Data collection with GPS, surveys, interviews, and landscape observations are skills I want to explore in future research projects.

Education, research, and public policies will be part of my future scholarship path. Either in the United States, Brazil, or any other location, I will bring the knowledge acquired during the dissertation process. Now I have expertise in spatial analysis, sensibility in observing intrinsic cultural ecosystem services values, critical thinking on environmental ethics, and experience with surveys and interview coding. I also have the hope necessary for a scholar's heart, believing that science and education are key to positive transformation in the society.