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EDITED BY
Stefano Salata,
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Oleksandra Nenko,
University of Turku, Finland
Ebru Ersoy Tonyaloglu,
Adnan Menderes University, Turkey

*CORRESPONDENCE
Richard leBrasseur,
r.lebrasseur@dal.ca

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Linking human wellbeing and urban greenspaces: Applying the SoftGIS tool for analyzing human wellbeing interaction in Helsinki, Finland

Richard leBrasseur*

Green Infrastructure Performance Lab, Department of Plant, Food and Environmental Sciences, Dalhousie University, Truro, NS, Canada

This article reviews a study into the relationships between greenspaces and the benefits to psychological, social, and physical aspects of human wellbeing achieved through interaction in the Helsinki urban region in Finland. This relationship is theorized, analyzed, and measured through the transactional paradigm of affordance theory and is operationalized through the use of a public participation geographic information system (PPGIS) questionnaire, SoftGIS, which activated the urban greenspace–human wellbeing *interaction through* its map-based data collection. Over 1800 unique place–based relationships were statistically analyzed. Findings revealed that Helsinki's greenspaces provided, overall, mostly physical and social wellbeing benefits; the psychological benefits such as reduction in stress and mental relaxation were not as frequent in these urban greenspace interactions. The results indicate multiple aspects of human wellbeing are supported by interaction with urban greenspaces of varying characteristics within the region but the urban greenspaces which provided the most human wellbeing benefits included large size, woodland typology, moderately maintained with loose or 'wild' vegetation, and few amenities such as benches and structures. The study's implications include urban planning, public policy, and human health as well as insight into the multifunctional design and strategic management of greenspaces in urbanizing regions to provide continued and improved ecosystem services and benefits to humans and nature.

KEYWORDS

urban greenspace (UGS), human wellbeing, public participation GIS (PPGIS), urban planning, affordances

Abbreviations: CES, cultural ecosystem services; ES, ecosystem services; HUR, Helsinki urban region; HWB, human wellbeing; PPGIS, public participation geographic information system; UGS, urban greenspace.

1 Introduction

As urban regions continue to expand and cities evolve, resulting in environmental changes. This spatial transition is most noticeable in a city's greenspaces and impacts both ecological systems and human activities including both ecological function (Forman, 1995) and human wellbeing (Millenium Ecosystems Assessment, 2005; Wu, 2013). The role of greenspace and human wellbeing is important to study as cities densify and urban development continues.

Urban planning and the advancement of healthy and responsive cities has emerged as an important practice requiring an integrated, strategic approach to develop multifunctional and ecosystem services providing greenspaces in city regions. Urban planning and land-use decisions in cities require comprehensive information in order to support effective decision making. Contact with the natural environment such as urban greenspace is a fundamental component of human wellbeing (Wilson, 1984). The role of urban greenspace in cities must better respond to human wellbeing constructs in order to increase the capacity for shaping healthier cities.

Yet, moving current practice in urban greenspace planning toward a holistic approach poses many challenges, such as the need for more inter- and transdisciplinary perspectives, comprehensive information about greenspace functions and benefits as well as more integrated assessments (Czembrowski et al., 2019; Kabisch et al., 2022). Human wellbeing is evidently linked to the environment, particularly in cities, however; it remains difficult to assess human behavior within those environments and how urban greenspaces specifically contribute toward human health and the wellbeing of the people engaged with them (Hansen and Pauleit, 2014). Negotiating what will have the maximum impact on urban residents is contextual, subjective, and ultimately problematic within spatial planning decisions.

There is an increasing need for a transactional research approach in which the focus is directed toward a real-life event and embedded in a locally meaningful context (Gobster et al., 2007). Ecological and spatial planning knowledge must be inclusive of the resident's use of their environment (Kahila and Kyttä, 2006). The role of urban greenspace and human wellbeing within the human–nature relationship is the focus of this research and critical to understanding in the face of continued growth in the number, size, and density of urban areas in much of Europe and the world. Cities will place more pressure on their existing greenspace(s) for diverse ecosystem services through urban resident interaction. This study advances conceptual frameworks and approaches to study and analyze the human–urban greenspace relationship specific to human wellbeing by asking the following questions:

1) What are the paradigms used to articulate the human and urban greenspace relationship?
2) How can cultural ecosystem services be framed within a transactional paradigm of the human–nature relationship?
3) Which approaches can be applied to best integrate spatial data and citizen knowledge specific to measure human wellbeing?
4) What types of people use what types of urban greenspaces for what types of human wellbeing benefits?
5) What types of urban greenspaces provide the most affordances or interactional benefits to human wellbeing measures?
6) How can landscape planning and design in the context of dynamic urbanizing environments contribute to improving human wellbeing?

First, a literature review frames the important concepts within this study and provides operational definitions. The next section presents the theoretical background in establishing the relationship between urban greenspaces and human wellbeing. This is followed by the data collection procedure, followed by results and analyses. Finally, the last section presents the discussion and conclusion.

1.1 Human wellbeing and ecosystem services

Human wellbeing (HWB) remains an ambiguous concept, without a universally agreed definition and often faced with dissimilar interpretations (e.g., Dolan et al., 2011). In this regard, HWB must be regarded as a multidimensional concept (e.g., McGillivray and Clarke, 2006). The World Health Organization defines HWB as "*To reach a state of complete physical, mental, and social wellbeing, an individual or group must be able to realize aspirations, to satisfy needs, and to change or cope with the environment. Health is, therefore, seen as a resource for everyday life, not the objective of living. Health is a positive concept emphasizing social and personal resources as well as physical capacities*" (World Health Organisation, 2016).

Many definitions in the literature for HWB refer to a person's 'happiness,' 'quality of life,' and 'life satisfaction' (Pollard and Lee, 2003) where wellbeing is being "*healthy in a way that includes physical, mental, spiritual, and emotional health.*" (Dolan et al., 2006). Components of HWB have perhaps most famously been articulated by Maslow's hierarchy of needs (Maslow, 1968), which includes physiological or survival needs as well as other aspects such as needs for esteem, belonging, and safety. Though literature disavows the hierarchical structure of Maslow's model, the components are still considered relevant. Similar to natural science's ecosystem health assessments of the biophysical landscape (e.g., Rapport et al., 1998), which include deconstructed ecological components; the social sciences have developed wellbeing components for humans. In reviewing over 22 studies, Hagerty et al. (2001) found the following seven broad HWB components included in most research frameworks: relationships with family and friends, emotional wellbeing, material wellbeing, health, work and productive activity, feeling part of one's community, and personal safety.

Research often equates wellbeing with these other components or constructs. Not only does this discount the diversity of characteristics of wellbeing, but also omits other important aspects. As a result, Gasper (2009) argued that new measures need to respect the diversity of wellbeing. The literature classifies measures of HWB into two categorizations: objective and subjective measures. Objective wellbeing is often measured through economic, social, and environmental statistics, typically with cardinal metrics. Subjective wellbeing, alternatively, is measured through the individual's feelings or experiences, with ordinal metrics (McGillivray and Clarke, 2006) and is considered to be a more accurate indicator of an individual's wellbeing.

HWB, thus, is primarily a subjective measure within the social sciences (Diener, 2009), and is influenced not only by life conditions and prior experiences, but also by personal values (Keith, 2001). Hone et al. (2014) referred to HWB as "flourishing," as first noted by Keyes (2002); "positive functioning" (Huppert and So, 2013) has also been documented. The subjective wellbeing measures are often simple and direct—assessing individual's thoughts and feelings about one's life and circumstances, and the level of satisfaction with those components. This is typically enacted through a self-reported measure.

Reflecting the interconnectedness of anthropocentric and ecological, or socio-ecological landscapes in cities, recent conceptual frameworks of HWB strive to illustrate the linkages between HWB and their urban greenspaces (UGSs), with this being achieved predominately through the concept of ecosystem services (ES) (e.g., Taylor and Hochuli, 2017; Bogaert et al., 2005) or natural capital (Millenium Ecosystems Assessment, 2005; Costanza et al., 2007; Smith et al., 2013).

ES is an integral component of EU policy and grew out of the desire for a better understanding of the relationship between the environment and HWB through the significant initiatives of the Convention on Biological Diversity (United Nations General Assembly, 2017) and the Millennium Ecosystem Assessment (MEA). Although the concept of ecosystem services has permeated many disciplines, four primary definitions are most common in the literature:

- The benefits people receive from ecosystems (Millenium Ecosystems Assessment, 2005).
- "The conditions and processes through which natural ecosystems, and the species which make them up, sustain and fulfill human life" (Daily, 1997).
- "Ecosystem services are components of nature, directly enjoyed, consumed, or used to yield human wellbeing" (Boyd and Banzhoff, 2007).
- "The benefits human populations derive, directly or indirectly, from ecosystem functions" (Costanza et al., 1997).

Taken as a whole, these four established definitions illustrate human-based benefits; though there are continued discussions to the varied meanings and semantics of the terms used such as 'outcome' and 'function' (La Notte et al., 2017).

Although the ES approach is increasingly significant within the literature, there are still challenges to be acknowledged, the ES framework is value-based, and often hedonic, in that ecological processes are conceptually translated into value-laden entities or components (Costanza et al., 2014). The concept for ES grew from conservation-based dialog expressed through economic-based goals. As such, the ES "value" is viewed as similar across the board—for all people of all characteristics, though recent advances in this model are becoming prevalent and more contextual (Maund et al., 2020; Andersson et al., 2021). Beyond the utilitarian approach and potential commodification impacts on ecological resources (e.g., Norgaard, 2010), the ES approach has not illustrated strong applicability to the phenomena found within the human–nature relationship, specifically human actions or responses including management (Vatn and Vedeld, 2012; Baskent, 2020).

The Millennium Ecosystem Assessment's (MEA) classification system is the most accepted and prominent in literature. The MEA report unfurled a wider understanding and use of ecosystem services and offered an expanded classification system (2005) for analysis. However, Boyd and Banzhaf (2007) provided the following updated definition informed by economics and accounting principles: "*. . .ecosystem services are components of nature directly enjoyed, consumed, or used to yield human wellbeing.*" (Emphasis by author).

The MEA's definition of cultural ecosystem services, however, opened the door to benefits beyond the economic-oriented end-products of ecological systems and phenomena (e.g., clean water and clean air) to include cultural meaning, recreation, psychophysiological, and spiritual fulfillment (Millenium Ecosystems Assessment, 2005, p. 40; see also de Groot et al., 2010). Simply termed as 'cultural goods and services' (UNESCO, 2004), these cultural benefits do not fit Boyd and Banzhaf's traditional economic valuation perspective, but are nonetheless important to meet ecosystem service necessities of 'wellbeing' and "human welfare" and cannot simply be disregarded. For example, ES benefits are not easily accounted for including the concept of social capital, for example, knowledge sharing and social-wellbeing benefits achieved through social interaction (Vallés-Planells et al., 2014).

Cultural ecosystem services (CESs) are an evolving framework focusing on the comprehensive suite of benefits humans receive from the landscape (Millenium Ecosystems

Assessment, 2005), both directly and indirectly, including recreation, personal wellbeing, and social interaction and other non-material benefits for people, often through interaction with greenspaces.

1.2 The influences of greenspace upon human wellbeing

A breadth of literature across multiple disciplines discusses the influences of greenspace and, to a degree, urban greenspace upon human wellbeing (HWB). An exhaustive review of the varied connections made in the literature between humans and nature or greenspaces would be imprudent. This research aimed to identify those specific facets of the human–nature relationship that have been identified as the HWB characteristics specific to urban greenspace (UGS) interaction. The literature provided to support these relational effects focuses on empirical research from multiple disciplines with measurable outcomes and results. Furthermore, the human–nature relationship pervades seemingly inexhaustible subject areas and disciplines; hence it was impossible to provide a complete review. Overall, this research highlights the substantive facets and notes those are poorly represented in the scientific literature.

Contact with the natural environment such as UGS is a fundamental component of HWB. Matsuoka and Kaplan (2008) reviewed 90 studies from the scientific journal Landscape and Urban Planning, and like Coppel and Wüstemann (2017) analysis concluded there was strong evidence that greenspace within the urban landscape is important for HWB. Furthermore, nearby greenspace influences wellbeing beyond spatial interaction (Kaplan, 2001; Ekkel and de Vries, 2017). The United Nations Sustainable Development Goals emphasize the importance of greenspace provision in cities "*to foster prosperity and quality of life for all*" (United Nations General Assembly, 2017). Furthermore, the World Health Organization notes greenspaces as a "*necessary component for delivering healthy, sustainable, livable conditions*" (World Health Organisation, 2016).

International studies in the Netherlands, Denmark, and the United Kingdom have also found that nearby greenspace positively influenced various aspects of human wellbeing. Higher levels of perceived general and mental health, lower stress levels, lower likelihood of obesity, and fewer health complaints were among the health measures associated with greener environments (Mitchell and Popham, 2008; Maas et al., 2009; Korpela et al., 2014). Recreational parks and UGSs provide opportunities for healthy physical activity and the relief of stress (Hunter et al., 2017). Furthermore, the passive benefits to physical and mental health of an urban landscape with trees have been documented (Ward-Thompson, 2011); enjoyment of green areas may help people to relax or may give them fresh energy. Such findings broadly confirm the conclusions of others concerning contact with nature, reduction in stress, and escape from dense urbanity (Ulrich, 1983; Kaplan, 1995; Hedblom et al., 2019).

Alternatively, greenspaces are not always regarded as having a positive impact on humans and the benefits derived from interaction with them not always beneficial. For instance, UGSs, particularly in dense cities, are viewed as dangerous (Jorgensen and Keenan, 2012). Other UGS characteristics, such as a lack of maintenance and cleanliness, or dense vegetation, may reduce social interaction and thus the development of social ties and social cohesion. UGSs carry disease and allergens (Ribeiro et al., 2019); children can procure serious injury from play within UGSs. UGSs can become overcrowded (Arnberger et al., 2005) leading to potential user conflicts (Arnberger, 2006) and even violence, as well as the reduction in the quality of the vegetation due to overuse (Kissling et al., 2009).

Fisher, Turner, and Morling (2009) suggested that ecosystem services are those aspects of ecosystems utilized (actively or passively) to produce HWB. HWB is a multifaceted construct (e.g., Diener, 2009; Stiglitz et al., 2009) with interacting and changing subjective and objective measures. Yet there is no agreement as to which components should be included in a valid theory and measure of wellbeing (Ryan and Deci, 2001; Hird, 2003). Regardless, whenever any of these terms and components are used, explicit qualification is required. For example, objective wellbeing does not fulfill the cognitive concept of 'needs' as clearly as subjective wellbeing (King et al., 2014). In summary, HWB is a distinct construct of the four human wellbeing domains: physical, psychological, social, and economic. Keyes (2002) supports this, stating that HWB requires the combined presence of high levels of emotional, psychological, and social wellbeing aspects through the lens of functioning, both individually and in society.

As evidenced, UGSs provide many benefits to humans, such as places for social activities, physical exercise areas, and more contemplative spaces to connect with nature (Lachowycz and Jones, 2013). Notably, emotional wellbeing is inclusive of concepts and definitions of psychological wellbeing (Bradburn, 1969; World Health Organization, 2005) and is not identified as a separate construct. Social wellbeing relates to social interactions at the community or societal level and relationships with others on a one-to-one, small group or family level. Physical wellbeing relates to the functioning of the physical body and is affected by disease and injury, often equating to physical health.

1.2.1 Social wellbeing benefits

An important aspect of UGS interaction is the social and socio-cultural benefits to HWB (Bell et al., 2008). This benefit is primarily met through an exchange or interaction between individuals or groups, often through communication such as talking or gathering such as picnics and games. (Thomas, 2011). Social ties among individuals, neighbors, and members of groups are important to HWB (Chiesura, 2004). UGSs provide opportunities where users can meet, talk, play, exercise, and socialize. These UGSs create opportunities for people of all ages to interact, increasing social health (Jennings and Bamkole, 2019), and providing a sense of connectedness (Leavell et al., 2019), meaning and purpose, thus reducing depressive symptoms (Kondo et al., 2018).

UGSs provide places for people to meet and develop social connections (Larson and Hipp, 2022). A study by Maas et al. (2009) found that less UGS in the environment coincided with feelings of loneliness and with a perceived decrease in social support. Similarly, social safety is perceived as being increased with the presence of UGSs (Sullivan et al., 2005), whereas enclosed UGSs are associated with a lack of safety and security. Additionally, UGS encourages a sense of community (Gomez et al., 2015) and also offers spaces for outdoor education and learning (Wolsink, 2016). UGSs are also associated with higher levels of social contact an increased feelings of social support among neighbors (Kim and Kaplan, 2004).

Another closely linked aspect of HWB within the social context is that of cultural benefits provided by UGSs. Cultural values are connections made with the landscape that are based upon prior experience such as family, upbringing, and education (Tuan, 1974). Additionally, evidence shows that social interaction with varied age groups, cultures, and ethnic backgrounds is more prevalent with the availability of GS (Palliwoda and Priess, 2021), potentially leading to increased "social cohesion" (Larsen, 2013) and social inclusion (Bush and Doyon, 2017). Social cohesion is defined as the ties that bind humans together in society and have a large bearing on individual wellbeing and the wellbeing of the larger community (Poortinga, 2006). Community gardens are correlated with increased social interaction and improved social networks (Rogge et al., 2020) as well as social cohesion (Veen et al., 2016). Public parks allow for spontaneous interaction or the "meeting of strangers" (Varheim, 2017). Informal social contact with other individuals increases psychological and social wellbeing (Kweon, Sullivan and Wiley, 1998) and overall social relationships (Douglas et al., 2017).

Social ties and a sense of community are also beneficial to groups of people and communities, not just individuals (Lee et al., 2015), providing 'social-control' within a UGS which supports police monitoring for undesirable behavior (Kuo, Sullivan, Coley, and Brunson, 1998). Weldon et al. (2007) supported this capacity-building aspect of greenspaces, particularly among young people, noting that increased public use can also lead to local stewardship and community-based maintenance. UGS has been shown to reduce negative social behavior such as aggression and violence by instilling social cohesion and social identity (Dempsey, Brown, and Bramley, 2012).

1.2.2 Physical wellbeing benefits

Literature has shown the positive and direct benefits to human physical health arising from use of and interaction with UGS and includes concepts of physical health, obesity reduction, increased recovery rates, and others (e.g., Cooper-Marcus, 2005; Tyrväinen et al., 2005; Ward Thompson, 2011; Akpinar, 2016; Kondo et al., 2018; Ma et al., 2019). Interestingly, some studies indicate that the benefits of outdoor GSs are more substantial than those from indoor physical activity such as gyms and stationary bicycles with similar intensity (Pretty et al., 2007), which may be due to the greater positive psychological effect UGSs provide. Studies have also shown higher rates of healing when hospitalized with the presence of GS (Cooper-Marcus, 2005) and reduced mortality (Heo and Bell, 2019). (Kaplan and Kaplan, 2011) noted that without exposure to GS humans suffer stress. Stress can produce physical symptoms such as headaches, pains and sore muscles, insomnia, and lead to colds or infections.

1.2.3 Psychological wellbeing benefits

A significant body of work by Rachel and Stephen Kaplan (1995) focused on attention restoration theory (ART) that provides evidence that UGSs not only reduce mental fatigue and stress, important components for human wellbeing and quality of life, but restore a person's capacity to pay attention, two critical components to effective human functioning in the modern world. Similar to ART, Hartig (2004) referred to "mental restoration" as important for human wellbeing. Both of these concepts evolved from Ulrich's (1983) psychophysiological stress reduction framework (Korpela et al., 2001; Kaplan, 2002). Recent studies correlate that more UGSs result in increased mental health and lower levels of stress (Dzhambov et al., 2018; Vujcic et al., 2019).

A variety of UGSs have been shown to provide psychological benefits, including both naturalistic UGS typologies as well as more anthropic ones (Taylor et al., 2002; Park et al., 2011; Grafius et al., 2018). Additional psychological benefits of UGS interaction include reduction in depression (Astell-Burt and Feng, 2019), reduction in ADHD in children (McCormick, 2017), increased peacefulness and tranquility (Marafa et al., 2018), and fewer reported stress-related illnesses (Reklaitiene et al., 2014). Furthermore, studies report that, even without direct interaction, just seeing a UGS can provide similar psychological and health benefits (Ulrich, 1983; Maas et al., 2009; Hitchings, 2013).

This research will focus on the social, physical, and psychological HWB benefits received from interaction with UGSs, focusing on the city or urban context. These three wellbeing constructs and their associated benefits span the spectrum of critical dimensions of HWB found within the human–nature relationships of UGSs. Although imperfections remain and interrelatedness is overt, these serve the purpose of categorizing the types of benefits and interaction with UGSs that affect HWB to the best degree possible.

To date, much of the literature within the context of subjective HWB benefits and UGSs has been confined to the more naturalistic characteristics of UGSs (e.g., their sense of wildness or naturalness). Cities have multiple dimensions; and same is true for their UGS, facilitating diverse scenarios for interaction. Place-based research on HWB has always proven difficult to correlate; understanding where and for whom UGSs and other environments provide which specific benefit is complex. As argued by Lee and Maheswaran (2011), research must consider a broader range of factors to arrive at a better understanding of the causal mechanisms behind the multifunctional benefits that UGSs yield. The work of Huerta and Utomo (2021), Sharifi et al. (2021), Navarrete-Hernandez and Laffan (2019), Gehl (2010), and Giles-Corti et al. (2005) assessed subjective measures within UGSs affecting HWB. Although most of these studies are inherently associated to UGS preference, they hold significant meanings specific to urban planning and the relational measures or assessments which can be applied.

1.3 Transactional relationships: Affordance theory as a framework for studying human wellbeing and urban greenspace interaction

The evidence that UGSs positively affect HWB is convincing but research is not unequivocal as to the mechanisms or processes that underscore the relationship (e.g., Maas et al., 2009; Van Herzele and de Vries, 2012; Korpela et al., 2014). Place-based research on HWB has always proven difficult to measure and correlate; understanding where and for whom UGSs and other environments provide which specific benefit is complex.

James J. Gibson and his wife, Eleanor, first proposed the concept of "affordances" to describe how humans interact with their environment (Gibson, 1979). Gibson stated that an affordance is a functionally significant property of the physical environment. Affordances are an "opportunity for action" (Heft, 2001). Importantly, however; an affordance is not achieved until there is an interaction of the individual with the environment. Affordance, therefore, is both a physical characteristic of the landscape and a perceived characteristic of the individual; an affordance is met when the individual's characteristics and activity are supported or intention is fulfilled by the environment's characteristics.

The theory of affordance, originating in the field of perceptual psychology, is finding increasing popularity in a variety of disciplines, particularly in the area of urban planning and urban design.

Due to advances in technology and interdisciplinary theoretical relationships, the application of affordance theory has evolved and is able to reduce the cognitive influence, that is, the human-based perception, toward more functional and direct relations (Ciavola et al., 2015; Sun et al., 2020; Pyysiäinen, 2021). Affordance theory provides a more integrated framework to analyze the individual–environment relationship within urban contexts than the capability theory (Sen, 1985) which focuses on individual capacities a less on the functional relationship. Affordances are not passive, they exist through action and dynamic relation (Menatti and Casado Da Rocha, 2016). Hartig (1993) referred to these mutually dependent landscapes of affordance as 'transactional' (Ittelson, 1996). Within this transactionalist perspective (Heft, 2010), the complex dynamic relationship between individuals and the environment is mutual.

Affordance theory is utilized in many objectivist perspectives on the human–nature relationship. Affordances, viewed as properties, often focus on elements or objects within the landscape. For example, a bench affords sitting in a much more accommodating way than a garbage can. But a bench offers more affordances than just sitting—for a human, it can be used to stretch legs over the back rest, it can provide a napping or sleeping surface, a social or solitary, resting place. A bench even provides shelter from rain or snow to small animals and birds. Though there are considered four categories of affordances (Gaver, 1991)—potential, perceived, utilized, and shaped—it is the functional affordance, the utilized or "actualized affordance" (Kyttä, 2002) that occurs after interaction with a UGS can be identified and documented, that is, the HWB benefit received through interaction. Affordances are "properties in the environment that have functional significance for an individual" (Heft, 2010, p. 18). Affordances, thus, indicate possibilities for action, particularly physical action or interaction, such as running or playing football, but also include passive interaction (Kyttä, 2004) such as observation or viewing, where sitting in an area may offer an expansive view of the landscape.

Overall, affordance theory's transactional relationship and the human's active role in the environment is thus a renewed theory to adequately study this critical relationship, thereby informing urban design, landscape management, and planning policy. Affordances within the landscape are physically tangible, and the process of action and engagement with greenspaces provides the mechanism to measure CES and HWB benefits. In other words, in order to fulfill a goal or objective within the landscape, the cognitive decision-making process guides this interaction (Pezzulo and Cisek, 2016). But it is the specific physical properties and characteristics of an environment, here an UGS, which invites a specific action; hence the mechanism for the causal relationship between intentional action and outcome. This functional, responsive feedback to a premeditated action is the mechanism which thus actuates the UGS–HWB relationship.

In this study's context, affordances are not an abstract concept but the instrument and structure (i.e., mechanism) to more objectively document this interaction than traditional perception and cognitive-based measures (i.e., abstract measures). Thus, the transactional paradigm and its relational mechanism of "interaction" as expressed within affordance theory provide a model to measure explicit "*in situ*" actions. Such a 'goal-oriented' operational affordance model provides for clear (i.e., transactional) experiences within the landscape and is useful for the study in determining the functional affordance properties of the UGS, and how individuals use the landscape and its GS to enhance their physical, social, and psychological wellbeing. For example, Kyttä (2002) applied affordance toward another functional aspect of the landscape—the social aspects of HWB in children such as interaction and bonding. Similarly, Clark and Uzzell (2006) presented the town center as an important space for teenagers due to the social opportunities it affords. Affordance theory applications are not limited to children's environments; studies have utilized greenspaces, rivers and streams, and other natural, semi-natural, semi-urban, and urban environments (Said and Bakar, 2005; Ward-Thompson and Travlou, 2009; Araujo et al., 2019). In summary, viewing ecosystem services and cultural ecosystem services within the context of UGS and HWB interaction allow examination into the human–nature relationship through the transactional perspective found within affordance theory (Gibson, 1979).

1.4 Measuring human wellbeing transactional benefits through SoftGIS

The theoretical framework of the affordance-based paradigm moves beyond mental constructs or cognitive concepts of preference and perception to account for the normative function of UGS as indicated through use and interaction. Cognition, perception, and preference studies often focus on elements within the landscape, but not the interaction (Hart and Moore, 1973; Sevenant and Antrop, 2009; Zigmunde et al., 2016; Shi et al., 2020). Although behavior can be objectively observed and recorded, there are often no effective, continuous, and safe means to collect user data required in outdoor environments such as UGSs. Additionally, it is not possible to accurately measure the interactional affordance received through direct observation, particularly multiple benefits from the same behavior or action (i.e., synergistic effects). As such, direct and indirect behavioral observation (Golicnik, 2005) is limited in its application. Overall, there is a need for higher quality information about UGS functions as well as more comprehensive, integrated assessments including multifunctionality (Hansen et al., 2019) and CES quantification.

Participatory mapping has been a well-practiced exercise within spatial planning to attach human value and preference to places (Corbett and Keller, 2005) in a variety of contexts and completed with variable levels of success (Brown et al., 2020; Fagerholm et al., 2021). Only relatively recently, however, geospatial technology has provided a more explicit means to express relationships between humans and place (Jankowski et al., 2016). Geo-questionnaires, found within constructs of participatory geographical information systems (PGIS) and public participation geographical information systems (PPGISs) (Dunn, 2007), involve a real-time, map-based interactional means to convey this relationship and promote communicative planning. The map-based methodology of SoftGIS developed by Kahila and Kyttä (2009) is a geocoded or spatially explicit social survey and most directly appropriates real-world phenomena such as human behavior and interaction. PPGIS questionnaires within the literature explore the various qualities of the landscape primarily through preferences or other value-based perceptions of spaces in order to gather information and inform planning decisions. However, this subjective methodology allows for misinterpretation and the synthesis of unreliable data.

1.5 Cultural ecosystem services, participatory mapping, and urban planning

Though there have been previous attempts to map CES (Norton et al., 2012; Albert et al., 2014), the application of a comprehensive CES approach to landscape analysis, public knowledge, and decision making is still lacking in the planning process (Forkink, 2017; Maes and Jacobs, 2017; Cortinovis and Geneletti, 2019). Most research studies on CES utilizing participatory methods have been conceptual and exploratory (e.g., Opdam et al., 2015; Mascarenhas et al., 2016) and lack specific mechanisms to include the CES concept in urban planning actions (Kabisch, 2015; Bezák et al., 2017; Rall et al., 2019). Additionally, CES service measurement is challenging utilizing traditional ES methods such as economic valuations and quantification (Chan et al., 2011) and the qualitative data collected lack rigorous statistical analysis or spatial correlation (Milcu et al., 2013).

A review by Cheng et al. (2019) assessed 20 CES evaluation methods within the literature and concluded that participatory mapping techniques which focus on the interactions between components were most suited to identify CES. The PPGIS is most often utilized as a social valuation or a preference method, but has been shown to be effective in assessing CES (Brown and Fagerholm, 2015) including UGS access and recreation use (Paracchini et al., 2014; Teff-Seker and Orenstein, 2018)) and landscape conservation or management qualities (Canedoli et al., 2017; Mukul et al., 2017). Most PPGIS studies focus on experiential aspects of landscape such as "sense of place" (García-Díez et al., 2020) and simple spatial location (Mascarenhas et al., 2016). Furthermore, only a handful of PPGIS approaches have studied CES within urban environments (Wang et al., 2019; Ronchi, 2021).

Literature's different methods used for ES classification and mapping limit the comparability of outcomes and call for a more consistent but flexible approach (Crossman et al., 2013;

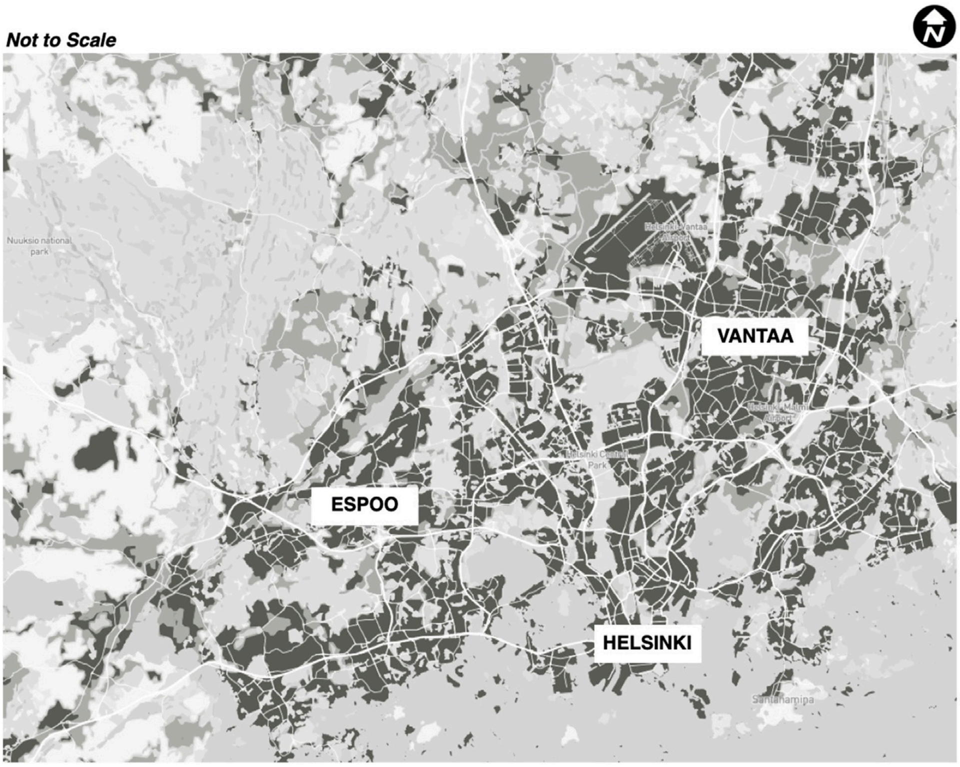

FIGURE 1
Helsinki urban region darker areas indicate urban population density, and lighter areas are less densely populated areas. No density metrics are known, this is a diagram only to show the spatial relationship between the urban areas and the less urban areas only. Source: Author.

Mascarenhas et al., 2015; Fisher and Brown, 2015; Maes et al., 2018). Overall, the interactional affordances for CES received from the landscape and UGSs are underdeveloped in the literature and participatory mapping; traditional PGIS studies are only able to capture perceptions, opinions, or comparative analysis (Viirret et al., 2019; Jones et al., 2020). Though the use of the PGIS as a participatory planning tool to document ES has increased recently, most studies focus on ES location and little on enhancing provision or actual use (Neugarten et al., 2018) and outcome benefits. Importantly, CES including HWB recognize that people choose where to spend their leisure time based on various greenspace characteristics and qualities (Gee and Burkhard, 2010; Lankia et al., 2015), thus the causal relationship between action and outcome is measurable.

The human–nature link exemplified within urban greenspaces and wellbeing are important components of city living and urban planning (Raymond et al., 2018). The continued development of spatial participatory techniques for practical CES assessment including the various constructs of human wellbeing is needed (Jones et al., 2020). Frameworks for capturing spatial interactions and quantifying CES benefits are important for planning and policy in urban regions (Nenko and Galaktionova, 2021). The PPGIS has been shown to influence policy and decision making (Boeraeve et al., 2018).

This study explores the UGS–HWB relationship through a PPGIS questionnaire within the case study urban region of Helsinki, Finland; the Helsinki urban region. To achieve this, a novel methodology to capture the transactional or affordance-based HWB benefits of UGS interaction including CES is operationalized. The use of SoftGIS documents specific human–nature interactions, here, UGSs and the transactional benefit outcome for HWB. This unique application of SoftGIS allows for a more direct correlation between landscape and CES and the interactional relationships between users and greenspaces. This study's research framework and results serve to inform spatial planning and policy through place-based citizen CES mapping and the knowledge of actual UGS use, not preference. The unique participatory approach to data interaction developed in this research has the potential to be adapted for CES selection in other strategic planning contexts.

2 Materials and methods

The UGS–HWB relationship is theorized, analyzed, and measured through a modified affordance model and is operationalized through the use of a public participation geographic information system (PPGIS)—SoftGIS—which activates the UGS–HWB transactional relationship through data collection.

2.1 Study area

Helsinki is the largest and most dense city in Finland. It forms the core of the Helsinki urban region (HUR) (Finnish: Helsingin seutu). The HUR is defined as the four 4) municipalities of Helsinki, Vantaa, Espoo, and Kauniainen and is considered an integrated urban region. The HUR has a total population of 1,491,845 inhabitants (2018), land area of 770.26 km^2 (Helsinki City Information and Statistics, 2018), and a population density of 1,936.81/km2. See Figure 1.

The HUR is undergoing continued urban expansion and density increase. This urban development has put more pressure on the existing infrastructure as well as the remaining greenspaces. Though the existing core structure of greenspaces, the "Green Fingers," provises a diversity of ES, including CES (City of Helsinki (2016), continued planning and management of the HUR's UGS is required to maintain Finland's high ranking in many wellbeing indices (e.g., OECD Better Life Index, UNICEF, UN, and Economist Intelligence Unit). Additionally, the New Economics Foundation's (NEF) National Accounts of Wellbeing project profiled Finland as one of the highest in Europe (Michaelson et al., 2009).

2.2 Questionnaire distribution

The distribution of the questionnaire was completed through digital methods. The digital, on-line survey questionnaire, that is, an internet-based approach, allowed the questionnaire to reach multiple and diverse respondents. The questionnaire's digital distribution could then be circulated and shared electronically and enables wide distribution in an efficient and cost-effective manner. The questionnaire's "hot-link" or URL was distributed via direct email and social media and included both English and Finnish language versions. This questionnaire distribution did not provide a "hard-copy" or paper means though efforts were made to accommodate questionnaire completion.

In order to reach a wide spectrum of users, a series of publicly available email distribution lists were collected including government and municipal agencies. The email included a brief summary of the project and the questionnaire survey link or URL and was sent to local council members, municipal and national employees, agency members, NGO's, university groups, and government-funded agencies (n = 181). These direct emails asked for these individuals to not only complete the survey themselves but to forward to their constituents, community members, employees, friends, and other interested individuals or groups.

The primary social media distribution means, Facebook, is highly used in Finland and Helsinki has many existing Facebook pages and Facebook groups shared among the population. A Facebook page and Facebook group were created specifically for this project and included a brief summary of the project and the survey link or URL. These were shared among other similar Facebook pages and groups including councils, parks, social and recreational groups, gyms, community centers, churches, and other interest groups as available.

Last, four separate sessions were set up at community centers with a laptop and internet connection for visitors to complete the survey. The survey was completely anonymous and confidential and received ethics approval, opting-out could occur at any time by the participant. The survey was available for 4 weeks during the summer.

2.3 Questionnaire data collection—SoftGIS

The primary data collection tool for this research was a geo-questionnaire which functioned as a geocoded or spatially explicit, internet-based survey tool to measure spatial-based human behavior within the greenspaces. Geo-questionnaires are a specific type of participatory geographical information systems and public participation geographical information systems (PPGIS) (Dunn, 2007) often used to document geo-location based interaction to inform a diverse set of questions and activities within communities (Rantanen and Kahila, 2009).

The survey's data collection was operationalized through an on-line, interactive, geo-location–based questionnaire, SoftGIS, as produced by Maptionnaire. Maptionnaire's SoftGIS tool is a web-based, interactive tool that allows participants to map and evaluate their interaction or experience with that space and is easily accessible on all web-browser formats. Unlike traditional empirical data collection and sampling captured exclusively through a text-based survey, this research's questionnaire was digitally map-based (i.e., internet-based) and focused on collecting biophysical-based, geospatial data of specific UGS simultaneously with human-based data to inform the human–nature relationship. In particular, this study's geo-questionnaire accrued both qualitative and quantitative data simultaneously, including socio-demographic information, UGS use interactions and those benefits achieved, and the UGS physical locations for those interactions (i.e., geocoded and map-based). The questionnaire's data collection was formatted into three distinct sections to collect data simultaneously on individual factors and greenspace interactions: respondent socio-demographic data, greenspace interaction or location data, and human wellbeing transaction data. It was estimated that it takes 6–10 min to complete.

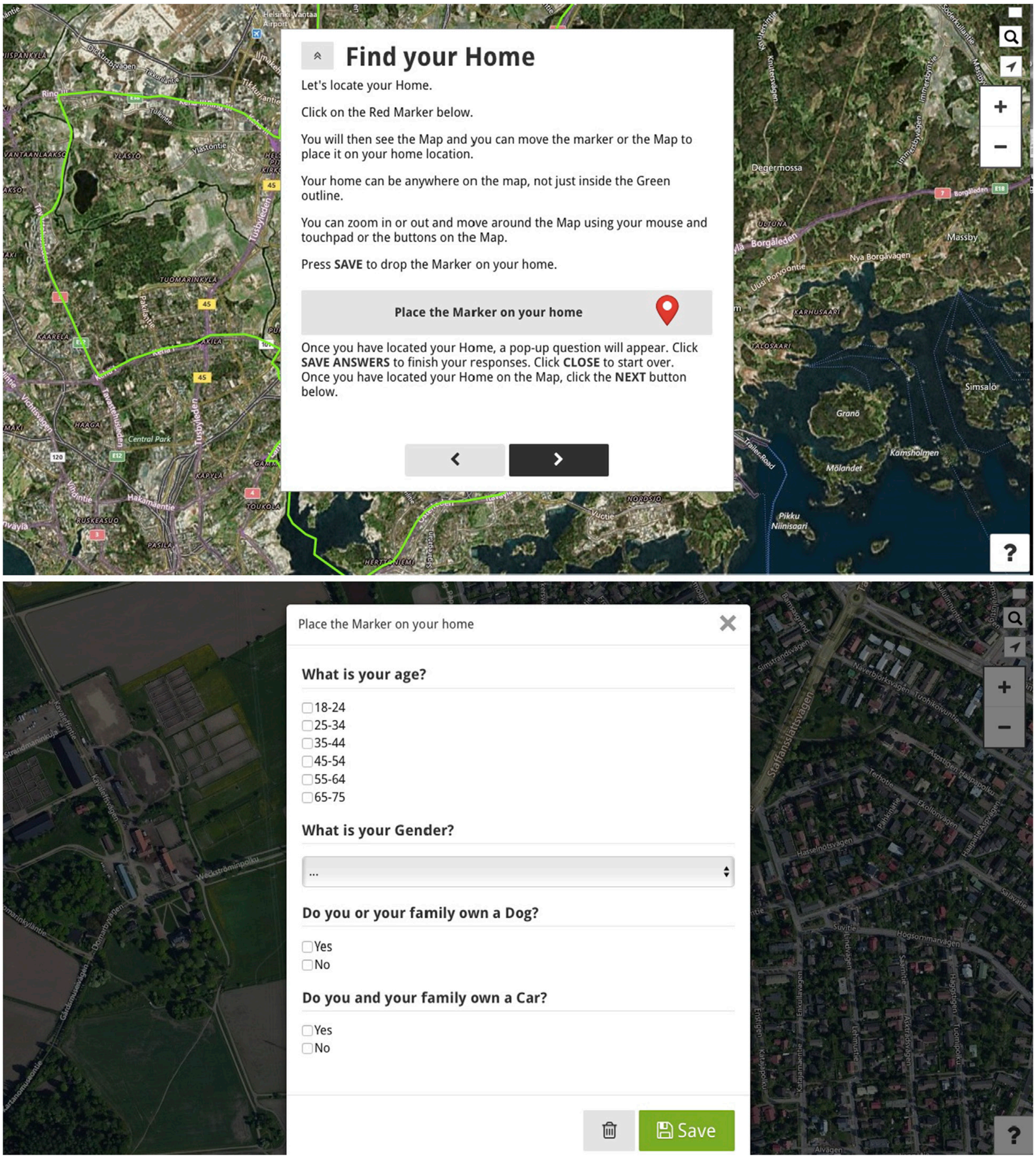

FIGURE 2
SoftGIS questionnaire—Part 1. Geo-locate home and socio-demographic information. Source: Author.

2.3.1 Part 1—Socio-demographic data

The first question asked respondents to identify on the map (geo-locate and drop a marker) their *Home* location. Once placed, a pop-up question asked respondents for their age, gender, dog ownership, and car ownership, as shown in Figure 2. This questionnaire did not ask for any socio-economic data such as income and education level. The questionnaire asked for respondents over the age of 18 and

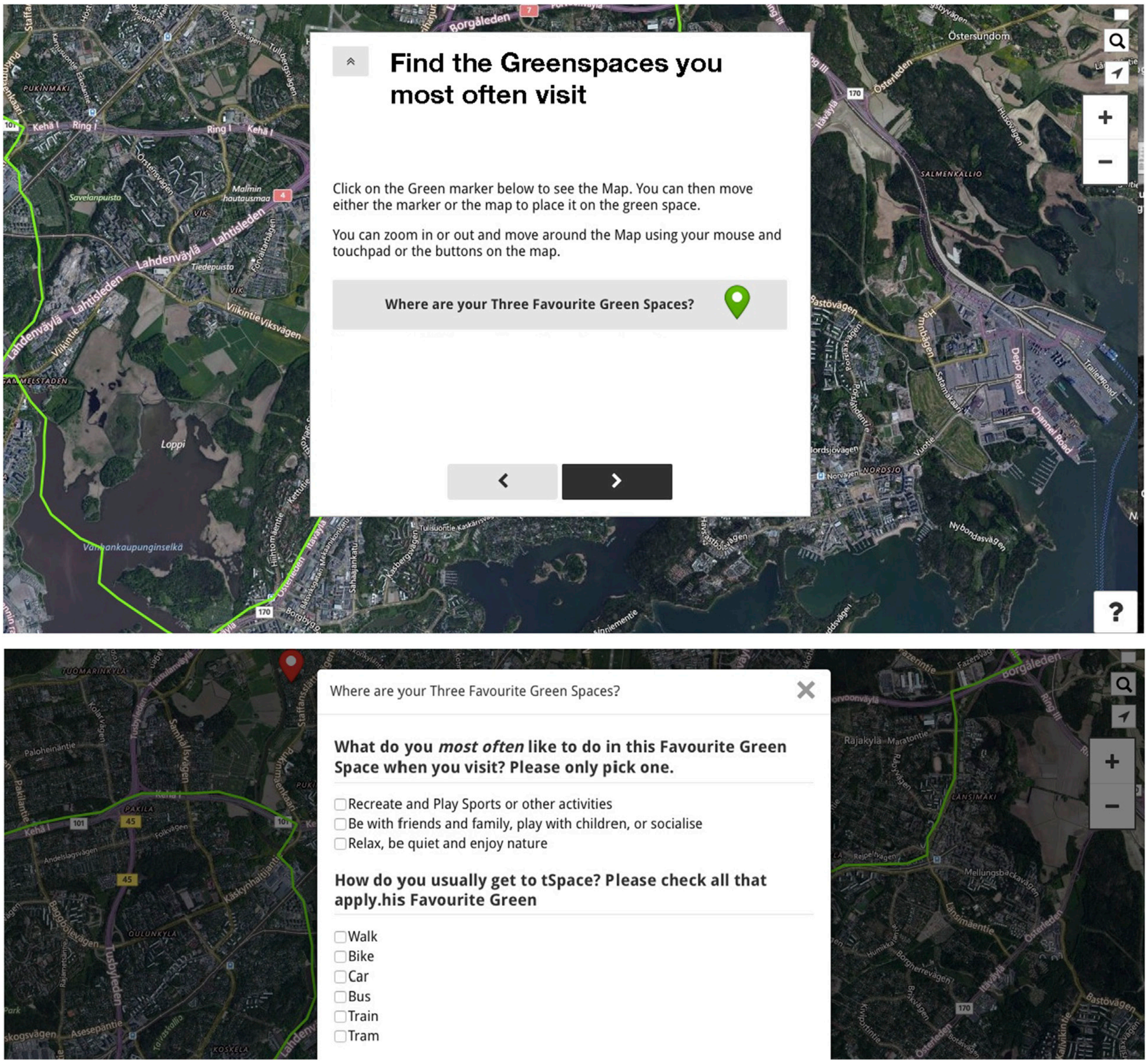

FIGURE 3
SoftGIS questionnaire—Part 2. Geo-locate green paces respondents like to visit. Source: Author.

not over the age of 75. This range estimates active persons able to utilize UGSs while also being of age to be documented in the demographic data collected. Owning a car allows individuals to travel to a UGS, though other forms of transportation exist, and the spatial distribution of UGSs in the HUR is notable and diverse.

2.3.2 Part 2—Greenspace interaction data

Part 2 used a series of questions designed to correlate specific, geocoded UGS locations to HWB affordances received from interaction. It first asked respondents to identify on the map (i.e., geo-locate and drop a marker) their three greenspaces they most often visit in and around Helsinki within the same map-based format, as shown in Figure 3. After that, they were prompted with a similar pop-up window to pick one of three activities they performed within the UGS. These answers were later coded to relate to physical wellbeing, social wellbeing, and psychological wellbeing.

2.3.3 Part 3—Human wellbeing transaction data

Once the marker was dropped on the UGS, a pop-up window appeared requesting the respondent to pick from a set of activities

TABLE 1 Part 3—Respondents were asked to select which activities they perform in the selected UGS. More than one could be selected. The coded human wellbeing benefit to interaction type is noted in the italicized and capitalized words, and was not visible to respondents.

What do you typically do at this greenspace when you visit? Please check all that apply
1 = Play sports and games or ride the bike. (PHYSICAL HWB BENEFIT)
2 = Sit and relax, read, be peaceful and enjoy nature. (PSYCHOLOGICAL HWB BENEFIT)
3 = Get together with friends and family, have picnics. (SOCIAL HWB BENEFIT)
4 = Walk the dog. (PHYSICAL HWB BENEFIT)
5 = Bring the kids to play. (SOCIAL HWB BENEFIT)
6 = Socialize with others, catch-up or gossip. (SOCIAL HWB BENEFIT)
7 = Walk, run, jog or hike. (PHYSICAL HWB BENEFIT)
8 = View wildlife and be in quiet natural areas. (PSYCHOLOGICAL HWB BENEFIT)
9 = Garden and Farm. (PSYCHOLOGICAL HWB BENEFIT)

or interactions reflective of functional affordances they perform within the UGS. These responses were then coded *post hoc* to specific HWB benefits—physical, social, or psychological as noted in Table 1. In this regard, the geo-markers represent activity or human interaction factors or affordances through behavior.

3 Results

All collected data were processed using Mapita Software within SoftGIS. All data were coordinated to the respondent number. The results came within Microsoft Excel. csv format. The effective individual sample size of respondents was n = 162. The effective UGS sample size was n = 347 or the total # of UGS markers placed with a HWB affordance.

3.1 Part 1—Socio-demographic results

Table 2 presents a summary of statistical results for the 162 individual responses. No weighing of responses and no inter-relational data analysis was conducted for these results. The results indicate the predominant profile of the respondents were male (52%) aged between 35–44 (26%) whose family did not own a dog (90%) and the household does not own a car (55%). The age results of the sample are mostly distributed evenly with 16 % between 18 and 24, 24 % between 25 and 34, 26 % between 35 and 44, 21 %between 45 and 54 but lesser on the older ages with 11 %between 55 and 64, and finally two percent between 65 and 75. These results are similar to the current age statistics of Helsinki and Finland with 25–29 year old individuals holding the largest age group

TABLE 2 Part 1 - Socio-demographic results. Individual respondents (n = 162).

—	#	%
Gender	—	—
Male	84	52%
Female	78	48%
Dog	#	%
Yes	16	10%
No	146	90%
Car	#	%
Yes	73	45%
No	89	55%
Age	#	%
18–24	26	16.10%
25–34	39	24.20%
35–44	42	25.80%
45–54	34	21.00%
55–64	18	11.30%
65–75	3	1.60%

with an overall average age of the population is 40.7 years in Helsinki, and 42.9 in Finland (Urban Research and Statistics, 2019).

3.2 Part 2—Greenspace interaction results

In Table 3, a simple UGS typology table was developed which coalesced the CORINE Land Cover Level II classification data (2018) to the best degree possible. This table was for informational purposes to qualify the UGS locations and no land cover data analysis was completed, Tables 1, 2;indicate the certain types of UGS respondents visit–predominately woodlands and grasslands (37%), park, garden, and amenity UGS (13%), and other natural or semi-natural greenspaces (13%)—are most often accessed by walking (51%). Respondents least visited cemeteries, churchyards, and civic spaces (0.5%). This result does not tell us if there is a high frequency or availability, overall, of each of those typologies of UGS within the region, only those which respondents indicated. The most often visited UGSs were Lamasaari Island (15%), Paloheina Woodlands (10%), and an unnamed UGS near Fastholma (5%).

3.3 Part 3—Human wellbeing transaction results

The questionnaire's UGS marker placement allowed for multiple affordances to the same marker. This simply means

TABLE 3 Part 1 - Greenspace interaction results. Individual UGS locations provided by respondents (n = 347).

#	%	UGS type
143	41%	Woodland and grassland
45	13%	Other natural or semi-natural GS
76	22%	Parks, garden, and amenity
35	10%	Green corridor
13	3.50%	Community garden, allotment, and city farm
12	3.50%	Outdoor sports and children's play area
24	7%	Cemetery, churchyard, and civic spaces
#	**%**	**UGS location**
100	29%	Lamasaari Island
76	22%	Paloheina Woodland
34	10%	Fastholma Greenspace
20	6%	Kivinnoka Greenspace
20	3%	Uutela recreation area
20	6%	Vantaa River near Silvola
1 (x77)	1%	All other UGS
#	**%**	**Mode of access**
178	51%	Walking
104	30%	Bike
38	11%	Car
24	7%	Bus
4	1%	Train
0	0%	Tram

each marker was allowed to have multiple responses for an individual's use or interaction with the UGS attached to it as part of the questionnaire format. Not all questions allowed for multiple responses and the results were not weighted, just simply counted as one of the three types of HWB benefit; each UGS marker as noted by an individual could have no more than three HWB benefits attached to it, and only one of each. As such, the UGS could have multiple uses or HWB benefits assigned to it, similar to the way UGS function for people in the real world. For example, although there were 347 individual GS locations provided by respondents, the total number of HWB markers analyzed was 385. The results show that 222 respondents visited UGS for physical HWB benefit (29%), 50 for a social benefit (13%), and 222 for a psychological benefit (58%).

3.4 Data analyses

A series of inter-relational analyses were completed with the data. Of the 385 responses, females and males chose similarly in their HWB benefits when visiting a UGS. Males chose physical benefits (42%) then psychological (32%) followed by social (26%). Females chose physical benefits (41%) then psychological (35%) followed by social (24%). Age wise, the largest group of respondents, aged 25–34, visited a UGS for a physical benefit (17%) The physical benefit UGS visited most often was by the age group of 25–34 (17%) followed by 35–44 (15%) with lowest 65–75 (1%). For social benefits, again 25–34 (9%) and 35–44 (6%) with lowest 65–75 (0%). For psychological benefits, also 25–34 (12%) and 35–44 (10%) with lowest 65–75 (0.5%).

Comparatively, based on the highest frequency results within the descriptive statistics, male respondents (42%), aged 25–34 (highest frequency age group) visited UGS most often for physical affordances Additionally, 51% of respondents whose household owned a car visited a UGS for a physical HWB benefit. This result does not indicate if they drove there in order to receive a HWB benefit, only the status of car ownership.

The respondents in this research had distinct patterns of UGS interaction. A total of 41% of all genders and ages predominately visited woodland, grassland, and park UGS typologies. Furthermore, the 35–44 age group respondents mostly visited woodland and grassland UGS typologies for a physical HWB benefit (66%). Prior research has shown that dog ownership increases UGS visitation frequency (Arnberger et al., 2022). Although the suggestion from this research is that dog ownership does not influence UGS use, dog ownership is very low, making generalization difficult. However, dog owners primarily visited UGS with their dogs for psychological HWB benefits (75%).

3.5 Geospatial mapping of human wellbeing and urban greenspace interaction

The spatial results of the SoftGIS questionnaire illustrate the geo-located data, and when combined with statistical analyses, allowed the production of intensity or "heat maps." This research illustrates its geospatial statistical findings utilizing intensity maps through two distinct approaches: concentration of geo-markers, or points, and distribution of point values. The use of heat maps, often referred to as density maps or cluster heat maps, provides a graphic illustration of the geographic variables and values summarized from this research's analysis and is a statistical analysis technique often utilized in cartography and urban planning.

Figure 4A illustrates each geo-marker location as represented by the diamond symbol and color coded to a specific HWB affordance or group of HWB affordances (See Map Key within Figure). Figure 4B illustrates those same geo-markers as distributed by concentration. Each map, thus, illustrates the geographical location of specific HWB affordances provided through UGS interaction. These maps serve as a general illustration to then analyze specific UGS locations and UGS spatial characteristics at a more refined scale. Simply, these

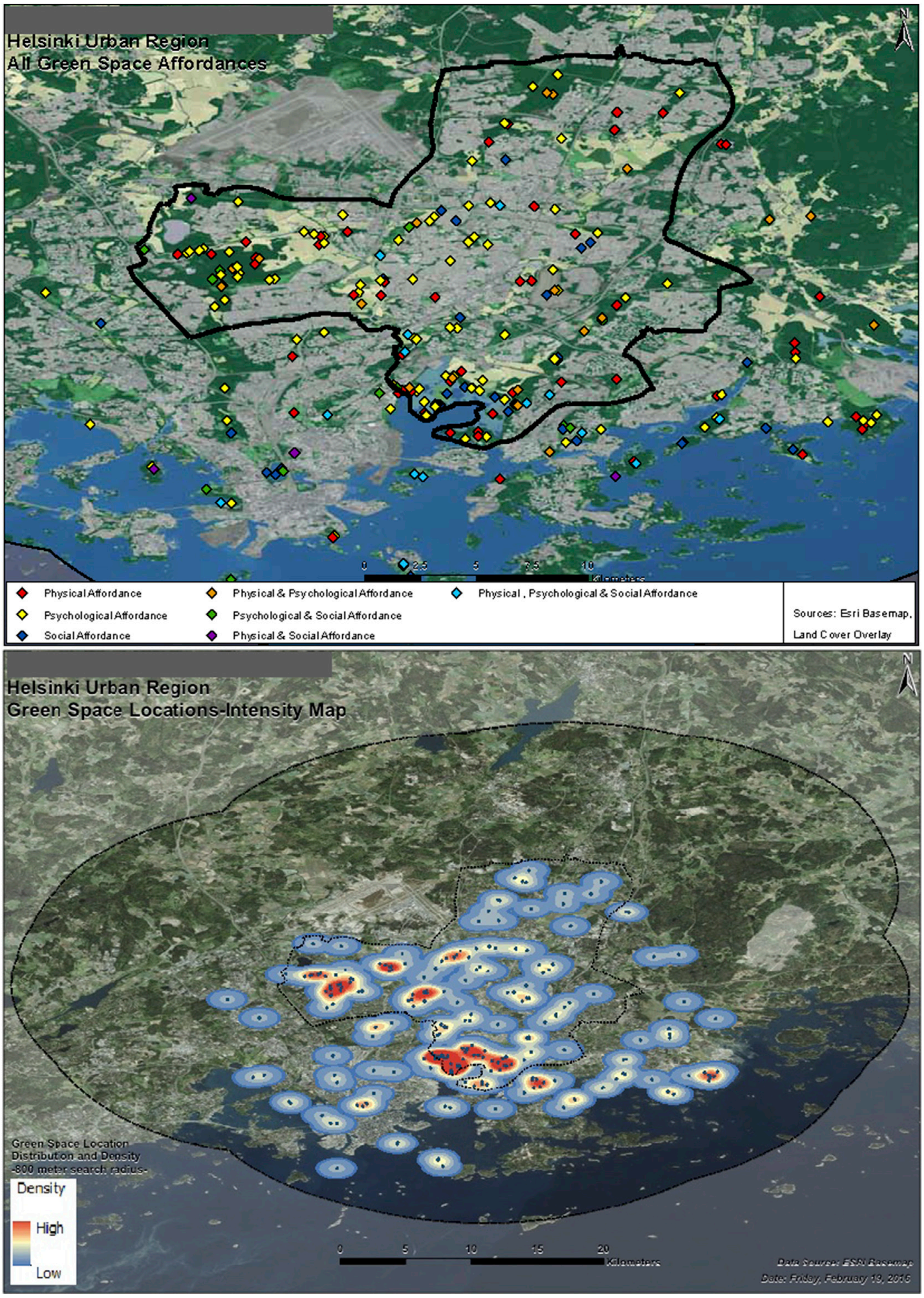

FIGURE 4
Human wellbeing affordance locations and intensity map. Source: Author.

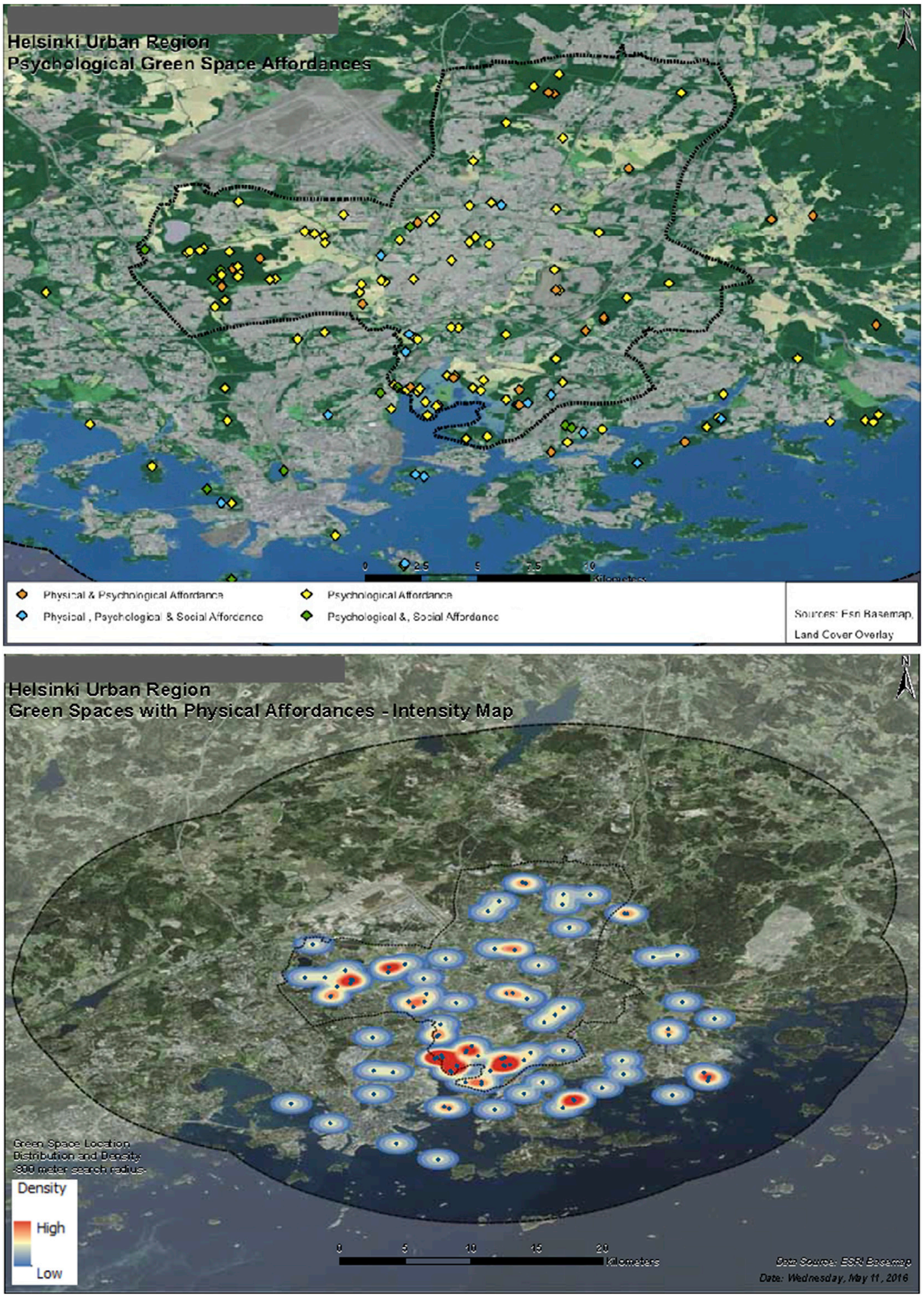

FIGURE 5
Psychological human wellbeing affordance locations and intensity map. Source: Author.

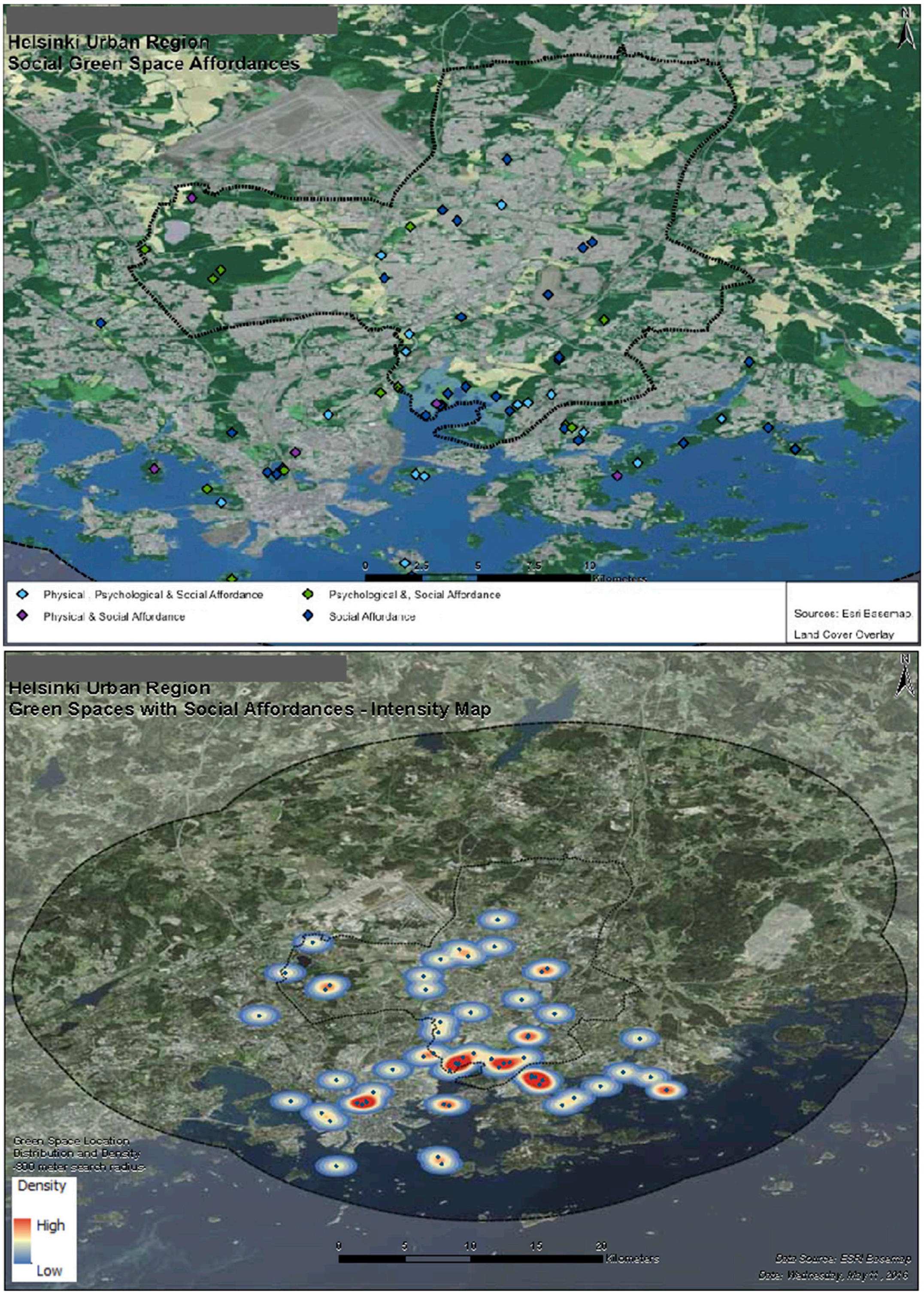

FIGURE 6
Social human wellbeing affordance locations and intensity map. Source: Author.

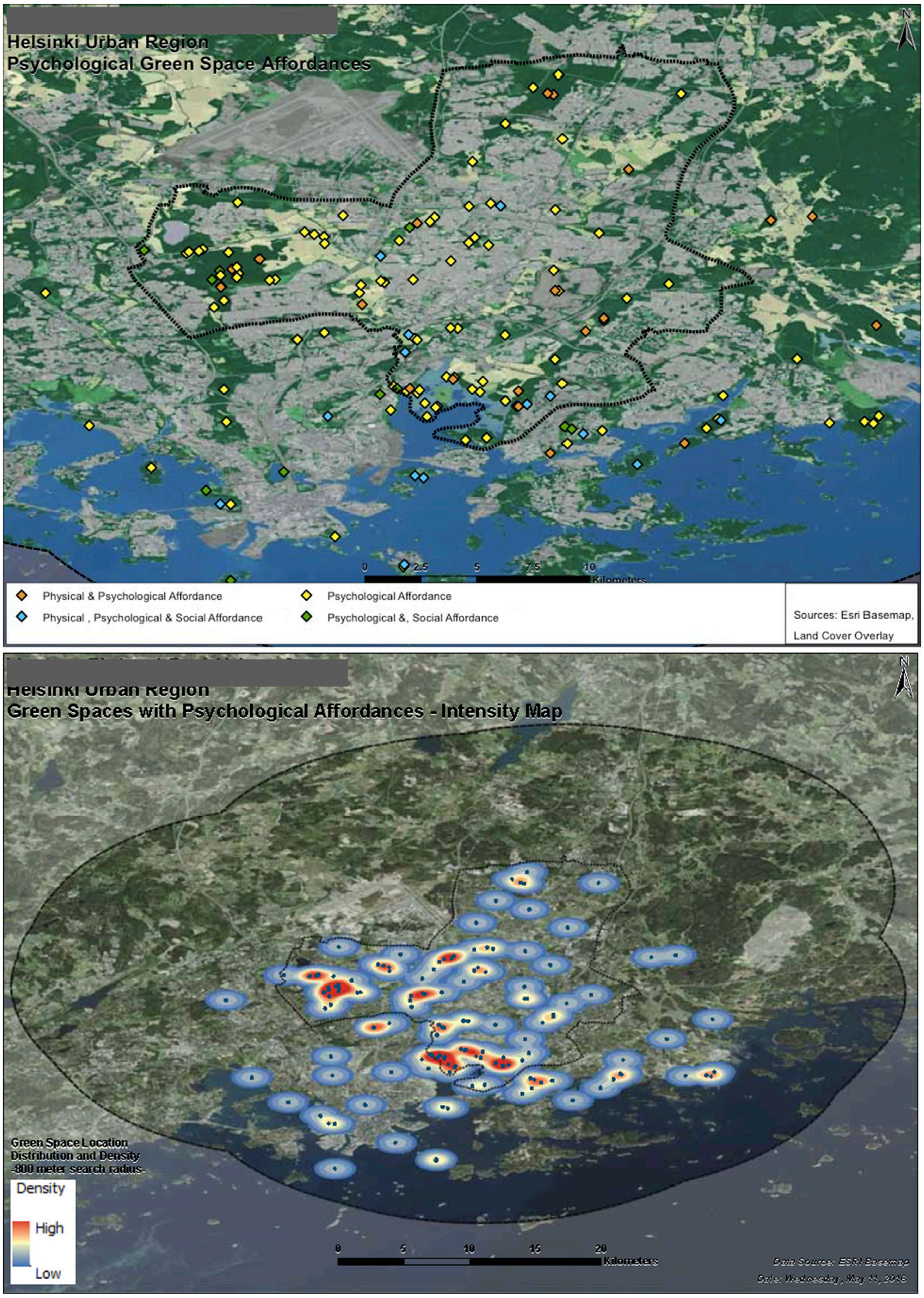

FIGURE 7
Physical human wellbeing affordance locations and intensity map. Source: Author.

TABLE 4 Human wellbeing affordances. Individual psychological UGS affordances (n = 112) provided by respondents. Individual social UGS affordances (n = 50) provided by respondents. Individual physical UGS affordances (n = 222) provided by respondents.

—	#	%
Psychological HWB benefit	—	—
Psychological only	53	47%
Psychological + physical	38	34%
Psychological + social	6	5%
Psychological + physical + social	15	14%
Social HWB benefit	#	%
Social only	7	14%
Social + physical	22	44%
Social + psychological	6	12%
psychological + physical + social	15	30%
Physical HWB benefit	#	%
Physical only	147	66%
Physical + social	22	10%
Physical + psychological	38	17%
Psychological + physical + social	15	7%

heat maps help visualize the spatial distribution and frequencies of the various UGS geo-markers and interaction patterns for HWB benefits.

Specific HWB affordance maps provide a more focused comprehension of UGS and affordance relationships. Figures 5–7 illustrate the three HWB affordances and their geo-marker locations and intensity maps. Table 4 summarizes the three HWB affordances.

3.5.1 Psychological affordances

As shown in Figure 5 and Table 4, there were a total of 112 geo-markers indicating a UGS which provided a psychological affordance. Of those, 47% were unique to only a psychological HWB benefit. The highest multifunctional psychological HWB UGS also provided a physical HWB benefit (n = 38, 34%). Psychological and social HWG UGSs were the least, overall, multifunctional UGSs only accounting for six geo-markers or.

3.5.2 Social affordances

As shown in Figure 6 and Table 4, of the total 50 social HWB geo-markers, seven indicated a UGS which provided only a social affordance (14%). The highest multifunctional social HWB UGS also provided a physical HWB benefit (n = 22, 44%)

3.5.3 Physical affordances

As shown in Figure 7 and Table 4, of the total 220 physical HWB geo-markers, 112 indicated a UGS which provided only a physical affordance (66%). The highest multifunctional physical HWB UGS also provided a psychological HWB benefit (n = 38, 17%)

Table 5 and Figure 8 illustrate the frequency of the UGS typology and its associated HWB benefit. Generally, respondents most often visited woodland and grassland UGS types for psychological HWB benefits (46%) and physical HWB benefits (44%), and park, garden, and amenity UGS types for social HWB benefits (34%).

In summary, these results suggest, generally, people who live in the Helsinki urban region, will visit certain types of UGSs in order to achieve their affordance goals—here, predominately woodlands and grasslands. This result does not tell if there is a high frequency, overall of those UGS typologies within the region, only which type the respondents visit. Furthermore, this population will, most often, visit a UGS of any typology for a psychological HWB benefit. Of the total 347 selected UGSs provided by the respondents, 77 or 22.2% were a singular marker and not shared by other respondents. This indicates respondents select uniquely when it comes to UGS visitation.

4 Discussion

Within this UGS–HWB relationship, interesting patterns emerge. The geo-questionnaire results and analyses not only provide insight into which UGS spatial characteristics are more

TABLE 5 Human wellbeing affordances and urban greenspace typologies. Individual UGS affordances (n = 385) provided by respondents.

HWB affordance	Parks, gardens, and amenity (%)	Woodland and grassland (%)	Other natural and semi-natural (%)	Outdoor sports and children's play areas (%)	Green corridor (%)	Community garden, allotment, and city farm (%)	Cemeteries, churchyards, and civic spaces (%)
Psychological	15	46	14	2	12	1	9
Social	34	27	11	8	8	5	6
Physical	21	44	10	4	13	1	7

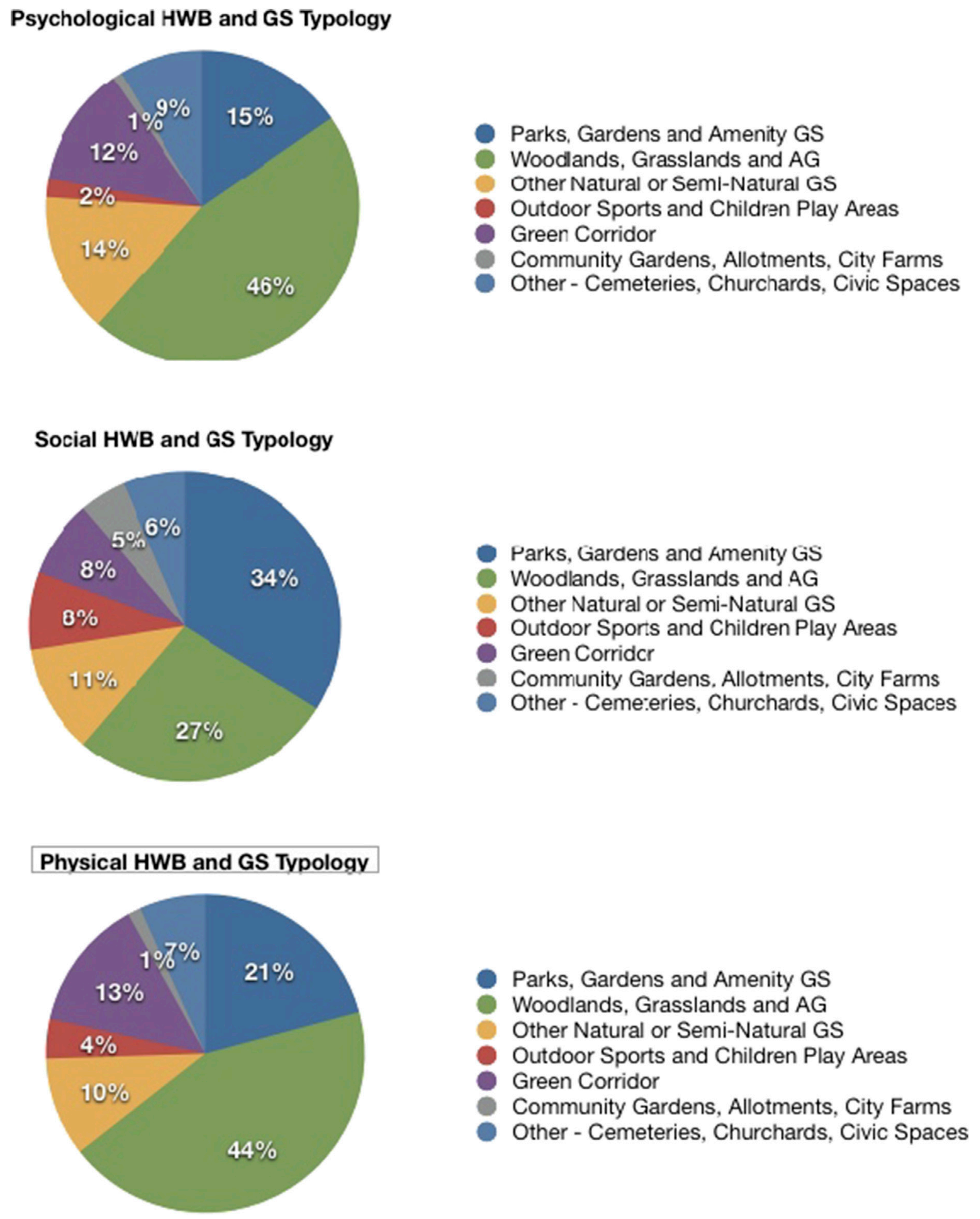

FIGURE 8
Human wellbeing affordance locations and urban greenspace typologies. Source: Author.

FIGURE 9
Psychological wellbeing urban greenspace characteristics. Ramsinranta Peninsula. Orthophoto Top—BingMaps (2022). Perspective photo bottom—GoogleEarth StreetView (2022).

related to specific HWB benefits or affordances, but also which type of HWB affordances are the most associated with UGS interaction. A brief discussion of the results and their findings will be structured through two distinct yet interrelated formats: first, a discussion of the specific HWB affordances as related to the specific UGS characteristics and attributes; and second, a discussion of those multifunctional UGS characteristics and attributes which provided for social, psychological, and physical wellbeing benefits simultaneously.

4.1 Human wellbeing and urban greenspace characteristic relationships

The SoftGIS results illustrate the geographical location of specific UGS where an affordance was received. This allowed further analysis of these UGSs focusing on their specific physical characteristics (e.g., type, size, shape, and density) and greenspace qualities (e.g., amenities, level of naturalness, level of maintenance, and visibility). An orthophoto, visual review of specific UGS as well as an on-site field visit was completed by the author, considered an expert in greenspace planning, in order to provide a simple summary of common visible spatial characteristics. The physical features of a UGS and the benefits achieved by individuals interacting with those UGSs provide a more direct means to synthesize this relationship and the UGS's CES performance.

4.1.1 Psychological wellbeing UGS characteristics

Of the 112 total psychological HWB UGS markers, the most frequent was the *Ramsinranta Peninsula* (n = 26, 23%). This is a

FIGURE 10
Social wellbeing urban greenspace characteristics. Hesperia Park. Orthophoto Top—BingMaps (2022). Photo bottom—Author.

large area which includes nature reserves, forests, weltands, beaches, national forests, and other greenspace types. This UGS is considered a woodland greenspace typology in which psychological-based responses were noted in 46% of those locations.

This UGS, overall, was large in size, with an irregular shape, and multiple edges along the Gulf of Finland. It is close to a major highway and many housing developments. There are many designated hiking or walking trails within this UGS with negligible vertical elevation change. This UGS was equally visited by males and females, but mostly by those aged 35–44, with no family dog or family vehicle. There is a diversity in vegetation types and heights in this UGS, varying from water edge to dense evergreen forest. There are minimal anthropic elements in this UGS such as few benches, tables, restrooms, plazas, and lighting. In this regard, psychological HWB affordances are strongly influenced by more naturalistic, informal vegetation qualities and environment, as shown in Figure 9.

These results support other research findings in Finland. For example, surveys have reported that proximity to nature is considered important in housing developments and residents usually favor natural environments (Kahila and Kyttä, 2006; Korpela and Yen, 2007; Tyrväinen et al., 2007). In summary, the results show that HUR respondents were able to mentally relax, de-stress, and enjoy nature more in a UGS that exhibits naturalistic characteristics.

4.1.2 Social wellbeing UGS characteristics

Of the 50 total social HWB UGS markers, the most frequent was *Hesperia Park* (n = 7, 14%). This is a small urban park located next to the central Helsinki train station and Botanical Garden. It is also connected to the Gulf of Finland and is focused around its central water terminus feature. There is an abundance of paved and unpaved walking paths and contains numerous well-maintained facilities and amenities. It is mostly grassed with few areas of multiple tree groupings. It is openly visible from within and outside. The vegetation is well manicured and maintained and not considered "wild;" this UGS is considered a park typology. It is simple in shape and has few edges and most edges adjoin an urban element such as a building or roadway. This UGS was equally visited by males and females, but mostly by those aged 25–34, with no family dog or family vehicle, as shown in Figure 10.

The other social HWB UGS markers noted similarities among the results including less naturalistic, highly maintained, simple in shape, and small to moderate in size. Overall, this evidence suggests that the respondents felt these HWB aspects more within UGS that were these types of UGSs afforded a means of social and socio-cultural sharing conducted not within an indoor setting, but within the landscape, a landscape of greenspaces which Finns strongly associate with their identity (Raivo, 2002). The relationship between UGS and social HWB findings supports aspects of community and

FIGURE 11
Physical wellbeing urban greenspace characteristics. Greenspace near Toyrynummi. Orthophoto Top—BingMaps (2022). Perspective bottom—GoogleEarth StreetView (2021).

personal identity, social cohesion or a 'sense of community,' cultural-value sharing, family bonding, and instilling a sense of belonging among others.

4.1.3 Physical wellbeing UGS characteristics

Of the 147 total physical HWB UGS markers, the most frequent was the *UGS near Toyrynummi* (n = 22, 15%). This UGS was linear in shape, a grassland land cover typology, contiguous or physically connected to another GS typology, with an irregular shape, and multiple edges. This UGS is close to a major highway and also a few dense housing developments. Importantly, it borders a linear trail along the Vantaa River, likely indicating hiking/running/cycling use. This UGS was equally visited by males and females, but mostly by those aged 25–34, with no family dog or vehicle, as shown in Figure 11.

These findings are strengthened by other UGS studies in Helsinki. UGSs considered 'safe' are positive mediators in resident's participation in outdoor physical activities (Pietilä et al., 2015). Furthermore, this area is considered a suburb and not part of the urban city center; thereby promoting a higher frequency of 'close-to-home' recreation activities (Neuvonen et al., 2007). Natural environments in Finland are also considered to positively influence recreational use of UGS (Semenzato et al., 2011). As this UGS includes a wide, multi-use path for bicycles, it is possible that this is considered a commuting route for which bicycle activity is considered a physical benefit.

4.2 Multi-affordance urban greenspaces

The geo-data analysis indicated those UGS which afforded or provided the full suite or all three HWB benefits to respondents—the physical, social, and psychological—within the Helsinki urban region. There were 15 of these UGS (4%)—these UGSs are considered the "big-hitters" from a human wellbeing interaction perspective. It is these unique UGSs which respondents reported a comprehensive set of HWB benefits such as physical exercise, being with friends and family, and relaxing and enjoying nature. Though their frequency is relatively low, these multi-affordance UGSs require further discussion.

The 15 multi-beneficial HWB UGSs are, generally, large in size when compared to other UGS markers. Most of these UGSs were considered a woodland typology. They also had a sense of privacy with limited visibility within and into the UGS, with many enclosed and more "private" spaces due to mixed species, randomly situated or "wild" vegetation. These UGS also seemed adequately maintained (i.e., no overflowing

FIGURE 12
Multi-affordance greenspace characteristics. Paloheina Woodland. Orthophoto Top—BingMaps (2022). Photo bottom—Author.

trash bins, mowed grass areas, and no damaged paving) with few facilities and amenities such as benches, tables, restrooms, and drinking fountains and unpaved paths. Overall, these multi-beneficial UGS were considered physically contiguous to or adjacent to another UGS on at least one side. This means the UGS was part of a larger green structure or group of interconnected UGS. Last, these 15 UGS were often close to a heavily trafficked road allowing easy access from multi-modal transportation. The results show that these multifunctional UGSs were most often associated with interactions of Paloheina Woodland and the Fastholma Greenspace. The author visited these two UGSs to visually document and subjectively analyze the UGS spatial characteristics.

The Paloheina Woodland is the name given for a large, forested greenspace area near the villages of Paloheina and Roihupelto northwest of the Helsinki City Centre, as shown in Figure 12. This UGS includes many designated wildlife refuges and is bordered by agricultural lands as well as a golf course, playground, dog parks, a fitness center and hockey rink, a memorial park, and the Vantaa River to the north. There are predominately wide unpaved paths suitable for hiking, jogging, and biking. Its relatively flat topography is dominated by mixed woodland vegetation and includes a designated old-growth forest area. There is a minimum amount of amenities and facilities within the UGS as well as being moderately maintained. There are dense housing developments on two sides of the UGS with multiple access points. This UGS is in proximity to a major roadway and forms part of the Helsinki Green Fingers.

The Fastholma Greenspace is the name given for a large greenspace area near the villages of Fastholma and Silvola

FIGURE 13
Multi-affordance greenspace characteristics. Fastholma Greenspace. Orthophoto Top—BingMaps (2022). Perspective bottom—GoogleEarth StreetView (2021).

northeast of the Helsinki City Centre, as shown in Figure 13. This area is most often associated with the Lammassaari Peninsula and its large birdwatching area and boardwalk trails. This grassland UGS typology surrounds a bay from the Gulf of Finland with many wetlands as well as forests. There are agricultural lands and residential housing adjacent as well as a major roadway. The trails are predominately unpaved with few amenities. This UGS also includes a cemetery, a few small beaches, community gardens, cultural museums, and a sports park. There is a small university campus and commercial area on the north edge of the UGS.

Both these UGSs had similar qualities and landscape composition. These UGSs lacked, overall, numerous facilities or amenities such as paved paths, lights, trash bins, benches, and toilets as well as designated gathering areas with tables and weather coverings. Both these UGSs are considered natural, not urban; they have characteristics of being wild or having a sense of ruralness to it. These UGSs had no formal recreation opportunities (beyond trail walking, wildlife viewing, etc). Though each UGS had a different predominant vegetation type—woodland and grassland, the composition was predominately natural or naturalistic. Overall, these UGSs lacked a formal spatial composition with minimal to moderate management. It is these qualities of UGSs which this study reports as providing the most diverse HWB benefits to residents.

4.3 Summary—Human wellbeing and urban greenspace interaction

The literature has suggested that physical contact with UGS influences HWB by providing psychological restoration, physical interaction, and social opportunities, among many others. This research supports such findings by showing that interaction with UGSs supports multiple aspects of HWB. These findings revealed that HUR's greenspaces provided, overall and generally to all users, mostly physical and social human well-being benefits; the psychological benefits such as reduction in stress and mental relaxation were not as frequent in these UGS interactions.

Perhaps not surprising, UGS-based HWB benefits are interrelated, with each supporting one another and interacting to facilitate benefits, this is referred to as the *synergistic effect* of interacting with the UGS. For example, physical health can be increased through strong social wellbeing (Uchino, 2006). Psychological wellbeing is shown to be more positive with strong social networks (Umberson and Montez, 2010). Physical and mental wellbeing are both components of positive UGS interaction where access, physicality, and mental restoration operate together. Jacobs (1961) demonstrated the correlations between human health and social interaction. Fan, Das, and Chen (2011) concluded that parks "*directly promote physical activity, and indirectly mitigate stress via the spaces' positive impact on social support*" (p. 1209). Similarly, walking, cycling, and other outdoor sports or activities have been shown to improve both physical and psychological wellbeing (Vujcic et al., 2019) and spiritual health (Irvine et al., 2013).

4.4 Study limitations

Establishing a causal relationship is difficult, as it is complex. Simplistic UGS interventions may, therefore, fail to address the underlying determinants of HWB that are not remediable by urban planning from a spatial perspective. Important greenspace or environmental factors such as accessibility, perception of safety, management quality, and others are key determinants of UGS use and the receipt of benefits. The individual factors affecting this relationship are myriad and future research studies should clarify these such as personality traits and preferences, socio-economic factors, ethnicity, cultural factors, and others. Additionally, respondents may achieve HWB affordances through other means than GS interaction, such as a gym, vacations and travel, work, or social groups so the overall transactional reporting may be skewed. Furthermore, subjective, human-based questionnaires are open to response bias or reverse causality as well as confounding variables.

Future study design should isolate these and other control variables to the best degree possible. This study did not provide any statistical analysis for the strength of relationships or significance.

The relationship between humans and UGS is also dependent upon the spatial qualities of the landscape. Each landscape, whether remotely rural or distinctly urban provides a diverse and unique array of physical features that in turn provide a wide variety of benefits to humans. A next step to this research's findings includes developing further relational provided by the specific UGS typological physical characteristics. This study only provided a simple, subjective analysis; more detail on the qualities and other UGS spatial features would begin to clarify HWB–UGS affordances. As noted by Rietveld and Kiverstein (2014), the qualities, properties, and characteristics of the landscape or UGS are just as important as the behaviors or interactions in any holistic understanding of affordance and this human–nature relationship.

4.5 Implications for urban planning and healthy cities

The overall concept of this study's UGS and urban green infrastructure benefits are implemented in urban planning but are often considered by separate governmental entities and policies focusing on singular issues such a recreation, management, public health, or biodiversity (Davies and Lafortezza, 2017). As urbanization occurs, the overall structure and characteristics of greenspaces change, and so too will the spatial design and management of those greenspaces to deliver services to the changing communities who interact with them. Growing city regions such as Helsinki face choices for land use; competition for UGS, their adequate valuation, and policy-based priorities are common hurdles (Braquinho et al., 2015). The complexity of the landscape, its varied ecosystems, and how the users themselves are experiencing and interacting with them are critical to understand. Continued efforts are required to further identify and clarify the relationship between CES, HWB, and UGS, particularly those removing subjective valuation and integrating a plurality of benefits. Multifunctional valuation approaches such as participatory tools provide a means to obtain intrinsic and relational values beyond the economic-centric "benefits for humans".

This study's results support the trend toward evidence-based design approaches such as documenting affordance-based UGS distribution, informing management strategies (i.e., wild and natural vs manicured greenspaces), and urban design elements (e.g., inclusion of amenities such as benches and lights). Importantly, the methodology and results can inform multi-disciplinary policy decisions for land use in urbanizing regions. Spatial planning concepts of accessibility, maintenance and management, as well as equitable distribution integrate with the multifunctional concept of green infrastructure and greenspaces in urban areas. Future interventions to increase or improve UGS ecosystem services can deliver positive health and social, for many groups, but there is a need for better inclusion of health and equity outcomes in studies on UGS interventions, and an improved monitoring of local UGS management and related multiple facets of HWB impacts.

Recently, a new PPGIS approach, volunteered geographical information (VGI) (Goodchild, 2007), such as crowdsourced data or user-generated information such as social-media geotags, has evolved as a type of citizen science (Jiang and Thill, 2015) or community science. VGI can track an individual's movement and location and has been applied to quantify CES provision (Guerrero et al., 2016; Havinga et al., 2020) and spatially model cultural interactions in landscapes (Daniel et al., 2012. VGI participatory mapping has been applied within CES studies including the UGS preference value (Nenko et al., 2022) and landscape preference (Van Zanten et al., 2016). VGI is unique in that it is able to provide a real-time record of *in situ* human–environment interactions as opposed to *ad hoc* SoftGIS; both provide spatial information about CES use. VGI data can be voluntarily and passively documented and are a valuable tool for revealing and quantifying CES in future studies.

This study and its public participatory methodology provide valuable insight to planners and decision makers which can engage the public, provide transparency, reduce stakeholder conflict, increase community cohesion, and inform more comprehensive planning and inclusive design solutions. There are many applications of this research. The results highlight the importance of including CES mapping within land-use planning and policy-making agendas to ensure the conservation of areas supplying cultural services that are critical for multifunctional wellbeing. Further research studies are needed on integration of different types of data and information (Cheng et al., 2019) but some straightforward opportunities exist. For example, in Helsinki, future studies can incorporate diverse socio-demographic and socio-economic information to better identify UGS use and benefit; thereby focusing future planning efforts to deliver CES to those communities best aligned to interaction. Additionally, the geospatial locations provide pathways to integrating infrastructures—green and gray—such as the 'Green Fingers' and transportation toward sustainable development and green cities (Hannikainen, 2019), thereby promoting CES-related decision making.

To conclude, this specific affordance-based study's operationalization of data collection removed subjective perception to the highest degree possible by focusing on interaction and transaction through activity. The methodology applied, the SoftGIS questionnaire, correlated physical UGS location to an individual's HWB benefit received as activated through behavioral interaction. In this research, survey participants were able to provide specific locations of UGS they visit and interact with, followed by descriptive attributes of what HWB benefit(s) they receive from that interaction. In this regards, the transactional perspective found within affordance theory could be accurately documented. The results indicate which UGS characteristics are influential with respect to the receipt of HWB affordances when residents interact with the UGS. The PPGIS survey used a series of questions designed to correlate specific, geocoded UGS locations to HWB affordances received from UGS interaction. This research's interaction-based geospatial data collection provided a more direct means to document relationships between humans and urban greenspaces, ultimately improving pathways to urban planning and policy in developing regions across the globe.

4.5.1 Permission to reuse and copyright

Data availability statement

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by the University of Edinburgh. The patients/participants provided their written informed consent to participate in this study.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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