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Article

A Preliminary Study on Connectivity and Perceived Values of Community Landscapes

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Abstract: Green spaces in residential community is important, yet understudied, feature as an urban ecological system. While large urban parks and remnant wildlands in urban areas tend to receive a public attention from conservation and management perspectives, less is known for the importance of spatial and ecological characteristics of the community-scale landscapes. This study investigates natural elements in four planned communities in Phoenix metropolitan area, Arizona, two of which represent conventional type of neighborhood and the other two exemplify the community development with a proclaimed vision of sustainability. These distinct type of communities, which capture variations in age, location, open space type, and a cross-section of housing density, are compared with regard to landscape connectivity as a means of gauging ecological condition for community sustainability. Using Geographical Information System and landscape connectivity indices, each community's landscape features including size, physical connectedness and ecological potential were examined. Furthermore, a questionnaire survey was performed to examine the perceptional differences between the two types of community residents. The findings demonstrate that the green spaces in conventional communities are more physically connected than the counterparts, but the naturalness and ecological quality manifested by the amount of the land that may serve as potential urban desert habitats were higher in the sustainable communities. The results of the survey indicated that the respondents inhabiting in sustainable communities possess a higher level of satisfaction than the people in conventional type of community due mainly to the amount of, easy access to, and perceived ecological values of, green spaces in their neighborhoods and surrounding areas. The study concludes that careful community design with ecological consideration can help create sustainable communities which can benefit both site-scale ecosystems and perceived human well-being.

Keywords: Ecological sustainability; Landscape connectivity, Green spaces, Resident perception, Master-planned community, Phoenix

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1. Introduction

As it is widely known, the triad of sustainability consists of environmental, social, and economic components. Ideally, the achievement of genuine sustainability can be made through a balanced approach for the three sectors among which bearable (environmental-social), equitable (social-economic) and viable (economic-environmental) visions are realized [1]. However, environmental sustainability is hard to track the execution, if not impossible, and as such it is often compromised to the other two sectors. For instance, many newly developed communities claim to stand for sustainability, but an incapacitated balance of sustainability essentials seems not support the perfect, balanced vision often making it a symbolic or marketing term [2]. Moreover, among the various parameters relating to environmental sustainability (e.g., water, air, energy, land use, biodiversity and food), the subject of ecological

sustainability has seldom been addressed in sustainability literature and planning practices especially in the residential community applications due largely to the community development's central focus on human system. However, ecological sustainability is not 'externalities' by conventional systems of economic thinking but can be a fundamental base upon which all natural and human systems harmoniously work together. As with the concepts of social and economic sustainability, the notion of ecological sustainability is as much a process as an outcome [3], and the ecological definition of sustainability stresses more on natural processes and the continued productivity and functioning of ecosystems [4] regardless of the scale and spatial settings.

Under the current circumstances that urban development pattern expands into and encroaches on natural lands along the urban edges in many metropolitan areas, it has become necessary to secure small-scale ecosystems in human dominated landscapes. A body of literature tackles with the issue of urbanization patterns as related to urban ecology and sustainability [5-7]. With the increasing acceptance of the notion of 'cities as ecosystem' [5,8], it is worthwhile to revisit contemporary community landscapes to unveil the relationships between spatial landscape pattern and ecological quality as a way to find less disturbing pattern for site ecology and weave the green 'granules' together with a broader urban ecosystems. This perspective questions how human communities can, and should, interact with non-human, living organisms and non-built features to embody ecologically sustainable community. In fact, cities have been perceived as ecological wastelands from a traditional conservation perspective [9]. Although urbanization as a primary process shaping cities is a known challenge to ecosystem services, however, it is also an opportunity for managing urban ecosystem services and rich biodiversity as a critical natural capital cities can possess [10]. Also, the Intermediate Disturbance Hypothesis [11] suggests that local species diversity and movement is maximized when ecological disturbance is neither too rare nor too frequent (Figure 1). This enables cities with a decent level of disturbance to maintain diverse and heterogeneous landscapes that would be rather conducive to local biodiversity.

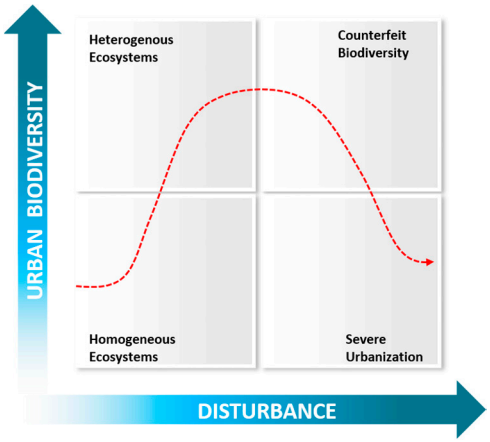

Figure 1. Intermediate Disturbance Hypothesis (Connell 1778).
Biodiversity in severely urbanized areas with high level of disturbance is low. Urban biodiversity is higher with a decent level of disturbance than purely homogeneous areas. High biodiversity with a high level of disturbances can be a misinterpretation due to the inclusion of non-native species.

While there are numerous studies dealing with urban green spaces in the context of human dimensions (for instance, [12-14]), they usually focus on public recreational lands (e.g., county or city parks) with limited consideration of the extended effects and benefits of the landscapes within residential communities. Other examples studying green spaces in residential areas used to employ a single facet of multiple characteristics and roles that they hold, such as human health [15-18], environmental justice [19], bird biodiversity [20], and vegetation-residents' socioeconomic status relation [21]. Although these aspects are all important to secure green spaces in human-dominated landscape, the general views on

residential green spaces are to some extent fragmentary and non-connective. Given the fact that master-planned community is becoming a prominent type of modern community development in large metropolitan areas, and also considering the lot size of contemporary housing units has increasingly been bigger, there are growing opportunities to offset the challenges resulting from large-scale development and lack of quality green spaces in residential communities. Designing with nature in the form of larger chunk of green spaces for communal use, such as community parks, natural trails, and shared adjacent natural reserves, organically connected with the common residential landscape features such as front and back yards and manicured streetscapes. Arguably, one of such practical approaches would rest on how these natural features are placed, arranged, and connected in the landscape of human communities will influence not only the residents' physical activities and satisfaction and but micro- and meso-scale ecological flows and processes.

This study investigates the green spaces in four master-planned communities in Phoenix metropolitan area with a particular emphasis on physio-ecological characteristics and residents' perception. The main objectives of the study are two-fold: (1) quantifying and comparing green space connectivity between conventional versus sustainable communities; and (2) understanding residents' use, perceptions, values, and satisfaction over the green spaces for the two types of communities. To achieve the objectives, the study attempts to answer the following questions: (1) What are the landscape features characterizing modern residential communities?; (2) How do people use and perceive their residential green spaces?; (3) Are there any notable differences in landscape connectivity measures and human's perception depending on development type?; and (4) What are the implications in community development and urban design practices stressing ecological sustainability?

2. Materials and Methods

2.1 Case Study: Two Types of Communities

Four master-planned communities in Phoenix metropolitan area were chosen, two of which represent conventional type of community (C1: Dobson Ranch; C2: Superstition Spring) and the other two exemplify the communities where the sustainability vision is anticipated in the community plans (S1: Verrado; C2: Las Sendas). These distinct type of communities, which capture variations in age, location, open space type, and a cross-section of housing density, were selected to compare landscape connectivity as a means of gauging ecological sustainability of the communities (Table 1). The community selection was made by the consultation with local urban planners and desginers. Dobson Ranch (C1) and Superstition Spring (C2) are located relatively closer to the urban center with an average of 29.5 km from the downtown Phoenix, whereas Verrado (S1) and Las Sendas (S2) are situated along the urban periphery with an average of 48.5 km from the urban core (Figure 2).

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Table 1. Basic profile of four selected communities (As of 2012)

Community Type	Conventional Community		Sustainable Community	
Community Name	Dobson Ranch (C1)	Superstition Spring (C2)	Verrado (S1)	Las Sendas (S2)
Year Built	1973	1995	2004	2004
Area (sq mi)	3,547	3,479	8,800	3,641
Distance from urban center (Km)	21	38	42	55
Number of residents	15,000	11,353	8,800	2,816
Housing type	SF/MF[1]	SF/MF[1]	SF/MF[1]	SF[1]
Existence of HOA	Yes	Yes	Yes	Yes

[1] SF and MF indicates single family and multi-family housing, respectively.

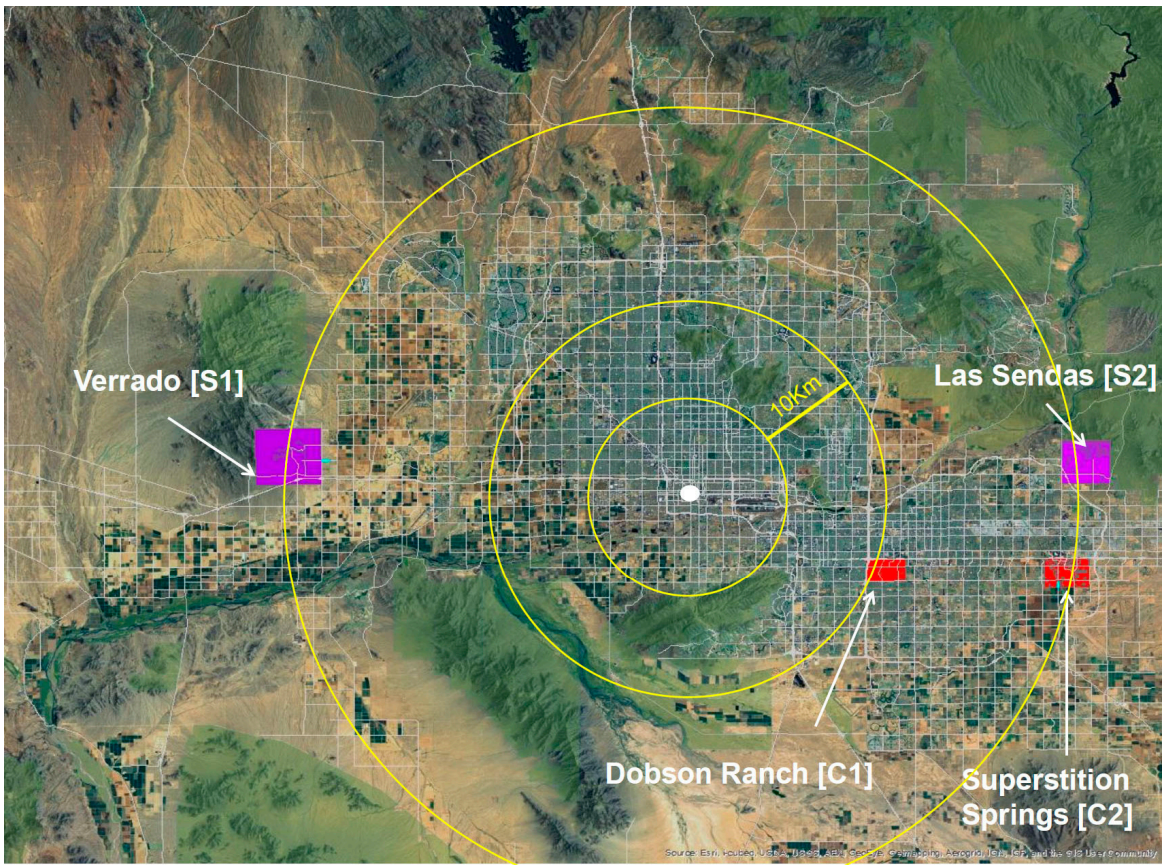

Figure 2. Location of selected communities (red: conventional communities; purple: sustainable communities)

2.2 Measures of Landscape Connectivity

To understand the spatial pattern of green spaces in the chosen communities, two sets of connectivity measures were employed. On the one hand, Structural Connectivity Index (SCI), a measure to quantify landscape pattern was used for each community using FRAGSTATS (ver. 4.2.1), a landscape pattern analysis software. Based on the physical composition and arrangement of the natural elements

and designed green space features, a numeric value of SCI represents the degree of physical connectedness of green spaces in each community. To identify the green spaces that need to be considered for the analysis, satellite images and land use maps were used. Additionally, scanned microfilms that contain the information of land use and zoning changes were used as a supplementary material especially in the selected conventional communities to understand land conversion from green spaces to non-natural land use. On the other hand, predeveloped map resulting from the Ecological Connectivity Index (ECI)-based connectivity modeling was utilized to identify the land parcels with higher ecological values (For details, [22]). The ECI translates continuous surface values from an ecological perspective into community's potential for sustainable landscapes.

2.3 Residents' Perception Survey

A questionnaire survey with a series of questions was designed, formulated, and distributed to the random sample of residents in each community, with the aim of understanding residents' preference, personal values and environmental priorities on their community green spaces. The total target population was 31,868 (as of 2013) and the sample size was 122 (58 individuals from conventional communities and 63 from sustainable communities). The unit of analysis is community group by each development type. The initial survey was made using an online survey tool, SurveyMonkey® from August to October in 2012, and the survey link was posted on community centers' websites and social media pages. The survey was then followed by face-to-face surveys mostly during the weekends from October, 2012 through April 2013. The face-to-face survey was performed primarily for those communities where online survey was not allowed or the response rate is extremely low. It complemented to diminish coverage error associated with systematic exclusion of eligible people, especially those who don't have a personal computer and/or access to internet. With the non-probability sampling method, sample members were sought mainly at community centers and neighborhood parks. The survey questions consisted of four domains including perception, values, preferences, and satisfaction, while requiring various response formats such as multiple answers, ranking, scale and open-ended questions that were supplemented by subsequent short-interview.

3. Results

3.1. Physioecological Green Space Quality

The landscape features that Dobson Ranch (C1) possesses include eight artificial lakes adjoined with greenbelt, golf courses and linear landscapes. Superstition Spring (C2) landscapes demonstrate a geometric form of several neighborhood parks along the engineered stream channels running across the area. Golf courses are a common feature to all chosen communities except Superstition Spring (C2) which instead possesses a small tract of urban agricultural land in the southern part of the area. Dobson Ranch (C1) and Superstition Spring (C2) communities are relatively flat in elevation and don't have sizable natural lands, while the other group of community illustrates varying degree of topography with a close proximity to urban natural reserves, such as the White Tank mountain near Verado (S1) and the Boulder mountain, the Sendas mountain, and the Tonto National Forest besieging Las Sendas (S2), for example (Figure 3).

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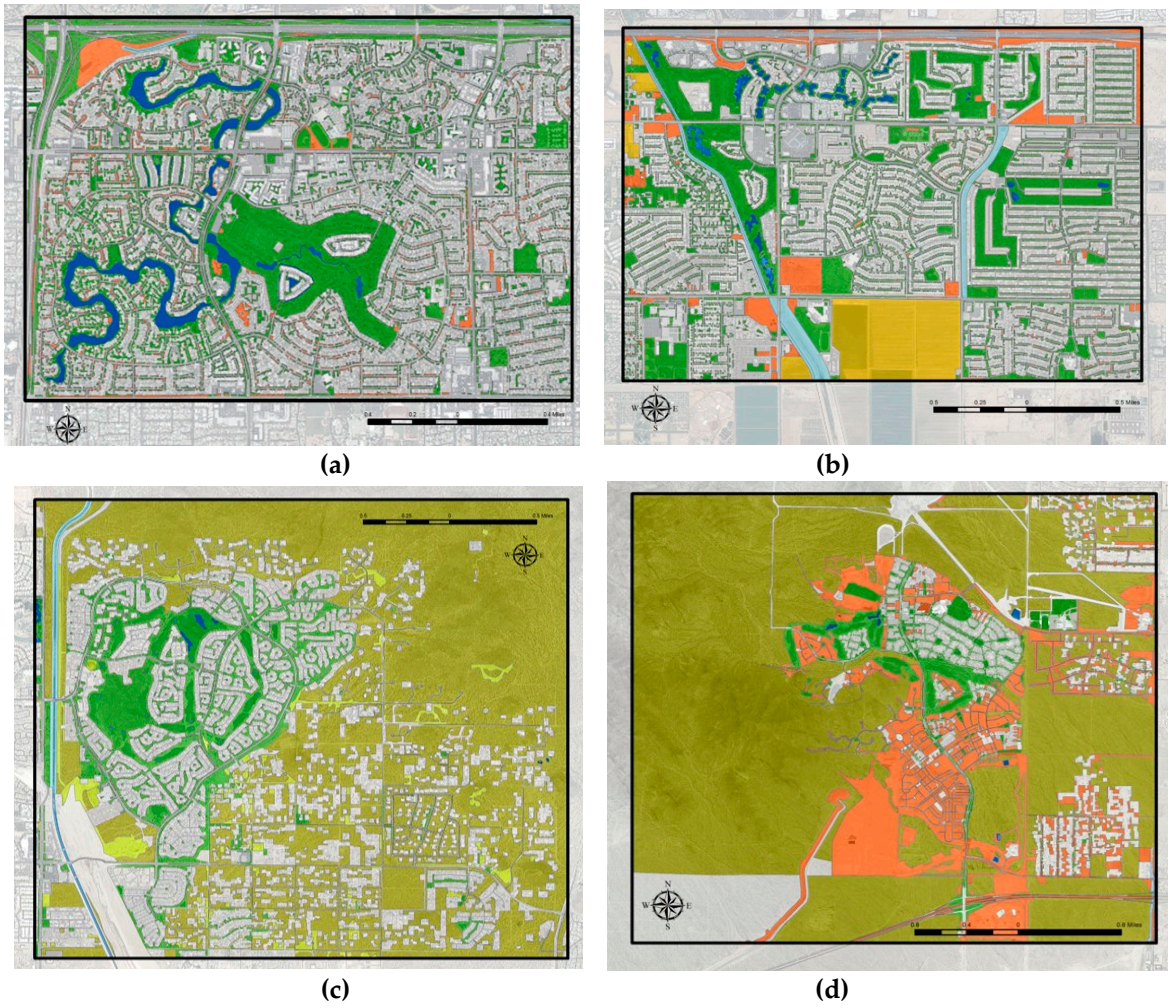

Figure 3. Physical properties of green spaces in selected communities. Green: urban green spaces; Yellow: urban agriculture; Orange: vacant areas; Brown: undisturbed area. **(a)** Dobson Ranch; **(b)** Superstition Springs; **(c)** Verrado; and **(d)** Las Sendas.

3.1.1 Structural and Ecological Connectivity

The structural connectivity values of the conventional communities appeared 0.075 for Dobson Ranch and 0.035 for Superstition Spring, which is slightly higher than those of sustainable communities, 0.043 for Verrado and 0.024 for Las Sendas. One of the reasons caused higher structural connectivity in conventional communities presumably results from long-established green space systems including old and matured trees and the existence of water features that are linked with other natural elements within the community boundaries (Figure 4). On the other hand, the distribution of higher ECI (Ecological Connectivity Index) areas are predominant in sustainable communities compared to the conventional ones. There are some spatial variables that might influence the result mainly related to locational context, size and dimension of natural elements and distance to the adjacent natural sources (Figure 5).

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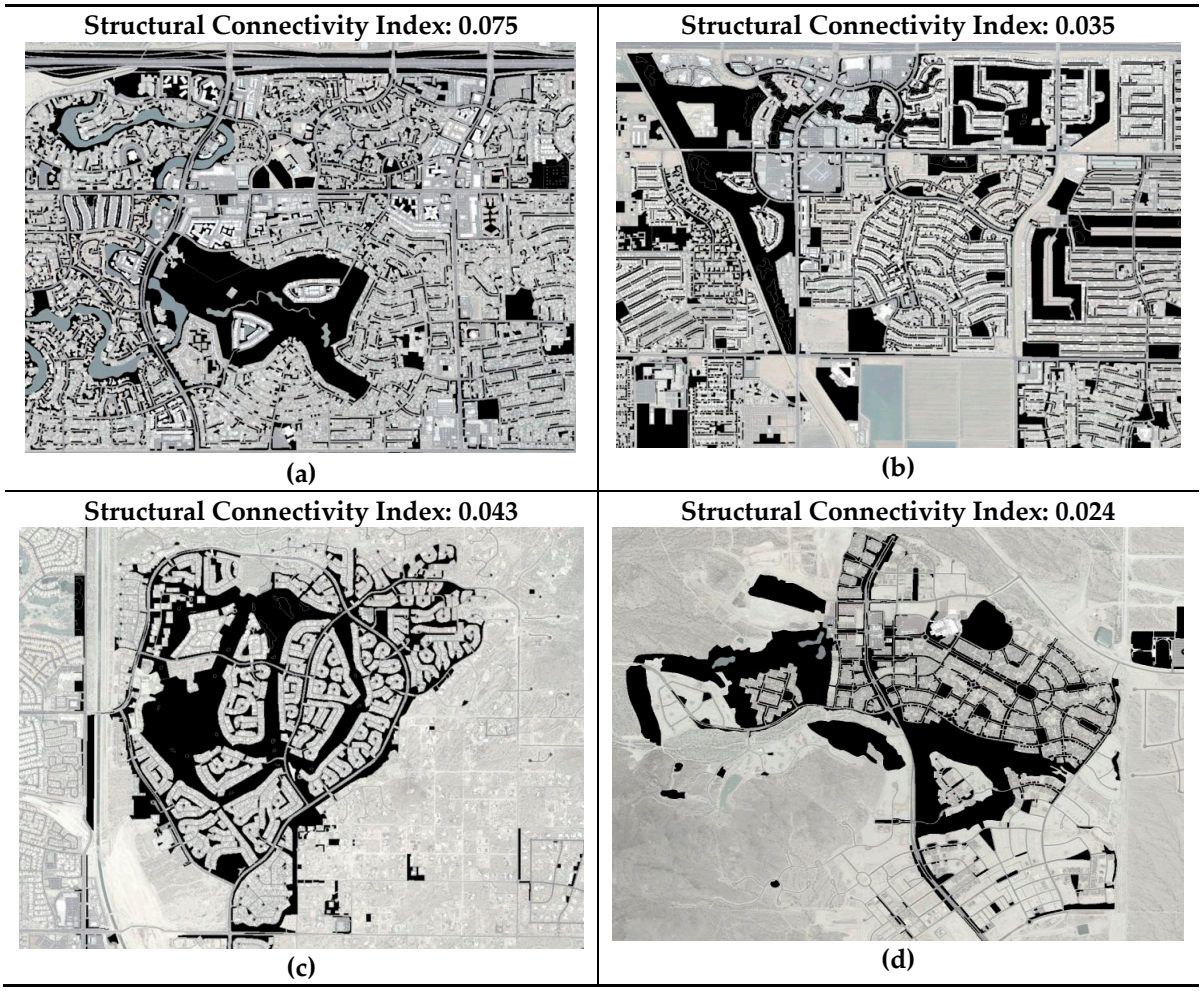
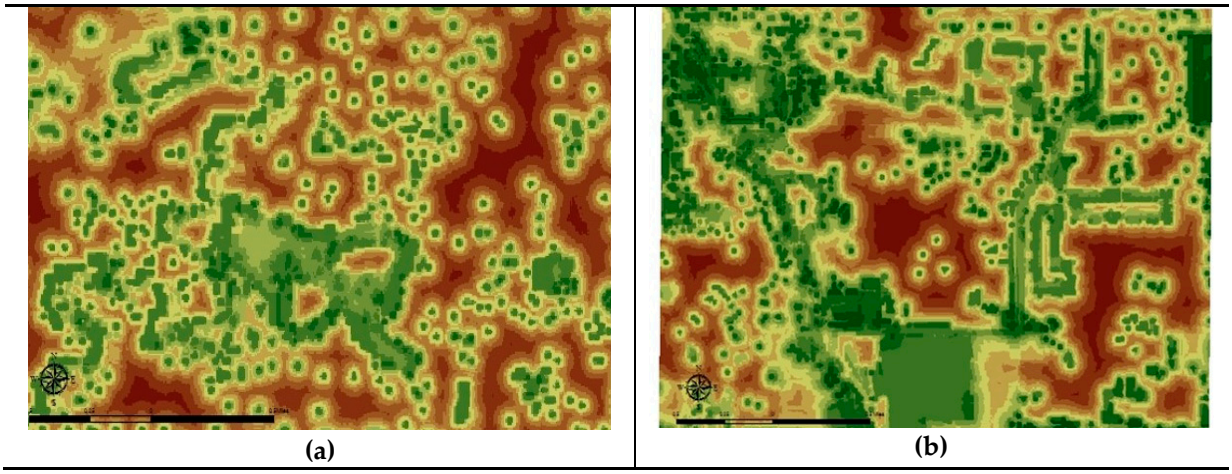


Figure 4. Structural connectivity of green spaces in selected communities. (a) Dobson Ranch; (b) Superstition Springs; (c) Verrado; and (d) Las Sendas.



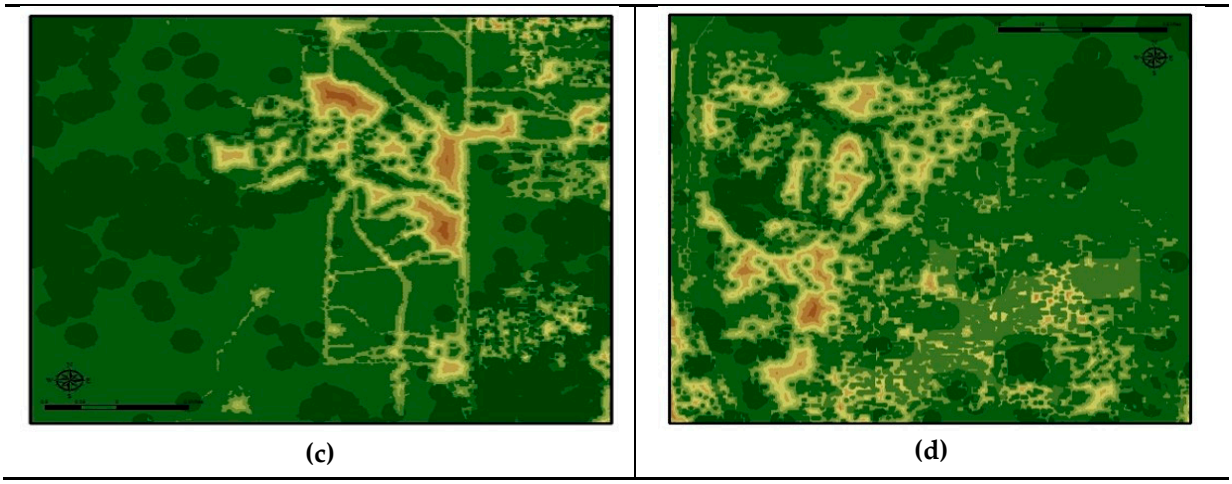


Figure 5. Ecological connectivity areas in selected communities (brown: low connectivity; green: high connectivity). **(a)** Dobson Ranch; **(b)** Superstition Springs; **(c)** Verrado; and **(d)** Las Sendas.

3.2. Residents' Survey

The main findings from the residents' survey can be summarized that there is community appreciation of green spaces with ecological, natural and aesthetic values regardless of the development type. However, it is obvious that a higher degree of satisfaction and coherent linkages into other values of green spaces are shown in the communities where sustainability was envisioned in the development process. The results reinforce the importance of surrounding nature, access to large ecological sources for their quality of life and socio-economic values. The following sections describe primary responses for the questions in three arenas of residents' perception, satisfaction, and preferences/values associated with natural features of their communities.

3.2.1 Residents Perception

- Uses and purposes

The residents in conventional communities mostly used private landscapes such as front and back yards followed by neighborhood parks. The landscapes most frequently used by the people in sustainable communities appeared to be community parks, mountain parks and natural trails, which can be categorized as shared or communal spaces (Figure 6). While the respondents in conventional communities used the green spaces mainly for sports/recreation and relaxation purposes, the landscape experiences with the counterparts were more evident in nature-related activities such as hiking and contact with wildlife. What is common to the both type of community is their primary usage of landscape for play with children, which reflects their desire for the spaces suitable for family (Figure 7).

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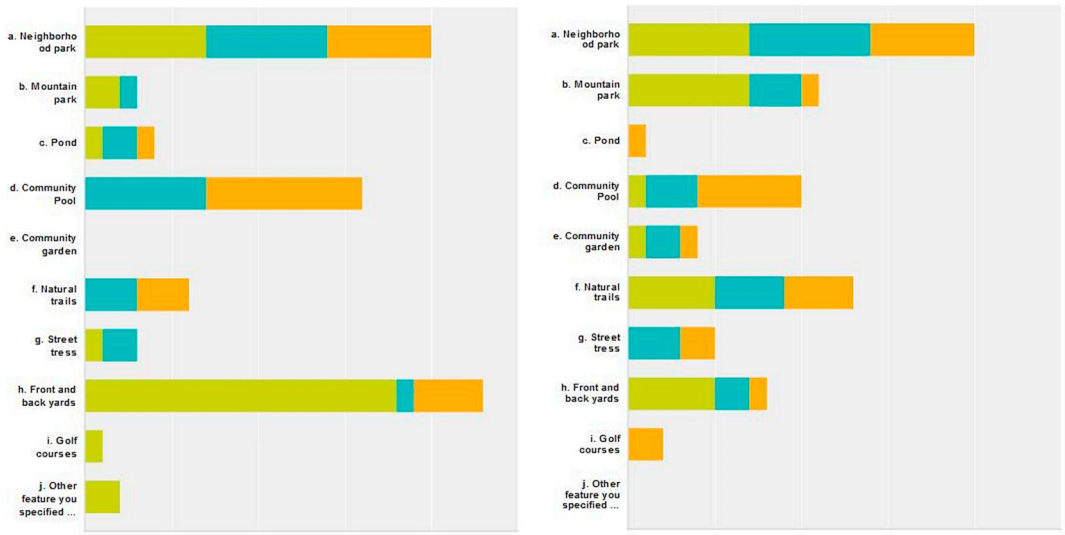

Figure 6. User preference ranking (green: 1st choice, blue: 2nd; orange 3rd choice) **(a)** Conventional community **(b)** Sustainable community

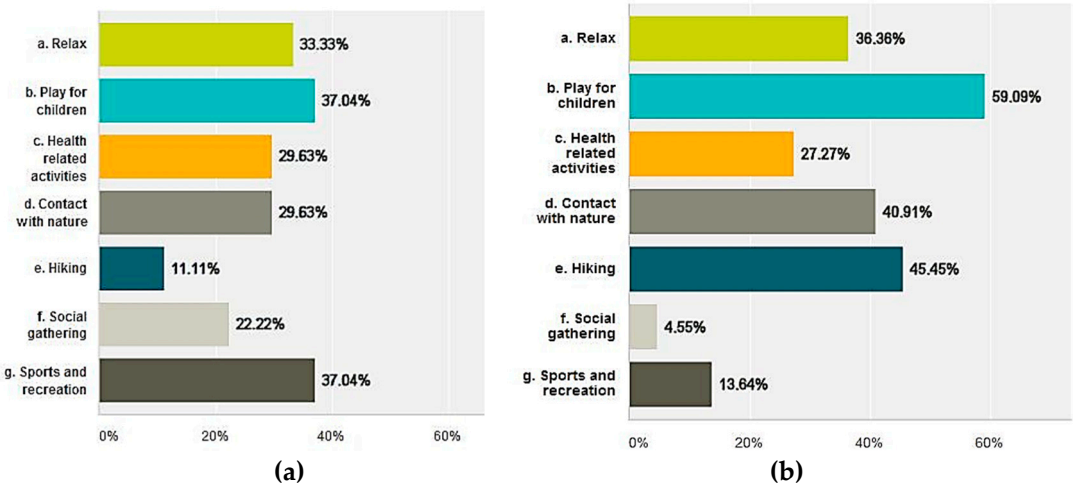

Figure 7. Purposes of landscape use **(a)** Conventional community **(b)** Sustainable community

- Perceived Accessibility to urban nature and sustainability

With regard to the perceived accessibility to nearest urban nature, approximately 60 percent (C1 and C2) and 95 percent (S1 and S2) of the respondents in each type of community indicated that there is an easy access to them (Figure 8). The perceived preference on the opportunity for wildlife encounter indicated that approximately 94 percent of the people would like to see wild small animals in their communities. To the question about their experiences with wildlife in the locales, 45 percent of the conventional community respondents answered that they have a high chance of observing small urban species such as raccoon, lizard, squirrel and rabbit, and many of them mentioned water birds such as ducks, cranes, geese, and great blue herons presumably resulting from the existence of the lakes within the communities. For the sustainable communities, 87% respondents listed the names of species that they often encounter, mostly the mid-sized mammals that may hardly be observed in urban areas, including coyote, mule, deer, and bob cat. As such, perceived ecological sustainability was higher in sustainable

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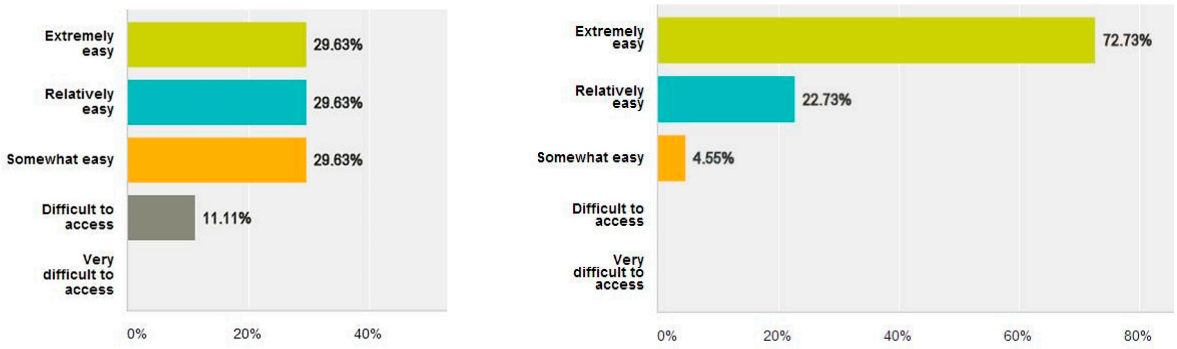
communities (92%) compared to the other group (62%) where a fourth of the total respondents viewed their community is far from being environmentally friendly or ecologically sustainable (Figure 9).



(a) **(b)**

Figure 8. Perceived accessibility to adjacent natural areas **(a)** Conventional community **(b)** Sustainable community

(a) **(b)**

Figure 9. Perceived sustainability between the two types of community **(a)** Conventional community **(b)** Sustainable community

3.2.2. Residents satisfaction

Overall quality of green spaces was highly appreciated by the respondents from the sustainable communities (100 percent for satisfaction). By contrast, 3.7 percent of respondents from conventional communities expressed extreme dissatisfaction over their green spaces, although about 67 percent is still satisfied with the landscape quality in their communities. The lack of satisfaction is attributed to the amount and management of green spaces rather than greenness (Figure 10).

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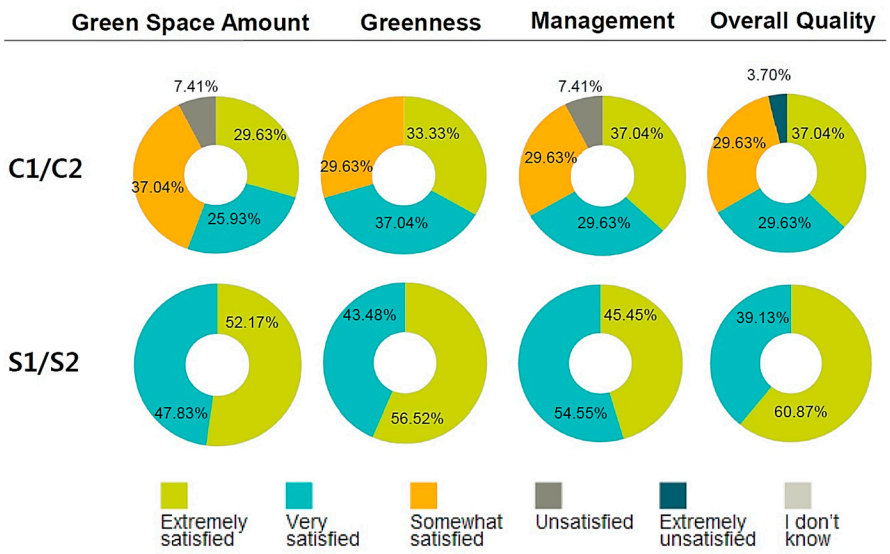

Figure 10. Resident's satisfaction for green space amount, greenness, management, and overall quality

3.2.3. Values & preferences

- Values of community green spaces

A majority of respondents recognize the potential roles and values of the green spaces in human communities. Most of the statements that specified the functions and possible impacts of community green spaces including human health, local habitat, quality of human life, contribution to the ecology of broader environment, increase in property values, and a sense of belongingness were appreciated by the respondents (Figure 11).

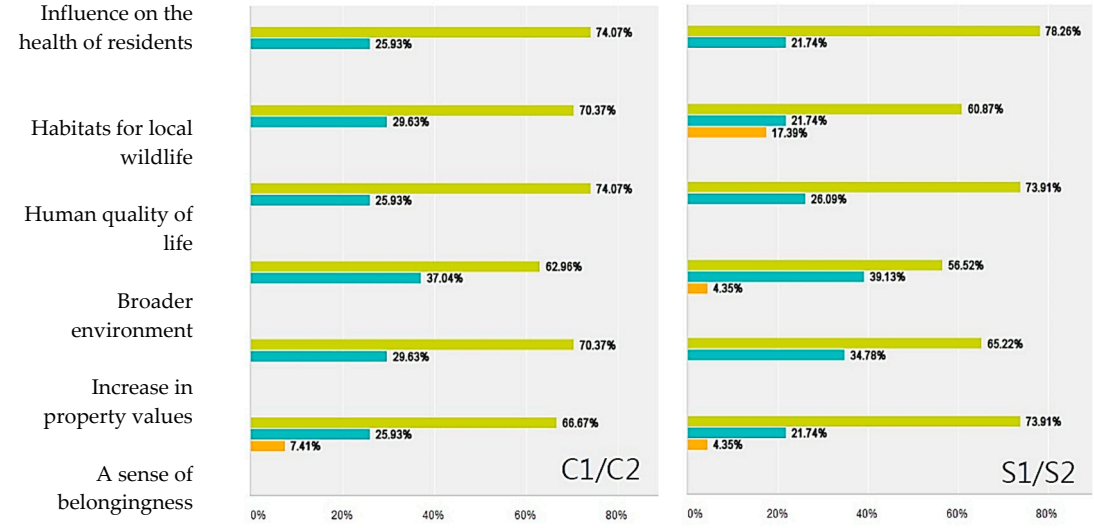

Figure 11. Residents values for the roles and services of community green spaces

- Preference & Landscape Demands

With the availability of landscape features in each community, respondents were asked to select the natural elements they value the most. The perceived uniqueness was found in the landscape features such as lakes, mountains, growing trees, wildlife, and natural trails. On the other hand, community

vegetable garden was one of the features that are not currently available in any of the communities but the most wished element by all four communities. Other landscape demands from the conventional communities includes groves for shade, benches for sitting, paved paths, a neighborhood park with bathrooms, more space for entertaining, and grass for children to play, while sustainable community respondents mentioned more water features such as ponds and natural washes, neighborhood parks with native plants, xeriscaping, botanical garden, and more spaces for outdoor activities such as half-pipe parks, bike paths and campground. Shading seems important to all the communities under the hot and dry climate.

To the optional question for comments regarding structure, arrangement, and nature of community green spaces, a respondent indicated the functional importance of the green spaces by stating as follows, "Green areas are very important; they are the perfect place for families to play and grow." Some people were quite conscious about the spatial and ecological aspects of the community green spaces: one person I interviewed said, "…they're pretty well organized. However, I don't like the disconnectedness of green space." Another person stated that "individual community green spaces need to connect better with public infrastructure like bike lanes, city parks, and other communities surrounding." As to value-related questions, Dobson Ranch (C1) residents viewed lakes, trees, wildlife, paths, and front yard landscape as valuable natural characteristics in and around their community, and Superstition Vistas (C2) residents valued the existence of adjacent mountain and overall landscape beauty. Verrado (S1) residents picked water fountains, mountain desert, petroglyphs, natural trails, wildlife, and growing trees as a unique set of their community landscape elements, while Las Sendas (S2) respondents expressed favor over mountains, natural trails, wildlife, and grass. Of the responses from the follow-up interview, several people stated that nature experience was one of the reasons they moved in and they enjoy the most of the community life because of the services the community landscapes provide with.

4. Discussion and Conclusions

This preliminary case study exhibited the variance between the physical green space connectivity and the areas of ecological significance. While the conventional communities demonstrated the decent level of physical connectedness of landscape features, sustainable communities showed a large portion of landscapes with higher ecological potentials resulting in part from the site location and not-yet-built areas within the community boundaries. Through the questionnaire surveys and brief follow-up interviews, it became evident that people desire to have quality green spaces and interact with nature in and around the community. This provides planning implications for community development that are responsive to both human and ecological values and beneficial to ecological and environmental improvement at site and city scales. There are some proven examples in which ecological elements were included in larger-scale planned community designs and also were liked by the public [23], which lends a possibility to apply ecological process and human connections to nature into ecologically sensitive development for planned communities in many metropolitan areas.

While overall quality of community landscapes can be addressed by the governance of individual Home Owner's Associations (HOAs) primarily as a post-development controls for landscape aesthetics and management, the ecological mechanisms manifested in the spatial arrangement, amount and connectivity of the community green spaces need to be considered in the early stage of community design and planning process. In fact, a study demonstrated home owners feel more 'natural' if there are more than just yards in their neighborhood and seek to promote urban ecosystem quality. Another interesting finding of this study is that the residents perceive their yards as an ecological actor and starting place for communication about ecosystem functions in such situation, not just as aesthetic attributes and other

contexts, indicating the complexity of homeowner conceptualizations of their community landscapes [24].

The quality of life and human well-being are a frequently declared catch phrase for contemporary community development. As the residents survey of this study implies, the general definition of 'livability' of a living condition that supports urban quality, safety, affordability, and civic involvement can be further extended to that of providing other sustainability benefits such as elevating green spaces quality, coexistence with urban wildlife and exposures to, and immediate experience with, urban nature as everyday landscape. As such, a higher degree of resident satisfaction could be achieved with careful landscape planning as a means to support public goods and urban ecosystem services. Arguably, the composition, configuration, and functions of the green spaces which may not be marketable points can virtually increase residents' appreciation over the place they live and even influence the long-lasting stewardship for local ecosystems and community sustainability.

Although this study does not provide a causal relationship between landscape connectivity and perceived sustainability, the results from the connectivity analysis and residents survey find a general correlation between them and emphasize unrecognized importance of physically and ecologically connected landscapes as a means to help balance out the sustainability of modern communities. For the cases taken as sustainable communities in this study, there are significant amount of lands that have not been specified for any particular uses yet in the community boundaries (Figure 12). Technically, the ratio of vacant lots to privatized landscapes is reasonably high in large-scale master-planned communities than traditional neighborhoods. When considering the fact that the large-scale master-planned community is becoming a dominant type of residential development, therefore, there are bountiful opportunities of capitalizing upon the non-specified areas in a more ecologically sustainable manner (e.g., comprehensive conservation subdivision planning), rather than setting aside for future piecemeal subdivision. Especially in a huge metropolitan area of which morphology interferes with urban ecology and biodiversity, preserving and maintaining the human communities' green spaces with ecological services is equally important as natural reserves outside the urban fringes. Like other big cities, Phoenix is experiencing a typical urban sprawl along with low urban density, and many other cities follow such a developmental path. The continuous development with less idiosyncratic landscape features will only produce cookie-cutter housing patterns contributing to another swath of sprawled land. One of the reasons the Phoenix metro area has the urban and suburban sprawl challenges has something to do with the grid system and cheap land with little land scrutinization for landscape cohesion and ecological values. Also, as a single family housing is increasing, lot sizes tend to be larger as well. The preservation of open, any natural lands-even marginal, in community plan boundary will be able to provide potential sustainable benefits and opportunities otherwise may be lost only making an overcast community experience.

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(a) (b)

Figure 12. Vacant areas (hatched) overlaid with the high ecological connectivity areas (dark green areas). (a) Verrado; (b) Las Sendas

Deliberate and careful urban design and planning that allow developers and planners to draw up potential areas for connectivity conservation can increase the community capacity to afford added values of landscape and ecosystems services and help create sustainable community. Furthermore, the ecological enhancement of the community-scale landscapes will be contributing to optimize regional linkages of broader ecological network. As Lynch (2016) argues [25], understanding how to better connect our cities with the benefits nature provides will be increasingly important as people migrate to cities and flourish in them. Having and holding green spaces in proper locations in individual communities will help to bridge natural infrastructure in between the human dominated landscapes, which will eventually be beneficial to deal with emerging social, ecological, environmental and aesthetic challenges of urban growth [26]. Neighborhood development per se inevitably reduces availability of habitat structure in urban landscapes which jeopardizes urban ecological sustainability [27]. However, through planning and design tools such as ecological design, spatial zoning and community engagement, the destruction of habitat structures can be minimized and the balance between socio-economic priorities and biodiversity conservation may become achievable even in the site scale as an individual neighborhood when those strategies can be practically implemented.

The study suggests that the development of connective green space should be allocated a more central position in spatial planning and community development. Future planning and design efforts need to consider the quantity, quality, and connectivity of neighborhood landscapes based on fine grained analysis of site features and context, inherent and emergent functions of site-scale ecosystems, and spatial relationship with surrounding landscapes at various levels. In doing so, the use of local green infrastructure concept and practices will be useful to foster community connections to ecological sustainability while promoting ecosystem and human health [28]. As Jerom (2016) argues [29], community-scale green infrastructure and related voluntary activities could contribute to broader-scale ecological networks and the increase of 'interconnectivity' between sites of green infrastructure [30] and 'continuity' across 'hubs' (larger areas) and 'sites' (smaller areas) [31]. As such, small scale green infrastructure integrated with urban and community development can become a significant mechanism for delivering multi-functional benefits attributed to green infrastructure more generally.

The cumulative effects of such practices will be able to bring ecosystem services into urban areas including: improving air quality, reducing stormwater, mitigating urban heat island effects, and creating

wildlife habitat [32-34]. Applying ecosystem services that are the benefits human derive from nature offers prospects for landscape and urban planning with the higher standards for landscape performance when economic and cultural benefits of ecosystems are identified. The properly functioning urban ecosystem services can then contribute to increasing urban sustainability [7,35]. The research infers that landscape connectivity helps human connection to nature at a local scale. Ecologically sensitive development and priority setting for ecological processes should be considered not only at the city scale but also multiple smaller scale for the development of human settlements to be seated along the urban outskirts. This connective approach sets helpful framework for reshaping our understanding of community sustainability and renewing community design and decision making practices that can promote ecological and human health. The pursuit of ecologically friendly alternatives to the mainstream community development may be one of the ways to write off the infamy of city as ecological wasteland and to turn the tide of community development toward more sustainable and multiservice-oriented.

Supplementary Materials

Figure 1. Intermediate Disturbance Hypothesis

Figure 2. Location of selected communities

Figure 3. Physical properties of green spaces in selected communities.

Figure 4. Structural connectivity of green spaces in selected communities.

Figure 5. Ecological connectivity areas in selected communities

Figure 6. User preference ranking (green: 1st choice, blue: 2nd; orange 3rd choice) (a) Conventional community (b) Sustainable community

Figure 7. Purposes of landscape use (a) Conventional community (b) Sustainable community

Figure 8. Perceived accessibility to adjacent natural areas (a) Conventional community (b) Sustainable community

Figure 9. Perceived sustainability between the two types of community (a) Conventional community (b) Sustainable community

Figure 10. Resident's satisfaction for green space amount, greenness, management, and overall quality

Figure 11. Residents values for the roles and services of community green spaces

Figure 12. Vacant areas (hatched) overlaid with the high ecological connectivity areas (dark green areas)

Table 1. Basic profile of four selected communities

Conflicts of Interest

The authors declare no conflict of interest.

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