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Optimization of Green Space Plant Configuration in Residential Areas of Chongqing Central Business District Based on Green Plot Ratio—A Case Study of Xuhui City Residential Community

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Abstract

The current urban green space construction was guided by a two-dimensional index evaluation system, resulting in weak ecological benefits of green space. Green plot ratio (GPR), as a three-dimensional indicator, can characterize the ecological benefits of green areas and the ability of green areas to participate in the operation and regulation of urban ecosystems. As an important component of urban green space, the GPR index was added to the two-dimensional index evaluation system to optimize the green space, which can promote the development of low-carbon, healthy and ecological green space. Based on the research of 22 residential districts in the central city of Chongqing, the Leaf area index (LAI) index of common native garden plants in Chongqing was formed to improve the accuracy of green capacity index measurement in Chongqing. The study also took the residential community of Sunrise City in Banan District of Chongqing as an example, and carried out the optimization design practice from four types of residential community green areas: green areas next to houses, road green areas, concentrated green areas, and green areas attached to public service facilities.

Keywords

Urban Greening, Ecological Benefits, Residential District, Leaf Area Index, Plant Selection

1. Introduction

Residential green space is the type of green space closest to people's lives, and is a functional space with residential beautification, recreation and leisure, and ecological services. Its ecological service function that indirectly affects the climate change of residential environment comes from the light and metabolic process of green plants. The optimization of plant configuration of residential green space can improve the ecological benefits of residential areas while meeting the people's beautiful pursuit of ecological, healthy and low-carbon living environment.

The current evaluation criteria of green areas in residential areas are two-dimensional indicators based on green space ratio, green coverage, per capita green area, per capita park green area, etc. (MOHURD, 2010). However, these indicators can only describe the amount and area of greenery in the two-dimensional space of the site, and cannot characterize the amount of plant greenery in the three-dimensional space, resulting in a single plant in most residential areas during the green space construction process, and weak greening intensity and ecological benefits (Zhang & Ding, 2008), so the three-dimensional evaluation index Green plot ratio (GPR) is needed to comprehensively assess the plant configuration of residential green space, from different Therefore, a three-dimensional evaluation index, Green plot ratio (GPR), is needed to comprehensively assess the plant allocation of green space in residential areas, and to address the problem of poor ecological benefits of green space in residential areas from the functional differences between different plant species and different green space structures by pushing the evaluation index system from two dimensions to three dimensions

2. Green Plot Ratio and Its System

Green plot ratio was assessed based on Leaf area index (LAI) and defined as the ratio of the total leaf area of all types of vegetation in the site to the site area (Ong, 2003), which is similar to Floor Area Ratio (FAR), a non-metric unit. The green capacity ratio serves as a biomass for investigating and supplementing urban green areas, and its role can improve the operation and regulation of urban ecosystems, mainly serving the ecological functions of soil and water fixation, cooling and purification, carbon sequestration and oxygen release, and dust and noise reduction.

2.1. GPR Index System and Calculation Formula

The GPR system involves computational models and statistical models of data at three levels: single plant, community, and plot. Specifically, it includes three parts. The first part follows the two-dimensional indicators (green space rate and green space coverage); the second part is an indicator to measure the ecological benefits of green space and greening level (green volume and green volume rate); the third part is the GPR and greening construction that combines green space construction with urban planning and construction index (Zhao & Rao, 2005).

Through the guidance of GPR system, the scientific plant selection and plant configuration of low ecological efficiency residential green areas can form a closely related residential microenvironmental ecosystem, improve the function of plants in carbon sequestration and oxygen release, dust and bacteria reduction, wind and noise prevention, regulate local microclimate and optimize ecological habitat.

The measurement of GPR is related to the two key indicators of plant leaf area (LA) and LAI, which can mainly reflect the richness of plant community structure, GPR is calculated as formula (1), and the green space GPR can be calculated after knowing either LA or LAI and plant projection area (Li et al., 2019). In addition, the Chongqing region has introduced the Chongqing Green Building Evaluation Standard (DBJ50/T-066-2020) based on the Chinese Green Building Evaluation Standard, and gives the estimation formula (2) of GPR, and hopes to apply it to all types of urban green space ecological construction evaluation (HAURDC, 2020).

$$\mathrm{GPR}=\frac{\mathrm{LA}}{S}=\frac{\sum\left(\mathrm{LAI}_1\times s_1+\cdots+\mathrm{LAI}_n\times s_n\right)}{S} \tag{1}$$

In formula (1), LA is the total leaf area of a site, and S is the total area occupied by the site.

$$\mathrm{GPR}=\frac{\sum\left(\mathrm{LAI}_t\times S_t\times n_t\right)+\sum\left(3\times S_s\times n_s\right)+S_g}{S} \tag{2}$$

In formula (2), LAI_t is the leaf area index of trees, S_t is the canopy projection area of trees, S_s is the canopy projection area of shrubs, n_t is the number of trees, n_s is the number of shrubs, S_g is the footprint of the lawn, S is the total area of the site. In the formula, the leaf area index of canopy sparse class of trees is taken as 2. The leaf area index of canopy dense class of trees is taken as 4. The projected area of trees is calculated according to the seedling table data, and the three-dimensional greening in the site can be included in the calculation. However, the variability of tree LAI is large, and judging tree LAI only by dense or sparse canopy may cause large errors to the calculation results.

2.2. Leaf Area Index

LAI was introduced by Watson in the 1940s, and the leaf area index is half of the total green leaf area per unit area of the ground surface (He et al., 2022), and is often used as an important parameter of vegetation canopy as a state variable in vegetation monitoring and ecosystem cycle models, and is important in quantitative assessment of physio and physical processes such as photosynthetic respiration, transpiration, and precipitation retention in vegetation (Ong, 2003).

The measurement methods of LAI are mainly divided into direct and indirect methods. The direct measurement method has the most accurate results, but the disadvantages of high workload and time consumption make it extremely unlikely to monitor vegetation LAI spatially and temporally; while the indirect measurement method mainly uses the relationship between LAI and leaf variables (green matter, infrared reflectance) inferred, thus allowing more spatial and temporal LAI values to be obtained, but the LAI accuracy of the indirect method needs to be calibrated by the direct method (Chason et al., 1991). The hemispheric photography method is the most accurate of the indirect methods and has the advantage of being easy to measure, fast to calculate, and highly accurate, allowing to reach an average error of only 11%. Therefore, this method will be adopted to complete this study.

3. Materials and Methods

3.1. Overview of the Study Area

Chongqing (29.51'02" - 30.22'24"N, 105.58'37" - 106.40'37"E) is in the southwestern China and has a humid subtropical monsoonal climate, which contains rich regional plant resources. A total of 45 families and 87 genera were involved. According to the Urban Green Space Classification Standard (MOC, 2017) and the current status of native plant distribution, the study sampling sites were determined to be residential green spaces (RG) in 22 residential areas within 3 - 10 years of completion in the central urban area, and 15 park green spaces were added to the study area range considering the actual plant data collection for the study (**Table 1** and **Figure 1**).

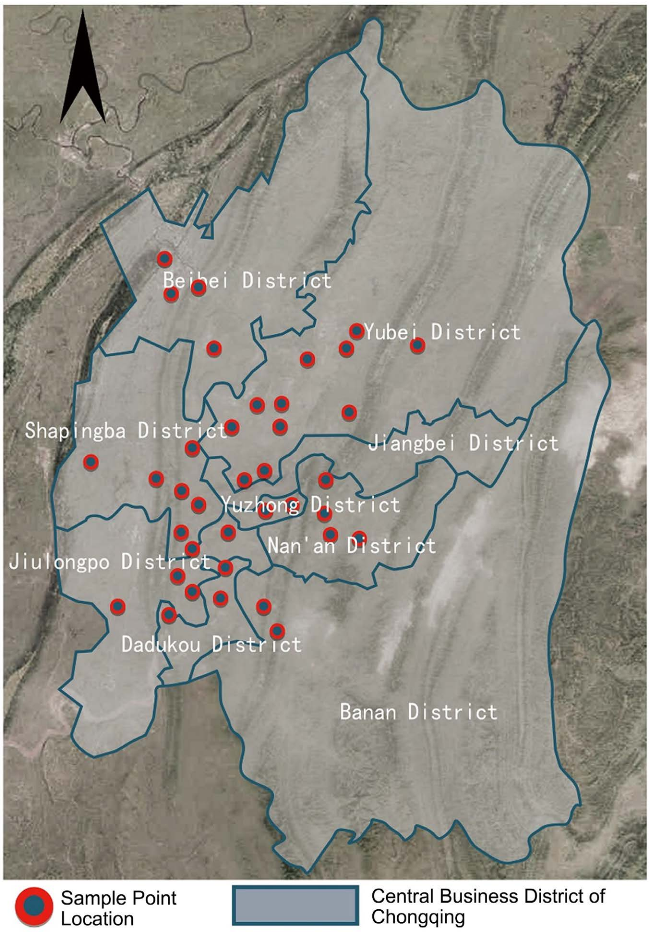

Figure 1. Map of sample points.

Table 1. List of parks for research.

Category	Name	
Integrated Parks	Yubei Central Park	Yongtouji Park
Community Parks	Dadukou Park	——
Specialized Parks	Pingdingshan Park	Baiyun Lake Park
Scenic spots	Goose Ridge Park	Nanshan Botanical Garden
	Chongqing Garden Expo Park	Huayan Tourist Scenic Area
Forest Park	Jinyunshan Forest Park	Hongensi Forest Park
	Gele Mountain Forest Park	Zhaomushan Forest Park
Wetland Park	Caiyun Lake Wetland Park	Jiuqu River Wetland Park

3.2. Sampling Method

Native garden plant research sampling was conducted using Digital Hemispherical Photography (DHP), and the sampling time was used during the summer season when the leaf area is the largest. Hemispherical images were acquired using a Nikon CoolPix 4500 digital camera with an external 183˚ wide-angle Nikon FC-E8 fisheye lens. The camera's built-in shooting parameters were set before image acquisition, and the camera's built-in "Fisheye 1" mode was selected to save the photos in JPEG image format with 2272 × 1704 resolution and low compression ratio (1:4) to ensure image clarity while reducing image file size and increasing the speed of subsequent software processing speed (Kay et al., 2021). To set the external parameters of the camera, the camera needs to be fixed on a tripod after a more horizontal alignment, with the camera 1.6 m above the ground, the lens facing upward, and the horizontal direction of the photo is the magnetic north pole (Ke et al., 2011), and the sampled images are shown in **Figure 2**. The sampling point was 1/2 of the line from the projected edge line of the tree's crown to the center of the trunk (**Figure 3**), and the tree species name, tree height, diameter at breast height, crown width, and sampling point data were recorded. The shooting time was chosen in the early morning or evening when there was a poor contrast between the sky and the branches and leaves caused by direct sunlight.

According to the urban residential area planning and design standards (GB50180-2018) on the residential area green space type division and residential area as-built drawings to determine the type of green space within the residential area, measuring the green space area and taking photos to record the surrounding environment, recording the planting points within the green space, and analyzing the plant configuration method.

3.3. Data Processing

The captured hemispherical photos were screened to exclude blurred and overlapping canopy photos, and a total of 2253 valid summer data were obtained. Based on the fact that manual determination of thresholds can affect the calculation results by about 10%, the photo data were processed using the Hemispherical plug-in for edge detection (**Figure 4**), an automatic thresholding algorithm to separate canopy and sky to improve the accuracy of the calculation results (Montero et al., 2008), and the GLA (GapLight Analyzer Version 2.0) software for hemispheric photos (**Figure 5**). The software processing yielded LAI4R (effective leaf area index extracted by integrating the zenith angle between 0˚ and 60˚), LAI5R (effective leaf area index extracted by integrating the zenith angle between 0˚ and 75˚), canopy openness, direct light on the forest, and scattered light on the forest floor to provide a basis for the GPR calculation (Nölke et al., 2015).

Figure 2. Ginkgo tree fisheye lens shooting results.

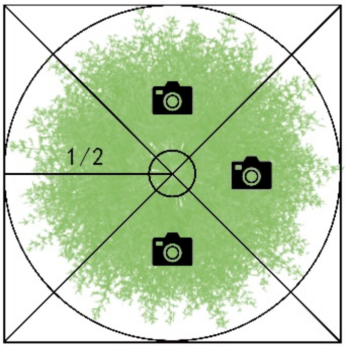

Figure 3. Fisheye lens shooting position.

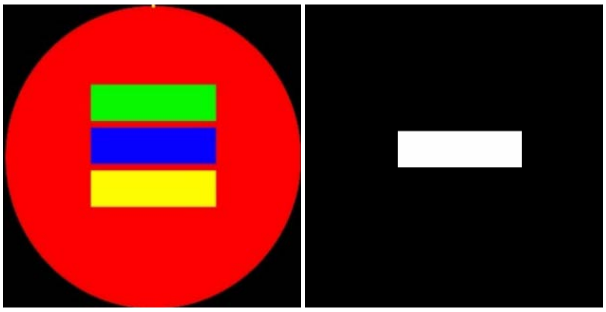

Figure 4. Hemispherical software edge monitoring and automatic threshold analysis and processing of samples.

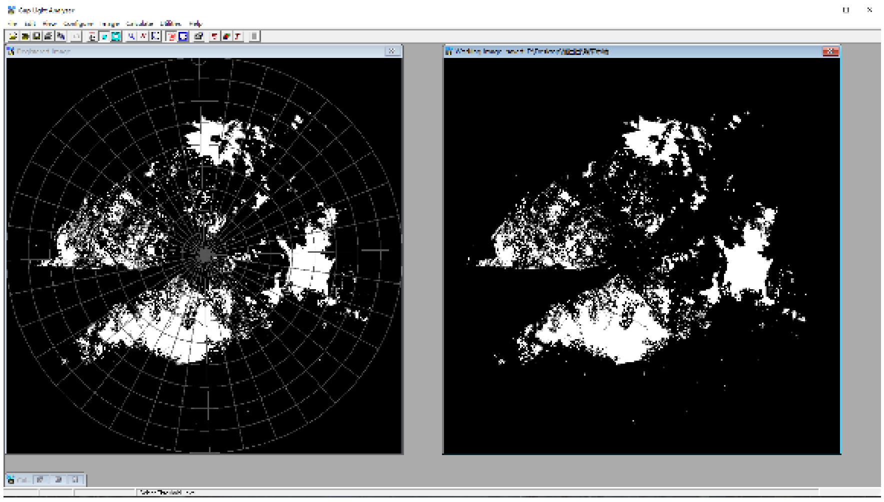

Figure 5. GLA software processing and analysis of Ginkgo sample images.

3.4. Data Collation

The mean analysis (95% confidence interval) of LAI of regional plants was performed in SPSS 26.0 to form a table of LAI indicators of common native garden plants in Chongqing (Table 2).

To further investigate the relationship between the frequency of use of summer native garden plants and LAI, the regional plants were clustered and analyzed according to LAI1. The LAI was divided into three clusters based on the final clustering center, and the LAI of 113 native garden plants was divided into three clusters based on the cluster members (Table 3), with high LAI plants (LAI ≥ 3.77), medium LAI plants (2.92 ≤ LAI < 3.77), and low LAI plants (LAI < 2.92).

4. Case Study of Green Space Optimization in Residential Areas Based on GPR

The case plot Xuhui City is located in Banan District, the central city of Chongqing, completed in 2014, with an area of about 12 hectares, building types containing high-rise and multi-storey, and a green space rate of 25%. The plant configuration in the green space of the district is too old, and the planting of trees in some of the green space is low, and there is a lack of plant management and maintenance for many years, so this district is selected as the basis for the green space plant configuration in the residential area, and the green capacity is used as the optimization means for optimization.

4.1. Principles of Planting

The optimization was carried out on the basis of the following principles:

1) Green development, focus on ecology. First of all, on the basis of respecting the topography of the site, understanding the ecological habits of native and introduced plants, reasonably configuring plants to achieve optimal GPR, maximizing the ecological benefits of residential green areas, increasing the total

annual average carbon sink, and enriching biodiversity.

2) Aesthetic perception and seasonal configuration. The planting of each layer of the complex community is sparse and dense, and the space is created freely. The planting of seasonal plants is increased moderately, so that leaves, flowers and fruits can be seen throughout the year, and each scene is different.

3) People-oriented, sustainable development. First of all, we should respect people-oriented needs and choose planting according to the functional attributes of different green areas. For example, green areas next to houses need to ensure privacy for low-rise residents, shade and shelter for road green areas, ventilation and light for centralized green areas, and open sight lines for green areas attached to public service facilities. In addition, the selection of plant species for each type of green space should be arranged according to the ecological habits of plants to reduce plant loss, replanting and later management and maintenance, and to create ecological green spaces close to nature in residential communities.

Table 2. Descending table of LAI indicators of commonly used native garden plants in Chongqing (summer).

Name	LAI1	LAI2	NO	Name	LAI1	LAI2	NO
Sloanea sinensis	5.28	3.68 - 6.88	1	Silktree Albizzia	3.4	1.88 - 4.93	58
Chimonanthus praecox	4.9	4.44 - 5.32	2	Chinese Soapberry	3.36	2.75 - 4.01	59
Celtis julianae	4.67*	/	3	False Acacia	3.34	2.83 - 3.89	60
Symplocos setchuensis	4.65	4.13 - 5.16	4	*Choerospondias*	3.33	2.76 - 3.92	61
Ulmus parvifolia	4.56	2.04 - 7.19	5	*Acer davidii*	3.33*	/	62
Fragrant Olive	4.45	4.16 - 4.72	6	Holly	3.31	1.41 - 5.29	63
Ficus virens	4.26	3.93 - 4.58	7	*Cinnamomum bodinieri*	3.31	3.05 - 3.65	64
Michelia maudiae	4.25	3.43 - 5.00	8	*Elaeocarpus*	3.29	2.99 - 3.69	65
Adinandra bockiana	4.23*	/	9	*Platanus*	3.26	2.86 - 3.64	66
Ficus benjamina	4.22	3.95 - 4.55	10	Chinese Tulip Tree	3.21	2.67 - 4.00	67
Elaeocarpus sylvestris	4.2*	/	11	Ornamental Peach	3.2	2.48 - 3.99	68
Schima argentea	4.16	3.62 - 4.80	12	*Quercus fabri*	3.18*	/	69
Trident Maple	4.13	3.57 - 4.70	13	*Prunus mume f. alphandii*	3.18	2.28 - 4.05	70
Acer oliverianum	4.11	2.80 - 5.45	14	Chinese Parasol Tree	3.14	2.68 - 3.67	71
Polyspora axillaris	4.08	3.03 - 5.11	15	*Melia azedarace*	3.12	2.43 - 3.82	72
Magnolia heptapeta	4.06	3.66 - 4.49	16	Palm	3.12	2.61 - 3.67	73
Butterfly Tree	4.06	3.51 - 4.77	17	*Crateva*	3.11*	/	74
Variegated Coral Tree	4.04	3.65 - 4.42	18	*Celtis sinensis*	3.08	2.73 - 3.57	75
Cottomrose Hibiscus	4.02	3.63 - 4.47	19	*Acer ginnala subsp. Ginnala*	3.07	2.04 - 4.26	76
Giant Dogwood	3.99	3.17 - 4.95	20	Japanese Flowering Cherry	3.07	2.81 - 3.50	77
Cinnamomum japonicum	3.97	3.69 - 4.30	21	Golden-Rain Tree	3.05	2.81 - 3.33	78
Myrica rubra	3.97	3.73 - 4.29	22	Chinese Yew	3.01	1.85 - 4.08	79
Castanea Mollissima Blume	3.95	2.53 - 5.48	23	*Ligustrum compactum*	2.98	2.39 - 3.68	80
Photinia davidsoniae	3.95*	/	24	Chinese Pistache	2.96	2.57 - 3.36	81

Continued

Michelia chapensis	3.94	3.57 - 4.44	25	Japanese Quince	2.94	2.37 - 3.51	82
Juniperus chinensis "Kaizuca"	3.93	3.37 - 4.46	26	Eucommia	2.92	2.29 - 3.58	83
Siberian Elm	3.93	2.96 - 4.81	27	Purple Magnolia	2.88	1.77 - 3.97	84
Pome Granate	3.89	3.43 - 4.33	28	Chinese Alangium	2.86	1.95 - 3.78	85
Chinese Cryptomeria	3.85	3.14 - 4.65	29	Apricot	2.85	2.57 - 3.08	86
Camptotheca	3.85	3.27 - 4.52	30	*Broussonetia papyrifera*	2.83	2.48 - 3.24	87
Everlasting Persimmon	3.83	3.35 - 4.38	31	Gingko	2.79	2.55 - 3.09	88
Machilus nanmu	3.8	3.28 - 4.36	32	*Robinia pseudoacacia var. inermis*	2.78	2.40 - 3.14	89
Zelkova serrata	3.77	2.35 - 5.22	33	*Quercus aliena*	2.72*	/	90
Chinese Honey Locust	3.75	2.09 - 5.45	34	*Quercus acutissima*	2.69	1.80 - 3.63	91
Liquidambar formosana	3.72	3.26 - 4.40	35	Coral Tree	2.67	1.17 - 4.13	92
Loquat	3.72	3.37 - 4.09	36	Crape Myrtle	2.67	2.37 - 2.99	93
Phoebe zhennan	3.67	3.42 - 3.92	37	Toog Tree	2.65	2.36 - 2.97	94
Chinese Arborvitae	3.66	3.13 - 4.21	38	*Eucommia ulmoides*	2.64*	/	95
Morus alba	3.64	2.76 - 4.45	39	*Prunus cerasifera "Atropurpurea"*	2.54	2.29 - 2.81	96
Bull Bay	3.62	3.38 - 3.92	40	Hall Crabapple	2.53	2.25 - 2.87	97
Chinese Horse Chestnut	3.62	1.81 - 5.47	41	*Pterocarya macroptera var. insignis*	2.53	2.10 - 3.04	98
Citrus maxima	3.61	3.10 - 4.30	42	*Cupressus funebris*	2.5	1.60 - 3.42	99
Maclura tricuspidata	3.6	2.25 - 4.91	43	*Diospyros lotus*	2.44*	/	100
Taxodium distichum	3.59	3.02 - 4.22	44	Fishtail Palm	2.39	2.04 - 2.95	101
Japanese Maple	3.57	3.29 - 3.91	45	Tree of Heaven	2.34	1.33 - 3.37	102
White Michelia	3.56	3.27 - 3.91	46	Willow	2.29	1.98 - 2.67	103
Acer palmatum "Atropurpureum"	3.56	2.97 - 4.17	47	Pekin Willow	2.28	1.85 - 2.71	104
Chinese Fan-Palm	3.56	3.07 - 4.13	48	*Pyrus pyrifolia*	2.24	1.49 - 3.03	105
Peach	3.56	3.14 - 4.04	49	Kalopanax	2.22*	/	106
Alnus cremastogyne	3.53*	/	50	Chinese Tallow Tree	2.16	1.67 - 2.79	107
Japanese Plum	3.52	2.46 - 4.68	51	Pear	2.1*	/	108
Chinese Juniper	3.51	2.75 - 4.44	52	*Taxodium distichum var. imbricatum*	2.09	1.67 - 2.58	109
Lindera megaphylla	3.49	2.96 - 3.99	53	*Diospyros oleifera*	1.97*	/	110
Metasequoia	3.48	3.14 - 3.99	54	Alexandra King Palm	1.88	1.61 - 2.38	111
Yew Podocarpus	3.46	2.96 - 4.01	55	Fortunes Paulownia	1.83	1.52 - 2.14	112
Deodar Cedar	3.43	2.93 - 4.26	56	Japanese Raisin Tree	1.61*	/	113
Yulania × soulangeana	3.41	2.88 - 3.86	57				

(Note * indicates that the sample size of the species was too small for 95% confidence interval description; LAI1 indicates the mean of leaf area index with 5% clipping; LAI2 indicates the mean of leaf area index at 95% confidence interval).

Table 3. Cluster analysis of 113 species of native garden plants in Chongqing.

	Clustering			F	Significance
Clustering group	1	2	3	259.879	0.000**
LAI	4.15	3.36	2.43		

4.2. Optimization Strategy and Effectiveness

4.2.1. Optimization of Green Spaces Next to Houses

The green space next to the house is a "green space delivered to the doorstep", which is accessible and practical, often enjoyed by the residents of the adjacent houses, and can reasonably organize the space and ensure good light and air circulation. By reconfiguring the plants, the optimization strategy and green capacity of this type of space is improved as shown in Table 4.

4.2.2. Optimization of Road Green Space

Road green space in residential community is the green space on both sides of the road and within the red line in residential community, which has the functions of shading, protection and enriching road landscape, and plays the roles of connecting, guiding, dividing and enclosing the site. Through the reconfiguration of plants, the optimization strategy and green capacity enhancement of this type of space are shown in Table 5.

4.2.3. Optimization of Concentrated Green Areas

Concentrated green space is generally placed in the center of residential areas or in the courtyard space formed by the enclosure of residential buildings, so concentrated green space has a direct impact on the creation of ecological environment in residential communities with richer plant mix and distinct landscape in all seasons, becoming a place where the mind breathes. Through the reconfiguration of plants, the optimization strategy and green capacity enhancement of this type of space are shown in Table 6.

4.2.4. Optimization of Green Space for Public Service Facility

The public service facility green space is dominated by plant materials, which constitute different functional and richly varied spaces with natural topography, landscape and architectural vignettes to provide residents with various characteristics, paying attention to landscape matching while also combining the functional needs of the site facilities. Through the reconfiguration of plants, the optimization strategy and green capacity enhancement of this type of space are shown in Table 7.

Table 4. Plant configuration of the original site and optimized site for multi-story house-side green space option 1.

Original site planting	GPR	Post-design site planting	GPR
Tree layer: *Zelkova serrata* (w = 9.2 m, h = 11.1 m) *Musa basjoo* (w = 4.2 m, h = 5.1 m) *Ficus benjamina* (w = 7.8 m, h = 10.5 m) Shrub layer: *Loropetalum chinense* var. rubrum Herbaceous plants: *Ophiopogon japonicus*, *Oxalis corniculata*	6.18	Tree layer: *Zelkova serrata* (w = 9.5 m, h = 12.3 m) *Musa basjoo* (w = 4.2 m, h = 5.1 m) *Ficus benjamina* (w = 7.8 m, h = 10.5 m) Cottomrose Hibiscus (w = 2.5 m, h = 3.8 m) Shrub layer: *Loropetalum chinense* var. rubrum, *Rhapis excelsa* Herbaceous plants: *Cynodon dactylon*, *Zoysia japonica*	7.44

Table 5. Plant configuration of the original site and optimized site of road green space option 1.

Original site planting	GPR	Post-design site planting	GPR
Tree layer: *Celtis sinensis* (w = 5.2 m, h = 12 m), Fragrant Olive (w = 5.2 m, h = 4 m), Japanese Flowering Cherry (w = 4.1, h = 6.1 m), Chinese Fan-Palm (w = 6.3 m, h = 8.9 m), Gingko (w = 7.4, h = 12.7 m) Shrub layer: *Lonicera japonica*, *Heptapleurum arboricola*, *Alocasia odora* Herbaceous plants: *Cynodon dactylon*, *Zoysia japonica*	7.1	Tree layer: *Celtis sinensis* (w = 5.2 m, h = 12 m), Loquat (w = 5.1 m, h = 3.5 m), Fragrant Olive (w = 5.3 m, h = 4 m), Japanese Flowering Cherry (w = 4.3 m, h = 5.9 m), Chinese Fan-Palm (w = 6.1 m, h = 8.9 m), Gingko (w = 7.1 m, h = 11.5 m) Shrub layer: *Lonicera japonica*, *Heptapleurum arboricola*, *Alocasia odora*, *Pittosporum tobira* Herbaceous plants: *Cynodon dactylon*, *Zoysia japonica*	7.78

Table 6. Plant configuration of the original site and optimized site of road green space option 1.

Original site planting	GPR	Post-design site planting	GPR
Tree layer: Gingko (w = 7.5 m, h = 13 m), *Cinnamomum bodinieri* (w = 9.3 m, h = 12.1 m), *Magnolia heptapeta* (w = 4.5 m, h = 6.8 m), Fragrant Olive (w = 5.2 m, h = 4 m), Bull Bay (w = 5.4 m, h = 9.5 m) Shrub layer: *Ligustrum sinense*, *Ligustrum japonicum*, *Buxus megistophylla* Herbaceous plants: *Cynodon dactylon*, *Zoysia japonica*	1.91	Tree layer: Gingko (w = 7.4 m, h = 12.6 m), *Cinnamomum bodinieri* (w = 9.0 m, h = 12.1 m), *Magnolia heptapeta* (w = 4.5 m, h = 6.8 m), Fragrant Olive (w = 4.6 m, h = 3.5 m), *Cinnamomum japonicum* (w = 4.5 m, h = 9.0 m) Shrub layer: *Lonicera japonica*, *Ligustrum japonicum*, *Ligustrum sinense*, *Photinia serratifolia*, *Phoenix roebelenii* Herbaceous plants: *Ruellia simplex*, *Cynodon dactylon*, *Zoysia japonica*	3.3

Table 7. Plant configuration table for the original site and optimized site of Public Service Facility Green Space Option 1.

Original site planting	GPR	Post-design site planting	GPR
Tree layer: *Ficus benjamina* (w = 7.5 m, h = 10.6 m), Fragrant Olive (w = 5.2 m, h = 4.3 m), Japanese Flowering Cherry (w = 4.2 m, h = 5.9 m), Shrub layer: *Loropetalum chinense* var. rubrum, *Viburnum odoratissimum*, *Pseudosasa japonica* Herbaceous plants: *Cynodon dactylon*, *Ophiopogon bodinieri*, *Ruellia simplex*	3.38	Tree layer: *Ficus benjamina* (w = 7.5 m, h = 10.6 m), Fragrant Olive (w = 5.2 m, h = 4.3 m), Japanese Flowering Cherry (w = 4.1 m, h = 5.7 m), Japanese Maple (w = 2.7 m, h = 2.9 m), Variegated Coral Tree (w = 8.5 m, h = 9.5 m) Shrub layer: *Loropetalum chinense* var. rubrum, *Viburnum odoratissimum*, *Pseudosasa japonica* Herbaceous plants: *Cynodon dactylon*, *Zoysia japonica*	4.6

5. Discussion

There are many regional characteristics in the research objectives of LAI determination of commonly used regional plants in Chongqing. In this study, the LAI of a variety of commonly used regional plants in Chongqing was not measured for four seasons: spring, summer, autumn, and winter. Whether there are significant differences in the LAI of regional plants in spring, summer, and autumn, and whether they exhibit regional characteristics due to the fact that Chongqing regional plants are in a more suitable and constant temperature environment.

6. Conclusion

Based on the three-dimensional index GPR, the common trees of Chongqing Native Plant List were used as the research object to investigate and measure the plants in Chongqing residential district, and the plant leaf area index table was derived. The four types of green areas in Chongqing Banan District were optimized with reference to the definition of green area nature and the construction drawings of the district design to improve the ecological benefits of the site and create a green low-carbon ecological landscape. The GPR can reflect the structure of green space community and is closely related to the function of residential community. Through the discussion of GPR of residential community, it provides reference and reference for the future planning and construction of residential community green space in Chongqing.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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