

Spatial Characteristics Analysis and Landscape Evaluation of Ancient Tree Resources in Changning City based on ArcGIS Method

LIU Ti¹, HE Xinye², WANG Yi³, CHEN Zheng^{4*}

(1. Hengyang Normal University, Nanyue College, Hengyang, Hunan 421002, China; 2. The Party Propaganda Department of Changsha Medical College, Changsha, Hunan 410219, China; 3. School of Computer Science and Mathematics, Central South University of Forestry, Changsha, Hunan 410004, China; 4. Business School, Hunan University of Technology, Hengyang, Hunan 421002, China)

Abstract Ancient and famous trees, known as “green cultural relics”, are precious natural and cultural heritage. In order to further grasp the basic characteristics of ancient tree resources in Changning city, understand their spatial distribution, and specifically identifying the environmental factors that significantly influence the distribution of ancient trees, the investigation and analysis of ancient and famous tree resources in Changning City were carried out. ArcGIS tools and map technology were used to establish three databases corresponding to ancient trees, scenic spots and road networks, to analyze the composition and distribution characteristics of ancient tree resources and explore the relationship between geographical factors and the distribution of ancient trees. The results show that there are 489 ancient trees in Changning City, belonging to 27 families, 43 genera and 62 species. According to the type and structure characteristics of ancient trees, there are 30 first-class ancient trees, 73 second-class ancient trees and 386 third-class ancient trees in Changning. According to the habitat and growth characteristics of ancient trees, 306 trees were distributed on the flat slope, 131 on the gentle slope and 21 on the slope. There are obvious differences in the distribution density of ancient trees in Changning City and the dominant species of ancient trees in 18 towns (streets) in Changning City are camphor trees. Then kernel density analysis tool and ArcGIS were comprehensively applied to analyze and evaluate the landscape value of ancient trees in Changning. Based on the resulting ancient tree resource data, landscape evaluation was carried out, formulating a scientific and reasonable scheme, thereby enabling a more vivid presentation of the landscape value of ancient trees in Changning City.

Keywords Changning City, Ancient and famous trees, Map technology, ArcGIS

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The resources of ancient trees can usually reflect the quality of an ecological environment. Therefore, in recent years, scholars such as Zou Chang (2027)^[1], Zhu Kun (2020)^[2], Liu Dawei (2020)^[3], Li Maolin (2021)^[4], Hu Ying (2021)^[5], Cheng Yongquan (2021)^[6] and Zou Yiqiao (2022)^[7] have frequently used ancient tree resources as a basis for evaluating habitats. They have conducted quantitative analyses of factors related to species characteristics and have carried out extensive summarizing research on the genus and species information of ancient trees in Changning City. Although in-depth research has conducted on the characteristics of ancient trees, there is still a lack of comparative analysis integrating multiple features, especially the analysis concerning the landscape value, tree age and diameter at breast height (DBH) of ancient trees in Changning City. Geographic information system (GIS for short) has important value in processing geographic information. ArcGIS is a practical application development software, favored by users with complete functions, and the application rate is significantly higher than other types of GIS software. Spatial analysis requires the construction of extensive databases.

By combining the numerical characteristics reflected by the research objects in various geographical locations, ArcGIS offers many functional modules and features a user-friendly interface interaction, leading to its widespread application today. This software can be used to analyze the numerical characteristics of the target in each geographical location and select the corresponding analysis mode to deeply analyze how the characteristics of the object can be changed under the interference of various factors, which can not only yield scientific conclusions but also provide evidence for informed decision-making^[8]. Based on the field investigation data, this study applied data statistical analysis and ArcGIS method respectively to carry out detailed spatial analysis on the specific sampling factors related to Changning's ancient trees, such as the species, structure, age and spatial distribution.

1 Factor analysis of ancient tree resources

Ancient trees have rich landscape attributes, enabling them to well reflect the characteristics of plant landscape in a region. With exceptionally

high ornamental value, they can well meet the ornamental and tourism requirements of different groups. As a tourism resource, ancient trees are increasingly gaining attention gradually developing into a new form of tourism industry. Changning City boasts abundant ancient tree resources, which are of high potential for utilization, yet they also face severe threats. Therefore, it is particularly important to study the landscape characteristics of the ancient tree resources in Changning. In this paper, based on the ArcGIS spatial analysis module, the sampling factors were determined by combining the collected data of ancient tree resources in Changning City and the existing conditions in the development of ancient tree resources, which involved resource agglomeration and ancient tree density. In the process of analysis, ArcGIS software was selected to analyze each factor in a quantitative way to understand the specific characteristics of ancient tree resources^[9].

1.1 Density of ancient trees

The number of ancient trees in a certain range is the density of ancient trees. A higher number of ancient trees indicates greater density. The specific distribution pattern of ancient trees

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* Corresponding author.

in the Changning shows that the distribution of ancient trees is not concentrated and are mostly scattered. Therefore, when developing landscape development, it is necessary to choose areas with higher density of ancient trees, which can better meet the scale requirements and also contributes to improving the overall landscape value.

1.2 Source market

The source market directly determines the economic value of scenic spots, and tourists are of vital significance to scenic spots. The scale of tourist source market can directly affect the popularity of scenic spots, and variations in popularity, in turn, lead to differences in its appeal to tourists.

1.3 Location traffic

The influence of traffic on people's travel is obvious. Convenient traffic can significantly shorten the time and psychological distance between people and the scenic spot. It can be said that the location traffic directly determines the appeal of scenic spots to tourists to a certain extent. Therefore, traffic conditions are a key factor to be considered in the development of tourism. Networks of water, land and air transport all significantly influence the accessibility. From the city's traffic situation of the city, the land transport network is an important factor.

1.4 Resource agglomeration

Resource agglomeration refers to the number of scenic spots within the specified range. In general, a greater concentration of scenic spots in a region enables a better fulfillment of the tourists' experiential demand. With more activities to play in a smaller space and time, the satisfaction of tourists will be significantly increased.

The analysis of sampling factors of ancient tree resources shows that when these four factors are satisfied at the same time, the utilization value of ancient tree resources can reach a relatively ideal state, but it is not conducive to the protection of ancient tree resources. For example, in order to better develop and utilize these ancient tree resources, it is generally necessary to harden the ground, and thus the habitat will be changed. Furthermore, with the expansion of the source market, the disturbance caused by tourist activities will also increase significantly. Therefore, it is necessary not only to evaluate the tourism value of ancient trees objectively but also to take them as key protection objects.

2 Data collection and vector database construction

2.1 Data collection

To meet the research requirements, the

data on local ancient tree resources, location traffic and scenic spots were collected in detail during the research process. The collection of data mainly came from three ways: the first was through the field investigation of the research group, the website portal of Changning government at all levels, and the collection of forestry, tourism and other relevant departments; the second was by using the "Shui Jing Zhu" software; the third was to obtain the historical and folk related information by consulting the historical documents such as the local Chronicles of Changning City. The basic data of ancient trees involved mainly include satellite pictures of the city, tourism resources, transportation maps, as well as family species, longitude and latitude coordinates of ancient trees. In this paper, these data were processed with statistical analysis and appropriate extraction, so as to carry out research on the resource exploitation of ancient trees in Changning and provide support for the formulation of a landscape value evaluation scheme of ancient trees in Changning.

2.2 Vector database construction

2.2.1 Satellite map of Changning City. The "Shui Jing Zhu" software was used to convert the satellite map of the city into a TIF format file. Then the satellite map was imported into the ArcGIS10.5, and the administrative boundary lines of each town were drawn after processing through the corresponding editor. The details are shown in Fig.1.

2.2.2 Changning City ancient tree longitude and latitude. Statistical analysis was made on the longitude and latitude data of ancient trees in Changning City by adding XY data key in the spreadsheet EXCEL 2007. The ArcGIS 10.5 software was used to upload the data to the satellite image, obtaining the distribution map of ancient trees as shown below. First, second, and third-class ancient trees were represented by red, blue and green respectively.

2.2.3 Traffic map of Changning City. The traffic map of Changning City was imported into ArcGIS 10.5 for registration with the satellite map, and calibrated with reference to the satellite map. Based on the traffic map, roads with different attributes were mapped using the editor tools in ArcGIS, such as expressways, national highways, provincial highways, as well as township road and village road (Fig.3). The map was subsequently used to analyze the correlation between ancient trees and transportation infrastructure. In the map, yellow lines represents expressways; red and green lines correspond to the national and provincial highways, respectively; blue lines are the township and village roads.

2.2.4 Distribution of main scenic spots in Changning City. In the research process, Google Maps was used to search for the scenic spots, obtaining their latitude, longitude and scope. The XY data keys and add keys were used to determine the location of the scenic spots, and then the editor tool was used to edit the map, finally obtaining the boundaries of corresponding scenic spots, which were then used to study the relationship between ancient trees and resource agglomeration. According to the statistical data,, the primary scenic spots in Changning city include the following 10 major tourist attractions: Dayi Mountain Nature Reserve, Paradise Lake National Wetland Park, Former Site of Shuikou Mountain Workers' Club Site, Ancient City Wall Ruins, Former Site of Changning County's 13th District Peasants' Association, Liaojiashangwan Ancient Folk House, Changning Farmers' Association Site group, Zhongtian Ancient Architectural group, Xijiang Rafting, China Seal Mountain.

3 Analysis on factors affecting ancient tree resources in Changning City and suggestions on protection measures

3.1 Kernel density estimation of ancient tree

Kernel density estimation is used to characterize the spatial distribution of an object. In the analysis process, it calculates the value per unit area based on the kernel function, fits and connects individual points, thereby generating a cone with a smooth surface^[10].

In this research, a comparative analysis was carried out to determine the output pixel of 306.78, and a radius of 2.5 km was set during the retrieval process. On this premise, Fig.5 was drawn to describe the density of ancient trees.

As is shown in Fig.5, there were 5 areas with a high density of ancient trees in Changning City and 24 sub-density areas. There were significant differences among different areas in this respect. In the high-density area, a total of 331 ancient trees were recorded, accounting for 17.45%. According to the age classification, there were 6 trees in the first class, 26 in the second class and 299 in the third class. The distribution density of ancient trees in this area is relatively high, which can meet the requirements of scale development and thus it has high development and utilization value^[11]. In terms of village distribution, the 5 high-density areas are located in Tashan Township, Xiling Town, and Yangquan Town, all of which enjoy relatively convenient transportation and high population flow. Among them, Tashan

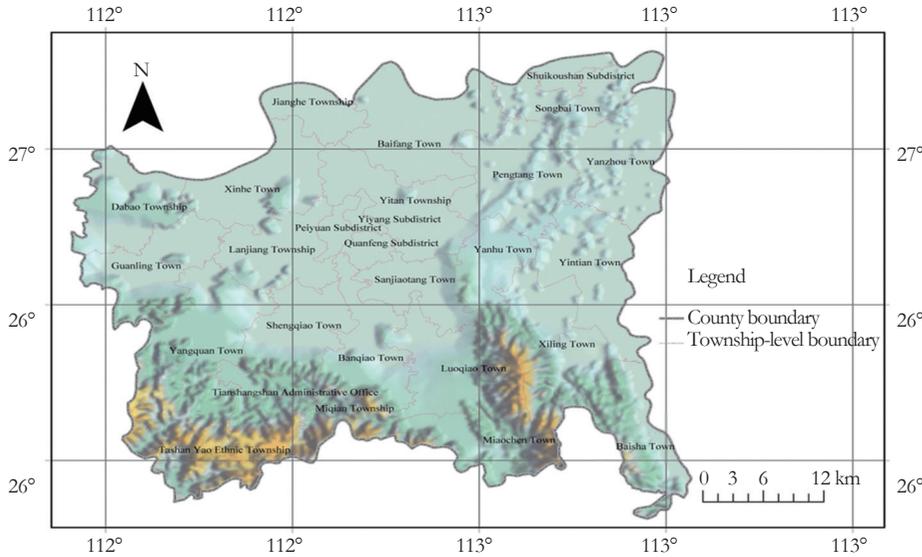


Fig.1 Satellite map of Changning City

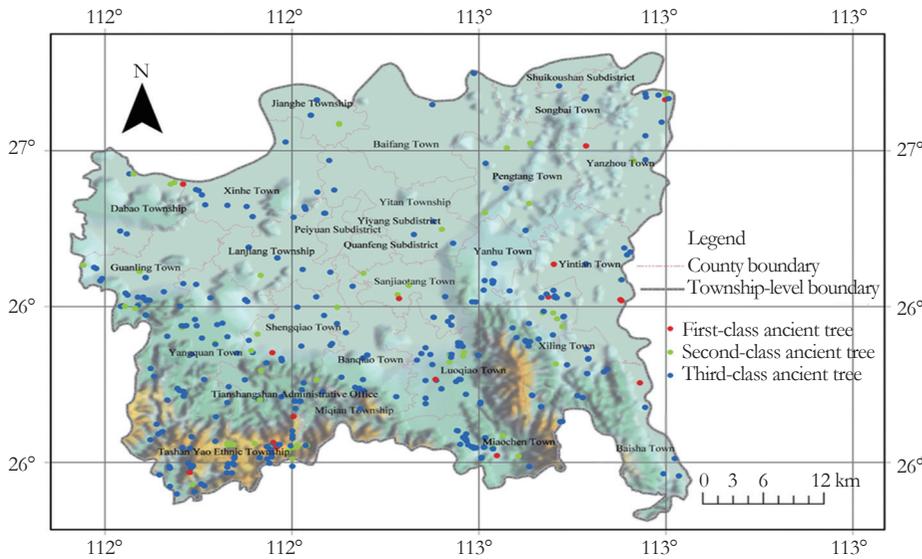


Fig.2 Distribution map of ancient trees in Changning City

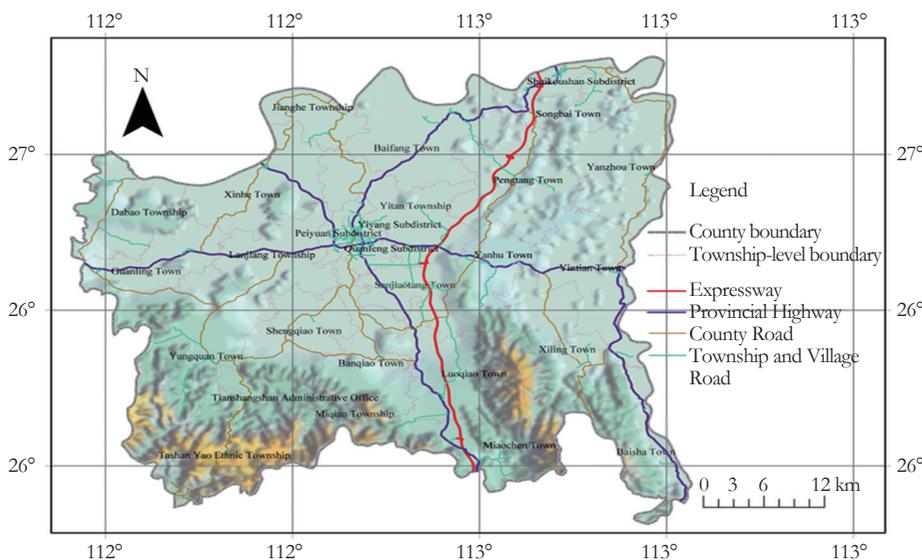


Fig.3 Main traffic network diagram of Changning City

Township is a key township in Changning City, known for its long history, rich culture and developed economy. Xiling Town boasts abundant cultural resources and has produced many scientists and senior generals, earning it the reputation of a “land of culture”. Yangquan Town is home to many ancient villages with a favorable climate and rich natural resources, and it has long been recognized as the historical and cultural village of Changning. Banqiao Town, with its long history, outstanding people and beautiful scenery, attracts a large number of tourists every year for leisure and entertainment. Tashan Township is also noted for its deep cultural heritage, with diverse and unique topographical features, fresh air, well-developed forests, water and lake resources. Therefore, it is evident that the high-density areas of ancient trees in Changning City possess solid foundational conditions for landscape development.

3.2 Buffer analysis of main roads in Changning City

Buffer analysis mainly involves constructing buffer polygons in a specific range near the scenic spot.

There are mainly six types of roads in Changning City, ranging from high-level expressways and national/provincial highways to low-level township and village roads, each with different transport capacities. Correspondingly, the buffer radius varies with the type of roads: 1,500 m for expressways and national highways, 1,000 m and 500 m for the provincial and city, respectively, only 100 m for the township roads. In this study, the ancient tree data were clipped to generate the map (Fig.6). Statistical analysis of the layer attributes revealed that over 1,300 ancient trees, accounting for 70.69% of the total, are located within these road buffer zones. Specifically, the numbers of the first class, second class and third class ancient trees within the buffers are 22,213, and 1,103, respectively. The traffic analysis showed that the proximity of these ancient trees to roads facilitates tourist access and enhances their potential tourism development value. However, future development in these areas may also pose challenges, such as ground surface hardening and reduced soil permeability, which could adversely affect the trees’ growth conditions. This problem is even more pronounced if the trees are located in the buffer zones of village and township roads.

The analysis on the buffer area of 6 types of roads suggests significant differences in the number of ancient trees located in different buffers: 46 ancient trees are located in the buffer

area of highways, accounting for 3.43% and comprising 1 tree of the first class, 5 of the second class and 40 of the third class; there are 433 ancient trees falling in the buffer zone of the national highway, accounting for 32.29%, and 4 trees of the first class, 7 of the second class and 356 of the third class. Statistical analysis showed that there are about 244 ancient trees in the buffer zone of the provincial highways, accounting for 18.19%, which contain 1 tree of the first class, 34 of the second and 209 of the third class. There were more than 600 ancient trees in the city buffer zone, accounting for 45.94%, and the number of ancient trees in the first, second and third class is 9, 90 and 514, respectively. According to the relevant data, there are 324 ancient trees in the township road buffer zone, accounting for 24.16%, and the number in the first, second and third class is 9, 55 and 260 respectively; 59 ancient trees are in the buffer zone of the village road, accounting for 4.40%, and the number of trees in the first, second and third class are 2, 15 and 42, respectively. Therefore, the distribution area of ancient trees in the study area is relatively concentrated, mainly along the city roads. The main reason is that there are more roads of this type in Changning City, and they are distributed in a larger scope.

3.3 Buffer analysis of resource agglomeration in Changning City

Based on the municipal government's "14th Five-Year Plan" for the development of the tourism industry and the existing tourist attractions planning, Changning City currently has a total of 10 scenic spots. In the process of research, 10 km was set as the buffer radius, and the obtained data was graphed to get Fig.7. Specific analysis of this figure shows that there are 1,072 ancient trees located within the resource agglomeration buffer zone, constituting a significant proportion of 56.51%. Among these ancient trees, there are 30 first-class ancient trees, 73 second-class ancient trees and 386 third-class ancient trees. As is shown in Fig 7, these ancient trees show high resource agglomeration, and their characteristics are obviously different from the types of scenic spots, indicating that the effect can be improved by means of regional resource combination. Notably, most of the ancient trees are located in the southwestern part of the city, a distribution pattern correlated with the higher density of scenic areas in that area.

Further investigation reveals that 230 ancient trees are in the buffer zone of Xiangshan Temple, accounting for 21.46%^[12], which includes 4 first-class, 35 second-class and 191 third-class ancient trees. There are a total of 136 ancient

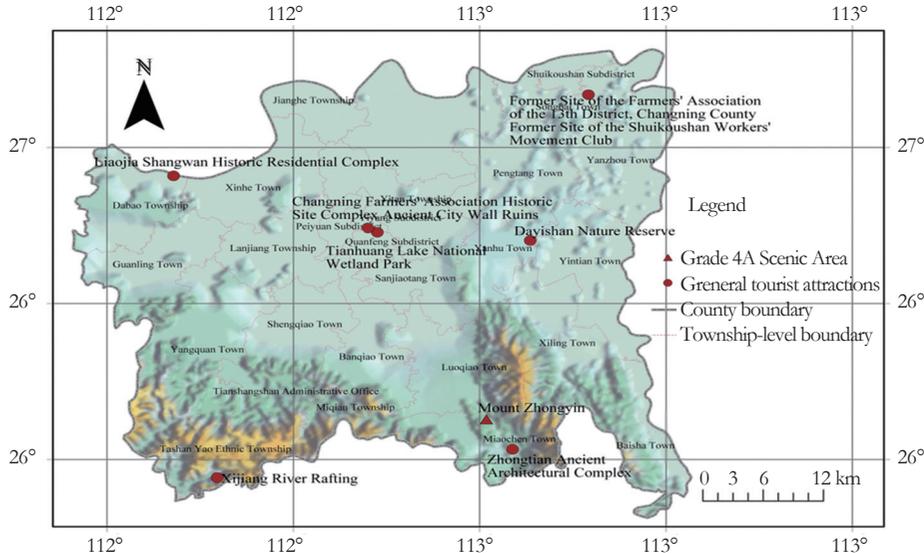


Fig.4 Main scenic spots diagram of Changning City

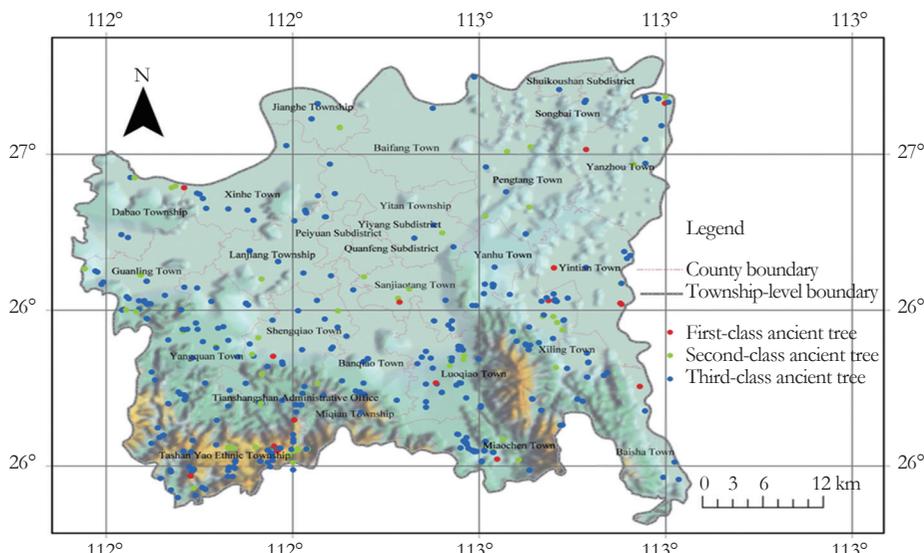


Fig.5 Distribution map of ancient trees in Changning City

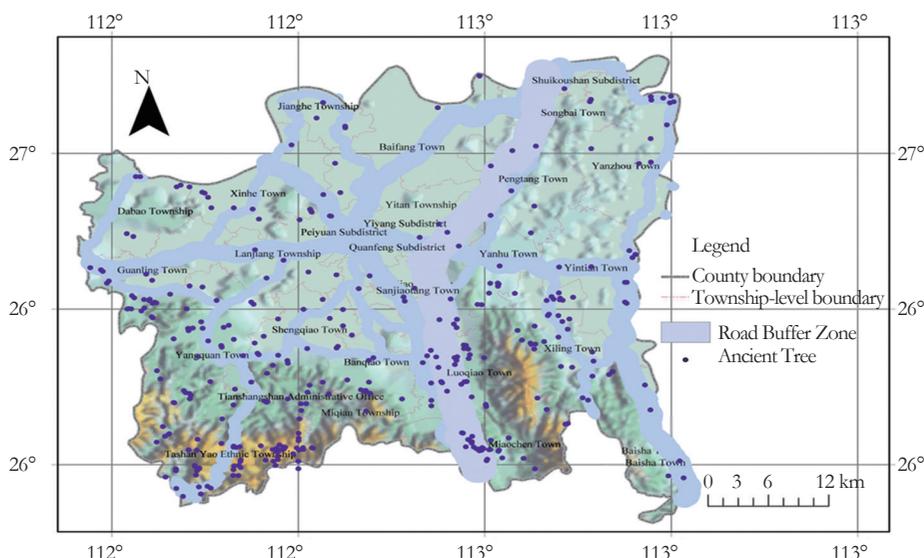


Fig.6 Road buffer analysis diagram of Changning City

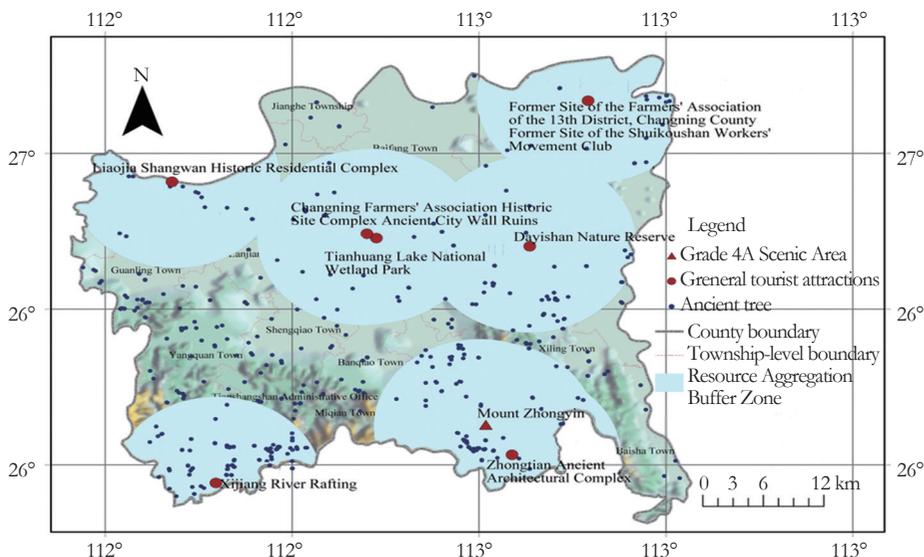


Fig.7 An analysis figure of resource agglomeration buffers in Changning City

trees in the buffer zone of Tashan Folk Custom Museum accounting for 2.69% of the total, and there is 1 one super-class ancient tree, 3 first-class, 21 second-class and 111 third-class ancient trees, respectively. There are 256 the ancient trees located in the buffer zone of Banqiao, accounting for 23.88%, and the number for the first, second and third-class ancient trees is 1, 34 and 221, respectively. A total of 238 ancient trees are located in Yinshan buffer zone of China, accounting for 22.20%, and the number for the first, second and third-class ancient trees is 9, 38 and 191, respectively. The Miaoqian buffer zone contains 354 ancient trees with a corresponding proportion of 33.02%, and the number of ancient trees in the first, second and third class is 5, 53 and 296, respectively. Baisha buffer zone contains 145 ancient trees, accounting for 13.53%, and the number of first, second and third-class ancient trees is 6, 20 and 119, respectively. There are 66 ancient trees distributed in the ecological buffer zone of Tiantan Lake with the corresponding proportion of 6.16%, and the number of ancient trees in the first, second and third classes is 2, 12 and 52, respectively. There are 69 ancient trees of this type distributed in the buffer zone of Yinshan, China, corresponding to 6.44%, and the corresponding number of first, second and third-class ancient trees is 2, 22 and 45, respectively. The number of ancient trees in the buffer zone of Shuikou Mountain scenic area is 326, accounting for 30.41%, and the number of ancient trees of the three classes is 10, 63 and 253, respectively. The number of ancient trees the buffer zone of Xiangshan Temple is 29 with the corresponding proportion of 2.71%

and the number of ancient trees of these three classes is 2, 10 and 17, respectively. There are 31 ancient trees distributed in the buffer zone of Tianhu Lake in Hengyang, accounting for 2.89%, and the number of ancient trees in these three classes is 1, 12 and 18, respectively. In the buffer zone of Xijiang Rafting, 310 ancient trees of this type are distributed, accounting for 28.92%, and the number of these three types of ancient trees is 5, 46 and 259, respectively. Comparing the above results reveals that the number of ancient trees near the old site of the resistance battle in front of the temple is significantly higher than that of other scenic spots, which also shows higher aggregation of ancient trees, followed by Shuikou Mountain scenic spot while the lowest is found in the Xijiang rafting buffer zone. However, based on extensive empirical experience, it is generally observed that a high agglomeration of ancient tree resources often correlates with a more profound impact on the habitat of ancient trees in the development process of nearby scenic spots.

4 Conclusion and discussion

4.1 Conclusion

Based on the latest correction data of ancient and famous trees in Changning City, the characteristics of ancient tree resources in Changning City are analyzed empirically. On the one hand, this study has important reference significance for Changning City to formulate feasible protection and development policies of ancient tree landscape value; on the other hand, it has theoretical guiding significance for the evaluation of ancient tree landscape value in similar areas. Other areas with similar

features can refer to the paradigm and statistical analysis of ancient tree characteristics in this paper to conduct objective and scientific evaluations of various features like the species characteristics, structural characteristics (DBH, tree height, crown width), correlation between tree age and tree growth structure, tree age characteristics, ownership characteristics and spatial distribution characteristics of local ancient tree resources. Imported with the longitude and latitude coordinates and class information of ancient trees, ArcGIS, is able to generate the spatial distribution map of local ancient trees. In addition, this study also helps to arouse the public's attention to the potential value of ancient tree resources and has practical guiding significance for timely discovering problems and formulating scientific cultivation measures for reserve resources, and promoting the protection and reasonable development of ancient tree resources^[13]. The results show that there are 489 ancient trees in Changning City, belonging to 27 families, 43 genera and 62 species. There are 27 families of ancient trees in Changning City, and the dominant families are Lauraceae, Fagaceae and Euphorbiaceae, with 189, 49 and 44 trees respectively. The dominant genera are Cinnamomu, Bischofia and Liquidambar, with the numbers of 182, 31 and 25, respectively. The dominant species are camphor tree, Chinese sweet gum and bischofia polycarpa, with 182, 39 and 31 trees respectively

The analysis of the type structure characteristics of the ancient trees in Changning city shows that the ancient trees in Changning city are relatively young in general, with 9 ancient trees aged 700–899 a, 21 aged 500–699 a, 73 aged 300–499 a, and 386 aged 100–299 a. There are 30 first-class ancient trees, 73 second-class ancient trees and 386 third-class ancient trees in Changning City. The average DBH, height and crown width of ancient trees in Changning City are 95.86 cm, 16.92 m and 11.67 m respectively.

The analysis of the habitat and growth status of ancient trees in Changning City shows that 306 trees are distributed on flat slopes, 131 on gentle slopes and 21 on slopes. In terms of soil type, 103 trees grow in red soil, 310 in yellow soil, and 76 in purple soil. As for altitude, 378 trees are distributed at an altitude of 0–200 m, 65 at an altitude of 201–400 m, 30 at 401–600 m, and 16 at 601–800 m. Concerning the locations, 8 trees grow in urban areas, 133 in rural streets, and 348 in remote suburban and wild areas^[14]. As for the status, 476 ancient trees are in normal condition, 1 is transplanted, 8 are damaged, and 4 are newly added. In terms of growth vigor,

472 trees are of normal growth, 14 show weak growth and 3 are endangered.

The spatial distribution characteristics of ancient trees in Changning City are as follows: There are 5 ancient trees in Baisha Town of Changning City, 10 in Baifang Town, 29 in Banqiao Town, 9 in Dabao Town, 30 in Guanling Town, 7 in Lanjiang Town, 32 in Luoqiao Town, 38 in Miaoqian Town, 2 in Peiyuan Sub-district Office, 15 in Pengtang Town, 4 ancient trees in Quanfeng Sub-district office, 22 in Triangtang Town, 18 in Shengqiao Town, 8 in Shuikoushan Town, 72 in Tashan Township, 6 in Tiantangshan Office, 76 in Xiling Town, 22 in Xinhe Town, 12 in Yanzhou Town and 33 in Yangquan Town., 7 in Yitan District, 4 in Yiyang Sub-district office and 28 in Yintian Town.

The findings of the analysis of the dominant species of ancient trees in the towns of Changning City shows that camphor tree is the dominant species of ancient trees in 18 towns (subdistricts) of Changning City , and the other dominant species of ancient trees are Guizhou Photinia (2) from Lanjiang Township, Chongyang wood (12) from Luoqiao Township, Southern yew (15) from Tashan Township, sweet clover (2) and evergreen chinquain (2) from Tiantangshan District Office, Chinese honey locust (5) from Xinhe Town and Minnan (4) from Yiyang District Office.

4.2 Discussion

This study focuses on the ancient trees in Changning City. Based on the survey of ancient and famous tree resources in Changning City and the need for ArcGIS analysis of the current situation of ancient tree resources in Changning City, we have researched, designed and developed the ancient tree resource database system based on ArcGIS and built the overall framework for the ancient tree resource database system in Changning City on the whole, finally setting up a reasonable logical structure for the database. Using ArcGIS technology for operation and processing, it is essential to specify the technology be applied to each module to

achieve the preset functions. Based on these, a meticulous design plan has been formulated with the fundamental goal of developing ancient tree resources and improving the utilization rate of these resources, forming a reasonable development approach. The system is highly operable, preparing for technological upgrades and expansion. It is also robust in terms of maintenance and holds significant reference value for the future protection, development, and utilization of ancient tree resources in Changning City. The integration of database and ArcGIS technology is undoubtedly a major breakthrough in the research field in China, with a strong sense of innovation that will lead to broad prospects for development^[15].

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