Legacy Characteristics of Ancient Trees in Areas with Different Urbanization Levels in Yunnan Yi Ethnic Regions (Postprint)

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Abstract

Urbanization development exerts significant impacts on both ethnic minority cultures and the natural environments that nurture these cultures. Ancient trees, preserved under human cultural influence, are thus hailed as "green cultural relics" and serve as crucial evidence for scholars investigating regional vegetation and ethnic cultural transformations. To explore how the impacts of urbanization on minority cultures manifest in regional characteristics of ancient tree legacies, this study investigates ancient tree resources across seven towns/townships forming an urbanization level gradient in the basin area of Chuxiong City, Yunnan Province, a primary settlement area of the Yi ethnic group. The results indicate: (1) The Chuxiong City basin area harbors 301 ancient trees belonging to 16 families, 22 genera, and 26 species, yet Pistacia chinensis, Platycladus orientalis, and Camellia reticulata account for over 75% of the total. (2) Lucheng Town and Donggua Town, with the highest urbanization rates, and Ziwu Town, with the lowest urbanization rate, exhibit higher ancient tree species diversity, but these are concentrated in temples, schools, and parks. (3) The species composition and spatial distribution in Lucheng and Donggua Towns demonstrate characteristics of external cultural influence, whereas Ziwu Town has preserved more primary vegetation of the Yi "sacred forest". (4) Townships with higher proportions of Yi population did not possess greater ancient tree diversity or retain more traditional "sacred trees". During urbanization development, ethnic minority cultures face the dilemma of gradual loss; studying the compositional and spatial distribution characteristics of ancient trees holds significant importance for strengthening ancient tree protection and enhancing ethnic cultural heritage.

Full Text

Characteristics of Ancient Trees in Areas with Different Urbanization Levels in Yi Ethnic Regions of Yunnan Province

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Abstract

Urbanization development exerts significant impacts on minority cultures and the natural environments that nurture them. Ancient trees, preserved through human cultural influences and revered as "green cultural relics," serve as crucial resources for studying regional vegetation dynamics and cultural changes in ethnic communities. To explore how urbanization affects minority cultures through the lens of ancient tree preservation, we investigated ancient tree resources across seven towns forming an urbanization gradient in the Chuxiong basin area, a primary settlement region of the Yi people in Yunnan Province. Our findings reveal: (1) A total of 301 ancient trees were recorded, belonging to 26 species, 22 genera, and 16 families, with *Pistacia chinensis*, *Platycladus orientalis*, and *Camellia reticulata* comprising over 75% of all individuals. (2) Lucheng Town and Donggua Town (highest urbanization rates) and Ziwu Town (lowest urbanization rate) exhibited higher ancient tree species diversity, with trees concentrated in temples, schools, and parks. (3) Species composition and spatial distribution in high-urbanization towns reflected foreign cultural influences, while low-urbanization Ziwu Town retained more native vegetation characteristic of traditional Yi "sacred forests." (4) Towns with higher Yi population proportions did not necessarily possess greater ancient tree diversity or more traditional "sacred trees." These results demonstrate that minority cultures face gradual erosion during urbanization, and studying the composition and distribution patterns of ancient trees is essential for strengthening both tree conservation and cultural heritage preservation.

Keywords: urbanization rate, ancient trees, species diversity, distribution characteristics, ethnic culture

Introduction

Natural environments and biological resources constitute the "cradle" of human culture formation and development. Specific biodiversity nurtures adapted cul-

tural practices, while cultural evolution reciprocally influences the types, composition, and structure of environmental and biological diversity (Mcneely et al., 1990; Wang et al., 2004). Ancient trees, defined as trees over 100 years old preserved through human cultural influence (Measures for the Protection and Administration of Ancient and Famous Urban Trees, 2000), represent valuable resources for investigating regional vegetation and cultural changes. Yunnan, a primary settlement area for minority groups, has witnessed the development of unique plant worship concepts among various ethnic minorities through long-term adaptation and utilization of nature. Under the influence of "sacred tree" and fengshui forest beliefs, many ancient trees have been preserved, providing important evidence for scholars studying regional vegetation and cultural transitions (Tian et al., 2018; Huang et al., 2020).

Urbanization refers to the natural historical process of transforming traditional rural societies into modern urban societies, representing an inevitable outcome of social development (Xie et al., 2006). Changes in land use types, increased population density, and rising per capita GDP are key manifestations of urbanization, and studies on ancient trees in some central and eastern Chinese cities have confirmed that these factors influence the quantity and diversity of preserved ancient trees (Yang et al., 2022; Li et al., 2021). However, in southwestern minority regions, ethnic culture constitutes another significant dimension of urbanization impacts (Jiao, 2014). Economic development and urban construction alter the nurturing environment for traditional culture, while the influx of foreign cultures challenges previously isolated ethnic traditions (Wang et al., 2004; Xie et al., 2006; Walker et al., 2009; Peng et al., 2012; Xu et al., 2014). As "green cultural relics," the composition and distribution characteristics of ancient trees not only reflect regional natural environments and vegetation features but also serve as important carriers transmitting local ethnic customs, living habits, and religious beliefs (Blicharska & Mikusiński, 2014; Lindenmayer & Laurance, 2017). Research on ancient tree resources and their ecological-cultural significance in minority settlement areas indicates that while these regions possess rich and symbolically unique ancient tree resources, their preservation and value change alongside social development and cultural transitions (Liu et al., 2000a; Tang et al., 2011; Tang et al., 2013; Tian, 2018; Huang et al., 2020; Yang et al., 2021). As China experiences rapid urbanization, whether the impacts of urbanization development on minority cultures manifest in regional ancient tree preservation characteristics remains insufficiently studied.

The Yi people represent one of China's most populous minorities, with the Chuxiong Yi Autonomous Prefecture serving as their primary settlement area in Yunnan. The Yi believe in animism, considering trees as providers of material resources and shelter for ancestors, thus venerating them as "sacred trees." Patches of sacred trees are called "Mizhi Forests" in the Yi language, with annual "Mizhi Festival" ceremonies held in the eleventh lunar month (Chuxiong Forestry Records, 1993; Liu et al., 2000b). This study focuses on seven towns in the Chuxiong basin area with significant urbanization level differences, investigating ancient tree resources to address: (1) How ancient tree composition,

diversity, and distribution characteristics vary across different urbanization levels in Yunnan Yi regions; (2) What impacts of urbanization development on minority cultures are reflected in preserved ancient tree characteristics, thereby clarifying relationships among urbanization, ethnic culture, and ancient tree preservation to establish conservation strategies rooted in minority cultural heritage.

1.1 Study Area Overview

Chuxiong City, the capital of Chuxiong Yi Autonomous Prefecture, has a Yi population of 115,597, accounting for 21.57% of the total registered population and 84.76% of the minority population (Chuxiong City Yearbook, 2019). As the political, economic, and cultural center of the prefecture and the earliest region to undergo urbanization, the Chuxiong basin area forms a clear urbanization gradient radiating from Lucheng Town (the municipal government seat) to surrounding towns, including Lucheng, Donggua, Lühe, Zixi, Donghua, Cangling, and Ziwu .

Urbanization level is typically characterized by population urbanization rate (urban population/total population) (Wang, 2019; Zhang, 1998). The urbanization rates and Yi population proportions for each town in the Chuxiong basin are shown in Table 1 (Chuxiong City Yearbook, 2019).

1.2 Ancient Tree Survey Methods and Evaluation Criteria

Following the *Technical Specifications for Identification of Ancient and Famous Trees (LY/T2737—2016)* and *Technical Specifications for Census of Ancient and Famous Trees (LY/T2738—2016)*, we conducted comprehensive surveys of ancient trees in the study area, recording species, age, coordinates, elevation, diameter at breast height (DBH), tree height, crown width, growth vigor, and habitat conditions. Ancient trees are classified into three levels based on age: first-level (over 500 years), second-level (300–499 years), and third-level (100–299 years). Growth vigor is categorized into four classes (normal, weak, endangered, dead) based on leaf, branch, and trunk conditions. Habitat conditions are classified into three grades (good, medium, poor) based on site conditions and human disturbance levels. As the survey specifications do not provide clear definitions for habitat grading, this study established detailed evaluation criteria based on previous research and local conditions .

Table 2 Habitat Assessment Criteria for Ancient Trees

Classification	Features
Good	Trees grow in natural or semi-natural environments (with minimal artificial facilities and human activities) where space, light, moisture, air, and soil conditions meet growth requirements, exhibiting normal vigor; or trees grow in artificial environments with protective measures ensuring adequate growth conditions and normal vigor.
Medium	Trees grow in semi-natural or artificial environments where basic growth conditions are met, but artificial facilities or human activities somewhat limit further growth, resulting in normal or weak vigor; unfavorable environmental factors can be relatively easily improved under these conditions.
Poor	Trees grow in semi-natural or artificial environments where growth conditions are inadequate, with artificial facilities or human activities severely limiting growth, resulting in endangered or dead vigor; unfavorable environmental factors are difficult to improve.

1.3 Analytical Methods

We employed redundancy analysis (RDA) to examine the distribution patterns of town-level ancient tree characteristics along explanatory variable gradients, using the "rda" function in the R package "vegan". Using ArcGIS 10.6, we converted Excel-formatted ancient tree records into point vector data. Administrative boundary spatial data for the

Chuxiong basin were obtained from the DataV.Geo Atlas platform (https://datav.aliyun.com/portal/school/atlas/area_{selector}), with all spatial data unified under the WGS-1984-UTM-Zone-47N projection. The nearest neighbor index was calculated using the Average Nearest Neighbor tool in ArcGIS 10.6 Spatial Statistics Toolbox to assess spatial clustering of ancient tree distribution points.

1.3.1 Relative Abundance and Species Diversity Index Calculation Relative abundance served as the plant characteristic value for RDA, calculated as follows (Zhang, 2004):

$$A_i = \frac{\text{Abundance of species } i}{\text{Sum of abundances of all species}} \times 100\%$$

Species richness was used to characterize species diversity (Ma, 1994):

$$G = \frac{S}{\ln A}$$

where S represents the number of species in the study area and A represents the study area size.

1.3.2 Nearest Neighbor Index Ancient trees can be abstracted as point features with three theoretical distribution patterns: random, uniform, and clustered, typically distinguished using the nearest neighbor index (R) (Zhang & Yang, 1991). The calculation formula is:

$$\bar{r}_E = \frac{1}{2\sqrt{m/A}} = \frac{1}{2\sqrt{D}}$$

where $\bar{r}_1$ represents the mean distance from each point to its nearest neighbor, $\bar{r}_E$ represents the theoretical nearest neighbor distance under random distribution, m represents the number of point features, A represents the study area size, and D represents point density per unit area. When $R = 1$, points tend toward random distribution; when $R > 1$, points tend toward uniform distribution; when $R < 1$, points tend toward clustered distribution.

2.1.1 Ancient Tree Species Composition

The survey recorded 301 ancient trees in the study area, including 7 first-level, 86 second-level, and 208 third-level trees, belonging to 26 species, 22 genera, and 16 families. The Fagaceae family contained the most species (4). *Pistacia chinensis* was the most abundant species, accounting for 59.23% of all individuals, followed by *Platycladus orientalis* (10.23%) and *Camellia reticulata* (5.65%). Other species were relatively scarce .

2.1.2 Ancient Tree Structural Composition

Statistical analysis of tree height, DBH, and crown width revealed that most ancient trees (49.17%) were 12–20 m tall. Trees with DBH of 64–127 cm were most common (51.16%), followed by those under 64 cm (38.89%). Crown width was predominantly 3–9 m (60.13%) [Figure 1: see original paper].

Growth conditions were generally good, with 283 trees (94.02%) exhibiting normal vigor, while 16 (5.32%), 1 (0.33%), and 1 (0.33%) were weak, endangered, and dead, respectively. Habitat quality was rated as good for 232 trees (77.08%), medium for 66 trees (21.93%), and poor for 3 trees (0.99%).

2.2.1 Ancient Tree Species Diversity

Lucheng Town had the most ancient trees (102 individuals, >30% of total), followed by Donghua Town (52), Zixi Town (42), and Cangling Town (41) at 13–17% each. Ziwu Town (23), Lühe Town (22), and Donggua Town (19) had fewer trees (~7% each). Species number and richness were highest in Lucheng Town, followed by Donggua and Ziwu Towns, while Cangling Town was lowest [Figure 2: see original paper]. Species composition varied significantly among towns, with Ziwu Town most distinct—its ancient trees were dominated by Fagaceae species (*Castanopsis delavayi*, *Lithocarpus dealbatus*, and *Cyclobalanopsis glaucoides*), which comprised ~48% of its total. The other six towns were dominated by *Pistacia chinensis* (31–98%). *Camellia reticulata* occurred in five towns (excluding Lucheng and Lühe), while *Platycladus orientalis* was most abundant in Lucheng Town.

Urbanization rates were highest in Lucheng and Donggua Towns (>75%), followed by Donghua Town (>20%), with Zixi, Cangling, and Lühe Towns >15%, and Ziwu Town lowest at 12.62%. Yi population proportions were highest in Donghua and Zixi Towns (>20%), followed by Cangling Town (>15%), with Lühe, Lucheng, and Donggua Towns >10%, and Ziwu Town lowest at 9.56%. RDA ordination showed that Axis 1 explained 25.59% of the distribution pattern, Axis 2 explained 15.54%, with cumulative explanatory power of 41.13% (significant at $P = 0.05$). Arrows for urbanization rate and Yi population proportion were relatively long, indicating strong explanatory power. The three towns with highest species number and richness occupied opposite ends of the urbanization gradient, with low-urbanization Ziwu Town distant from high-urbanization Lucheng and Donggua Towns, reflecting distinct species composition. However, towns with higher Yi population proportions (Zixi, Donghua, and Cangling) did not exhibit higher species numbers or richness [Figure 2: see original paper].

2.2.2 Spatial Distribution Patterns of Ancient Trees

ArcGIS mapping and nearest neighbor index analysis revealed clustered distributions in Lucheng, Donggua, Lühe, and Ziwu Towns, and uniform distributions

in Donghua, Zixi, and Cangling Towns [Figure 4: see original paper], . Habitat analysis showed Lucheng's trees primarily in schools (33.33%) and parks (27.45%), Donggua's in temples (57.89%), and Ziwu's concentrated in temples and adjacent forestland (78.26%), consistent with clustering indices. Schools in Lucheng (8 species) and temples in Donggua and Ziwu (6 species each) were the most species-rich habitats, collectively hosting 18 species (~69.23% of total) [Figure 5: see original paper].

3.1 Impacts of Urbanization on Ancient Tree Preservation and Distribution

The survey of seven towns in the Chuxiong basin recorded 301 ancient trees belonging to 26 species. *Pistacia chinensis* (Anacardiaceae) dominated numerically (58.75%), with *Platycladus orientalis* (Cupressaceae) and *Camellia reticulata* (Theaceae) collectively exceeding 75% of all individuals. Except for Ziwu Town, which was dominated by Fagaceae species, the other six towns showed highest proportions of *Pistacia chinensis*, while *Camellia reticulata* occurred in five towns and *Platycladus orientalis* was mainly distributed in Lucheng Town.

Liu et al. (2000a) conducted vegetation surveys in undisturbed Yi "sacred forests" in Chuxiong, documenting 21 tree species dominated by Fagaceae such as *Castanopsis delavayi* and *Cyclobalanopsis glaucoides*, representing regional primary forest vegetation. Although our study recorded more ancient tree species than these sacred forests, the species composition in six towns (except low-urbanization Ziwu) no longer reflected sacred forest characteristics. Historical records and local interviews revealed that forest resources in Yi areas suffered large-scale logging during cultural transformation movements before and after the founding of the PRC, with urbanization further accelerating primary vegetation destruction (Chuxiong Forestry Records, 1993; Lai, 2016).

Why then were *Pistacia chinensis*, *Platycladus orientalis*, and *Camellia reticulata* preserved in large numbers? Are they associated with Yi worship or customs? Research indicates that *Pistacia chinensis* is neither a traditionally worshipped species nor used in Torch Festival celebrations or residential construction (Liu et al., 2000b; Shan, 2015; Dong, 2017; Yang, 2022). We hypothesize that *Pistacia chinensis* is a pioneer species that established after primary forest clearing and land-use change, subsequently preserved under increasing Han Chinese influence and Confucian culture (Gao et al., 2015; Li, 2022). While *Platycladus orientalis* and *Camellia reticulata* symbolize "auspiciousness" and "love" in Yi culture (Liu et al., 2000b), their preservation was also influenced by foreign cultures—for example, 18 *Platycladus orientalis* individuals (58% of total) were found at the Chuxiong Confucian Temple within Lucheng Primary School, reflecting Confucian cultural identity.

Plant community homogenization is a widespread issue in China's urban green spaces, driven by shifting human preferences (Qian et al., 2016). In traditional life, minorities' daily needs directly sourced from nature, and various trees were

protected for different functions. However, urbanization reduced dependence on plants, while aesthetic or culturally singular preferences for certain species led to spatial dominance by few species, gradually diminishing regional native tree diversity and uniqueness.

High-urbanization Lucheng and Donggua Towns and low-urbanization Ziwu Town exhibited higher ancient tree diversity but clustered distributions, with highest species richness in temples, schools, and parks. Temples and schools serve as venues for religious and cultural activities and transmission, facilitating ancient tree protection (Jim & Zhang, 2013; Qiu et al., 2022). Zheng (2020) found higher ancient tree diversity in moderately populated counties nationwide, while Li et al. (2021) reported highest ancient tree density in high per capita GDP areas in Jiangsu Province. However, our results contradicted these patterns: moderately dense Lühe and Cangling Towns (ranking 3rd and 5th in population density) and high-GDP Zixi and Cangling Towns (ranking 1st and 2nd in per capita GDP) did not follow these trends, suggesting that culture may be a more important driver of ancient tree preservation in Yunnan's minority regions (Huang et al., 2020; Huang et al., 2021).

Investigation revealed that high species diversity in Lucheng Town's Lucheng Primary School (housing Chuxiong Confucian Temple) and Chuxiong No. 1 Middle School (formerly Longquan Academy) resulted from artificial planting of species with clear Confucian cultural characteristics such as *Platycladus orientalis*, *Sabina chinensis*, and *Lagerstroemia indica* (Zhao, 2021). Donggua Town's Chaoyang Temple and Ziwu Town's Wulong Temple both enshrine Yi indigenous and Buddhist deities, but Chaoyang Temple's ancient trees were mostly artificially planted with Buddhist-symbolic species (*Lagerstroemia indica*, *Osmanthus fragrans*, *Prunus mume*, and *Platycladus orientalis*) (Chen & Zhao, 2021). In contrast, Wulong Temple and its adjacent hillside retained a small, less-disturbed forest patch with ancient trees (*Castanopsis delavayi*, *Cyclobalanopsis glaucoides*, and *Lithocarpus dealbatus*) resembling primary forest characteristics, which local Yi elders identified as the remaining "sacred forest." Thus, although both high- and low-urbanization towns showed high diversity, the reasons differed: the former reflected strong foreign cultural influence with many artificially planted non-native species, while the latter retained more sacred forest vegetation due to limited foreign cultural input and land-use change. Notably, culturally significant species like *Pistacia weinmanniifolia* and *Ficus hookeriana* were rarely preserved, and towns with higher Yi population proportions (Zixi, Donghua, and Cangling) did not exhibit sacred forest characteristics, indicating gradual loss of Yi culture.

3.2 Ancient Tree Conservation from a Cultural Heritage Perspective

Urbanization disrupts traditional regional concepts through population mobility and information dissemination, enabling exchange and integration among minority, other ethnic, and modern cultures to form regional cultural pluralism. Simultaneously, modern lifestyles and foreign cultures weaken minorities'

cultural identity and belonging, with more pronounced cultural attenuation in higher-urbanization areas (Xie et al., 2006; Xu et al., 2014; Hu, 2017). This study confirms these findings: as urbanization increases, preserved ancient trees show diversified cultural characteristics, while traditional Yi "sacred tree" culture gradually erodes, posing an urgent challenge for effective cultural preservation.

Cultural heritage and ancient tree conservation are interconnected and mutually reinforcing. Centuries-old ethnic beliefs and clan regulations enhance public participation in tree protection, while strengthening tree conservation serves as a medium for awakening cultural consciousness. Practical approaches include landscape optimization and promotional activities. For example, improving tree habitats while incorporating Yi cultural elements—such as "tiger" and "fire" motifs in 图腾 or sculptures on tree protection fences—can create ethnic atmosphere. Information boards beside ancient trees can introduce Yi sacred tree legends, customs, and festivals, evoking reverence by recounting ancestors' plant connections. Furthermore, leveraging symbolic meanings for cultural activities, such as holding blessing ceremonies at schools where *Platycladus orientalis* (symbolizing "auspiciousness" in Yi culture) before college entrance exams, can bridge ancient and modern Yi culture through human-tree interactions.

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References

BLICHARSKA M, MIKUSINSKI G, 2014. Incorporating social and cultural significance of large old trees in conservation policy[J]. *Conserv Biol*, 28(6): 1558–1567.

CHEN X, ZHAO Y, 2021. A study on landscape art of Quanzhou Buddhist temple[J]. *Chin Overseas Arch*, (10): 133-138. [Chen Xi, Zhao Yang, 2021. Research on landscape art of Quanzhou Buddhist temple[J]. Chinese and Overseas Architecture, (10): 133-138.]

CHUXIONG LYJ, 1993. *Chuxiong Forest Industry Record*[M]. Dehong: Dehong People Press. [Chuxiong Municipal Forestry Bureau, 1993. Chuxiong Forestry Records[M]. Dehong: Dehong Nationalities Publishing House.]

CHUXIONG Office of Local Chronicle Compilation Committee, 2019. *Chuxiong City Yearbook (2019)*[M]. Dehong: Dehong People Press. [Chuxiong City Local Chronicles Compilation Committee Office, 2019. Chuxiong City Yearbook (2019)[M]. Dehong: Dehong Nationalities Publishing House.]

DONG B, 2017. Research on the design and development of traditional Yi residential buildings in Chuxiong district[J]. *Art Ed*, (23): 180-181. [Dong Bin,

2017. Research on the design and development of traditional Yi residential buildings in Chuxiong district[J]. Art Education, (23): 180-181.]

GAO Y, MENG FX, ZHU KS, et al., 2015. Characteristics of main plant populations and communities in Konglin, Shandong Province[J]. *For Resour Manag*, (3): 70-77. [Gao Yuan, Meng Fanxu, Zhu Kongshan, et al., 2015. Study on characteristics of main plant populations and communities in Konglin, Shandong Province[J]. Forest Resources Management, (3): 70-77.]

HU YL, 2017. The process of urbanization does great harm to national traditional culture: Impact analysis and reflection[J]. *Heihe J*, (5): 183-185. [Hu Yanlong, 2017. The process of urbanization does great harm to national traditional culture: Impact analysis and reflection[J]. Heihe Journal, (5): 183-185.]

HUANG L, LE C, ZHOU LH, et al., 2021. Large old trees in human settlements: distribution patterns, drivers and conservation practices[J]. *Guihaia*, 41(10): 1665-1673. [Huang Li, Le Cheng, Zhou Lihua, et al., 2021. Large old trees in human settlements: distribution patterns, drivers and conservation practices[J]. Guihaia, 41(10): 1665-1673.]

HUANG L, TIAN LL, ZHOU LH, et al., 2020. Local cultural beliefs and practices promote conservation of large old trees in an ethnic minority region in southwestern China[J]. *Urban For Urban Green*, 49(11): 126584.

JIAO KS, 2014. Minority population's urbanization level and its trends in China[J]. *Ethno-Natl Study*, (4): 13. [Jiao Kaishan, 2014. Minority population's urbanization level and its trends in China[J]. Ethno-National Studies, (4): 13.]

JIM CY, ZHANG H, 2013. Species diversity and spatial differentiation of old-valuable trees in urban Hong Kong[J]. *Urban For Urban Green*, 12(2): 171-182.

LAI Y, 2016. The value of Yi's tree culture and its inheritance and development[J]. *Chin Agric Sci Bull*, 32(4): 26-32. [Lai Yi, 2016. The value of Yi's tree culture and its inheritance and development[J]. Chinese Agricultural Science Bulletin, 32(4): 26-32.]

LI KD, ZHANG GF, 2021. Species diversity and distribution pattern of heritage trees in the rapidly-urbanizing province of Jiangsu, China[J]. *Forests*, (12): 11.

LI YK, 2022. What kind of tree is the Kai wood in the Konglin forest?[EB/OL]. https://baijiahao.baidu.com/s?id=1743812162331537910&wfr=spider&for=pc. [Li Yunkun, 2022. What kind of tree is the Kai wood in the Konglin forest?[EB/OL]. https://baijiahao.baidu.com/s?id=1743812162331537910&wfr=spider&for=pc.]

LINDENMAYER DB, LAURANCE WF, 2017. The ecology, distribution, conservation and management of large old trees[J]. *Biol Rev*, 92(3): 1434–1458.

LIU AZ, PEI SJ, CHEN SY, 2000a. An investigation and study on the plant worship by Yi people in Chuxiong, Yunnan[J]. *Biodivers Sci*, 8(1): 130-136. [Liu Aizhong, Pei Shengji, Chen Sanyang, 2000. An investigation and study on the

plant worship by Yi people in Chuxiong, Yunnan[J]. Biodiversity Science, 8(1): 130-136.]

LIU AZ, PEI SJ, CHEN SY, 2000b. Yi nationality's sacred groves and biodiversity conservation in Chuxiong, Yunnan[J]. *J Appl Ecol*, 11(4): 489-492. [Liu Aizhong, Pei Shengji, Chen Sanyang, 2000. Yi nationality's sacred groves and biodiversity conservation in Chuxiong, Yunnan[J]. Chinese Journal of Applied Ecology, 11(4): 489-492.]

MA KP, 1994. Methods for measuring diversity of biological communities I: α methods for measuring diversity (I)[J]. *Biodivers Sci*, 2(3): 162-168. [Ma Keping, 1994. Methods for measuring diversity of biological communities I: α methods for measuring diversity (I)[J]. Biodiversity Science, 2(3): 162-168.]

MINISTRY of Construction of the People's Republic of China, 2000. Measures for the protection and administration of ancient and famous urban trees[R/OL]. http://law.lawtime.cn/d632164637258_2_{p1}.html. [Ministry of Construction of the People's Republic of China, 2000. Measures for the protection and administration of ancient and famous urban trees[R/OL]. http://law.lawtime.cn/d632164637258_2_{p1}.html.]

MCNEELY JA, MILLER KR, REID WV, et al., 1990. *Conserving the World's Biological Diversity*[M]. Beijing: China Environmental Science Press. [McNeely JA, Miller KR, Reid WV, et al., 1990. Conserving the World's Biological Diversity[M]. Beijing: China Environmental Science Press.]

PENG Y, LIU XH, XUE DY, et al., 2012. Effects of urbanization on indigenous plant diversity: a case study of Langfang City, China[J]. *Acta Ecol Sin*, 32(3): 7. [Peng Yu, Liu Xuehua, Xue Dayuan, et al., 2012. Effects of urbanization on indigenous plant diversity: a case study of Langfang City, China[J]. Acta Ecologica Sinica, 32(3): 7.]

QIAN SH, QI M, HUANG L, et al., 2016. Biotic homogenization of China's urban greening: A meta-analysis on woody species[J]. *Urban For Urban Green*, (18): 25-33.

QIU ZZ, HU XB, QIAN H, et al., 2022. Analysis of spatial distribution characteristics of ancient and famous trees in Xintian County[J]. *J Cent S Univ For Technol*, 42(10): 11. [Qiu Zuzhou, Hu Xijun, Qian Hui, et al., 2022. Analysis of spatial distribution characteristics of ancient and famous trees in Xintian County[J]. Journal of Central South University of Forestry and Technology, 42(10): 1-11.]

SHAN W, 2015. The comparative study on design of Yi ethnic furniture between Chuxiong and Liangshan[D]. Wuxi: Jiangnan University. [Shan Wei, 2015. The comparative study on design of Yi ethnic furniture between Chuxiong and Liangshan[D]. Wuxi: Jiangnan University.]

TANG CQ, YANG Y, OHSAWA M, et al., 2011. Population structure of relict *Metasequoia glyptostroboides* and its habitat fragmentation and degradation in

south-central China[J]. *Biol Conserv*, 144(1): 279-289.

TANG CQ, YANG YC, OHSAWA M, et al., 2013. Survival of a tertiary relict species, *Liriodendron chinense* (Magnoliaceae), in southern China, with special reference to village fengshui forests[J]. *Am J Bot*, 100(10): 2112–2119.

TIAN LJ, 2018. The composition and characteristics of heritage trees in ethnic minority areas in Southwest China: a case study of Guizhou Wuchuan Gelao and Miao Ethnic Autonomous County[D]. Chongqing: Chongqing University. [Tian Lijuan, 2018. The composition and characteristics of heritage trees in ethnic minority areas in Southwest China: a case study of Guizhou Wuchuan Gelao and Miao Ethnic Autonomous County[D]. Chongqing: Chongqing University.]

TIAN LJ, HUANG L, ZHOU LH, et al., 2018. The composition and distribution of heritage trees in Guizhou ethnic minority areas: A case study of Wuchuan County[J]. *Chin J Ecol*, 37(9): 2768-2775. [Tian Lijuan, Huang Li, Zhou Lihua, et al., 2018. The composition and distribution of heritage trees in Guizhou ethnic minority areas: A case study of Wuchuan County[J]. Chinese Journal of Ecology, 37(9): 2768-2775.]

WALKER JS, GRIMM NB, BRIGGS JM, et al., 2009. Effects of urbanization on plant species diversity in central Arizona[J]. *Front Ecol Environ*, 7: 465-470.

WANG J, YANG YM, WANG J, et al., 2004. Cultural diversity and biological diversity[C]. *Progress in Biodiversity Conservation and Research in China — National Symposium on Biodiversity Conservation and Sustainable Use*: 57-68. [Wang Juan, Yang Yuming, Wang Jing, et al., 2004. Cultural diversity and biological diversity[C]. Progress in Biodiversity Conservation and Research in China — National Symposium on Biodiversity Conservation and Sustainable Use: 57-68.]

WANG N, LI DN, LI XY, 2019. A study on the effect of financial industry supporting for new urbanization construction in Hebei province[J]. *J Business Ed*, 33(5): 123-144.

XIE ZJ, CHU CJ, GUO J, 2006. Urbanization: cultural unification or cultural multiplication?[J]. *J Dalian Minzu Univ*, 4(33): 21-1431. [Xie Zhijun, Chu Chenjie, Guo Jian, 2006. Urbanization: cultural unification or cultural multiplication?[J]. Journal of Dalian Minzu University, 4(33): 21-1431.]

XU LM, 2014. Thoughts on promoting the prosperity and development of minority culture under the background of urbanization[J]. *J Party School Shanxi Provincial Organs CPC*, (5): 3. [Xu Liman, 2014. Thoughts on promoting the prosperity and development of minority culture under the background of urbanization[J]. Journal of the Party School of Shanxi Provincial Committee of the CPC, (5): 3.]

YANG FQ, 2022. The evolution and inheritance of traditional folk houses of the Yi nationality in Chuxiong[D]. Kunming: Kunming University of Science and Technology. [Yang Fuquan, 2022. The evolution and inheritance of traditional

folk houses of the Yi nationality in Chuxiong[D]. Kunming: Kunming University of Science and Technology.]

YANG XX, WU YH, TIAN Q, et al., 2021. The characteristics and spatio-temporal distribution of ancient and famous trees in Lanzhou City[J]. *Grassl Turf*, 41(06): 37-45. [Yang Xiuxiu, Wu Yonghua, Tian Qing, et al., 2021. The characteristics and spatio-temporal distribution of ancient and famous trees in Lanzhou City[J]. Grassland and Turf, 41(06): 37-45.]

YANG YB, BAO GD, ZHANG D, et al., 2022. Spatial distribution and driving factors of old and notable trees in a fast-developing city, Northeast China[J]. *Sustainability*, (14): 13.

ZHANG C, YANG BG, 1991. *Basis of Quantitative Geography*[M]. Beijing: Higher Education Press. [Zhang Chao, Yang Binggeng, 1991. Basis of Quantitative Geography[M]. Beijing: Higher Education Press.]

ZHANG GT, 1998. Discussion on establishing index system of urbanization level[J]. *Urban Prob*, 81(1): 6-9. [Zhang Gengtian, 1998. Discussion on establishing index system of urbanization level[J]. Urban Problems, 81(1): 6-9.]

ZHANG JT, 2004. *Quantitative Ecology*[M]. Beijing: Science Press. [Zhang Jintun, 2004. Quantitative Ecology[M]. Beijing: Science Press.]

ZHAO Y, 2021. Studies on the plants of Confucian temple—taking Shanxi, Hebei, Shandong, and Henan region as an example[J]. *Urban Arch Space*, 28(1): 178-180. [Zhao Yue, 2021. Studies on the plants of Confucian temple—taking Shanxi, Hebei, Shandong, and Henan region as an example[J]. Urban Architecture and Space, 28(1): 178-180.]

ZHENG MM, 2020. Distribution pattern of Chinese heritage trees and its retention mechanism[D]. Chongqing: Chongqing University. [Zheng Mingming, 2020. Distribution pattern of Chinese heritage trees and its retention mechanism[D]. Chongqing: Chongqing University.]

Note: Figure translations are in progress. See original paper for figures.