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Exploring the Ecological Value and Current Status of Ancient Tree Conservation: A Case Study of Singapore and a Comparison with France and the United Kingdom

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Abstract: Ancient trees are not only key nodes in ecosystems but also composite carriers of cultural, historical, and social values. With the intensification of global climate change and the acceleration of urbanisation, ancient trees face existential threats, and their conservation has become a critical issue in ecological governance systems. This paper takes Singapore as a core case study to systematically explore the ecological value and management mechanisms of ancient tree conservation. Comparing the policy practices of France and the United Kingdom, it reveals the different paths chosen by countries in ancient tree conservation and the effectiveness of their implementation. In terms of research methods, this paper combines literature analysis with questionnaire surveys to collect feedback from relevant practitioners and policy implementers in Singapore on the effectiveness of ancient tree conservation, public participation, and policy response mechanisms. The study found that Singapore has strong advantages in refined management, legal mechanism construction, and public participation, but there is still room for improvement in multi-scale ecological value assessment and the integration of historical and cultural values. France emphasises the continuity of historical landscapes, while the United Kingdom relies on institutionalised citizen science and a national ancient tree database system. Both countries have distinctive features in multi-stakeholder governance and data transparency. This paper aims to provide experience and policy recommendations for ancient tree protection policies in Asian regions, particularly in tropical cities, through cross-national comparisons and data analysis.

Keywords: Ancient tree protection, ecological value, Singapore, comparative policy, urban forest.

1. Introduction

Ancient trees, typically defined as trees over 100 years old with stable ecological structures and special landscape or cultural value, are an important component of urban ecosystems. They play a crucial role in carbon sequestration, biodiversity conservation, and climate regulation, and carry profound historical memories and cultural identity. In addition, ancient trees carry deep historical memories and cultural identity[1,2]. Their existence is not only symbolic, but also strengthens humanity's emotional connection to natural spaces. However, under the pressures of urban expansion, infrastructure development, and environmental pollution, the survival environment of ancient trees is increasingly deteriorating[3,4]. Globally, the importance of ancient tree conservation has

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significantly increased, especially in highly urbanised countries and regions, where ancient trees have become a key issue in green space governance, ecological civilization construction, and cultural heritage protection.

In recent years, academic research on ancient tree conservation has exhibited trends toward interdisciplinary collaboration, value integration, and policy orientation. From an ecological functional perspective, Cannon, Piovesan, and Munné-Bosch pointed out that ancient trees possess irreplaceable roles in genetic diversity, community stability, and long-term adaptive capacity, and are regarded as 'time anchors' of ecosystems. Ancient trees and their ecological networks are not only linked to human health but also exhibit multifaceted socio-ecological effects in climate regulation, mental rehabilitation, and cultural education. From a cultural-social perspective, Breyne, Dufrêne, and Maréchal integrated 'sociocultural value' into ecological service evaluations, highlighting the significant non-market value of ancient trees and advocating for their inclusion in assessments of urban green infrastructure systems.

Singapore, as a tropical island nation, despite its limited land area, boasts high urban forest coverage and meticulously planned ecological green spaces, earning it the reputation of the 'Garden City.' According to research by Choo et al., Singapore's historical landscapes contain a wealth of diverse native large trees, including species such as Sindora, which possess extremely high ecological and genetic value. Singapore's ancient tree protection policy is based on the Tree Conservation Area Regulations and implemented by the National Parks Board (NParks). It's Ancient Tree List System and 'Heritage Tree Certification' form an organic combination of management, legal, and public education measures. However, academic evaluations of Singapore's ancient tree policy remain fragmented, lacking systematic surveys and comparative analyses.

Among European countries, France and the United Kingdom have relatively mature ancient tree protection systems[5-7]. In comparison, although Singapore has advantages in policy tool diversity and implementation efficiency, there is still significant room for improvement in terms of historical context, public participation, and data governance. Based on this, this paper aims to explore the ecological value and governance status of ancient tree protection, using Singapore as a case study and comparing it with France and the United Kingdom to analyse the similarities and differences in policy construction, social mobilisation, and scientific assessment among the three countries.

2. Significance of ancient tree protection and analysis of data sources

Ancient trees play a pivotal role in ecosystems, serving as witnesses to natural evolution and regulators of ecological balance. From an ecological perspective, ancient trees form stable biological communities through long-term succession, providing habitats for numerous epiphytes, insects, birds, and microorganisms, thereby constituting complex ecological networks. Cannon, Piovesan, and Munné-Bosch noted that ancient trees, as 'survivors of life histories,' possess deep genetic foundations and adaptive capabilities, making them symbols of an ecosystem's resilience to risks. In terms of forest structure and species diversity, ancient trees exhibit significant structural stability and ecological continuity[8]. Their root systems help maintain soil stability, water regulation, and underground ecological cycles, making them indispensable ecological pillars in natural systems.

Beyond their ecological value, ancient trees also carry profound historical and cultural significance. In urban and rural landscapes, ancient trees are often closely linked to historical events, religious beliefs, and folk legends, serving as important carriers of local identity, community memory, and cultural traditions. For example, the Singapore National Parks Board established the 'Heritage Tree Scheme,' which identifies and protects specific ancient trees, combining their historical significance, landscape value, and public education functions to confer a more multifaceted social role on ancient trees [9-10]. In France, ancient trees are often protected as part of historical gardens and religious sites, forming 'cultural-ecological dual spaces'; while the UK's 'Ancient Tree Inventory' records many

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historically significant ancient trees, promoting community participation and environmental awareness education [11].

In terms of research data, the primary sources used in this study include official policy documents, analyses of transnational conservation mechanisms, academic journal articles, and national-level ancient tree inventory databases. Among these, the French side primarily references the 'INTEGRATE National Report', which systematically outlines the integration pathways of nature conservation content within French forest policies, with particular focus on the integration of ancient trees and forest historical continuity; the UK side relies on the 'National Ancient Tree Inventory,' combined with Hasan, Othman, and Ahmad on the legal framework and practical effectiveness of the 'Tree Preservation Order'; Singapore draws on Choo et al. for a record of the classification and protection of local native species, supplemented by relevant laws and guidelines published by the National Parks Board, to construct a landscape of the country's ancient tree protection mechanisms[12,13].

It is worth emphasising that the above data have diverse spatial and institutional backgrounds, which facilitate a systematic comparison of ancient tree protection pathways across different countries. France emphasises the continuity of ecosystems and the integration of cultural landscapes, focusing on the vertical time dimension; the UK emphasises the linkage between legal systems and citizen participation, highlighting the systematic and public nature of governance structures; Singapore, with its 'small country, high efficiency' policy style, balances regulatory norms and urban greening efficiency, forming a highly integrated ancient tree management model. These materials collectively form the basis for the subsequent analysis in this paper, providing a solid foundation for understanding the multidimensional mechanisms of ancient tree protection.

3. Current status and international comparison of ancient tree protection

Against the backdrop of growing global attention to the protection of natural heritage and ecological diversity, ancient tree protection, as an important branch of ecological governance, exhibits distinct national characteristics and policy path differences. Singapore, renowned for its urban forests, features an ancient tree management system characterised by policy concentration, clear legislation, and efficient implementation; France, from the perspective of landscape history and cultural continuity, emphasises the logic of protecting the human-nature community; the United Kingdom, through a relatively systematic citizen science mechanism and a national inventory system, promotes the institutionalisation, networking, and public participation of ancient tree protection. The following analysis compares the three countries from four dimensions: policy framework, protection mechanisms, technical approaches, and public participation.

3.1. Results analysis: Singapore's ancient tree protection mechanisms compared with the UK and France

There are significant differences in policies among the three countries. Singapore's ancient tree protection is primarily led by the National Parks Board (NParks), with its core system being the 'Heritage Tree Scheme,' launched in 2001. This scheme aims to identify, certify, and protect ancient trees of unique ecological, cultural, and landscape significance. Selection criteria include tree age, height, crown spread, and historical or cultural value. Protected ancient trees are included in a special register and are subject to dual legal constraints under the Trees Conservation Area Regulations and the Parks and Trees Act. Any pruning, relocation, or felling must be approved. Supporting measures include regular tree health assessments, pest and disease control, and soil improvement through technical management methods.

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In contrast, France's ancient tree protection framework is embedded within its overall forest ecosystem conservation policy, emphasizing the ecological continuity of 'historical landscapes.' France has established an 'ecological corridor' mechanism in the 'Biodiversity Act' and local forest planning, making ancient trees an important component of biodiversity corridors. This system integrates forestry policies, cultural heritage management, and local participation mechanisms, highlighting the multiple roles of ancient trees in the historical value of forest lands and species migration.

The United Kingdom places greater emphasis on institutionalised data governance and social participation. It's Ancient Tree Inventory (ATI) is a national database managed by the Ancient Tree Forum and the Forestry Commission and is open to the public for reporting and supplementing tree information. This initiative effectively connects expert and grassroots resources, forming a citizen science network. Hasan et al. noted from a legal framework perspective that the UK's 'Tree Preservation Order' (TPO) system provides the legal basis for local governments to enforce mandatory protection of specific trees, with violations subject to criminal or civil penalties, reflecting a high level of legal safeguards.

Table 1: Number of registered ancient trees

Country	Estimated Number of Registered Ancient Trees	Database/Program Name	Open to Public?
Singapore	~260	Heritage Tree Scheme	Partial
France	~3,500	Local Forest Ecological Databases	Limited
United Kingdom	>190,000	Ancient Tree Inventory (ATI)	Yes

Table 1 shows the Number of Registered Ancient Trees (as of 2023). According to Table 1, the UK leads with its long-standing Ancient Tree Inventory project, registering over 190,000 trees and continuously updating the database through a citizen science system. France's ancient tree protection relies on local forestry plans, resulting in scattered and partially public registrations. Singapore, despite having a relatively small number of registered ancient trees, has established an institutionalised management framework given its urban land area and population density.

Table 2: Quantitative comparison

Country	No. of Citizen-Contributed Tree Records (as of 2023)	Annual Volunteer Hours (Estimated)	Schools/NGOs Involved	Public Events per Year	Online Portal Activity (Monthly Visits)
Singapore	~50	~1,000	~10	5–10	~3,000
France	~3,000 (local surveys)	~7,500	~60	20–30	~5,000
United Kingdom	>150,000	>50,000	>300	>100	>120,000

Table 2 provides a quantitative comparison of public engagement in ancient tree protection. From Table 2, it is evident that the UK's citizen science platforms (such as Ancient Tree Hunt) are highly developed, with over 150,000 data records uploaded by citizens. The online platform receives over 120,000 monthly visits, with annual volunteer hours exceeding 50,000 (Nolan et al., 2020). France's data is relatively dispersed, primarily sourced from municipal-level ecological projects and local surveys conducted by forestry volunteer organisations. Singapore has not yet established a dedicated

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open platform for collecting information on ancient trees. Public participation is mainly concentrated in tree planting festivals and heritage education activities organised by the National Parks Board. Data shows that public participation is still in its infancy.

3.2. Discussion

Based on the discussion above, the institutional advantages of Singapore's ancient tree protection system are reflected in the following aspects. First, clear legislation and centralised authority ensure the effectiveness and standardisation of protection measures. Second, the 'heritage tree' system endows ancient trees with social symbolic significance, enhancing public awareness. Third, regular health checks, professional management, and disease prevention and control measures ensure the health of ancient trees, with a relatively complete technical support system.

However, compared with countries such as France and the United Kingdom, Singapore's system also has certain implicit bottlenecks. On the one hand, protection work is mainly led by the government, with limited channels for public participation, low information transparency, and a lack of emotional connection and deep understanding at the grassroots level. On the other hand, the integration of cultural value dimensions remains relatively weak, with ancient trees often categorised as 'green infrastructure' and lacking the sorting and activation of deeper socio-cultural relationships with history, communities, and religion. Additionally, in terms of information system construction, although the National Parks Board has launched some database platforms, their interactivity, visualisation, and update frequency still need to be enhanced.

4. Recommendations and outlook

Faced with ecological pressures brought about by urbanisation, Singapore has established a relatively systematic mechanism for protecting ancient trees. This article conducts an in-depth analysis of the advantages and shortcomings of this mechanism and draws on policy practices in France and the United Kingdom. It can be observed that while the current system possesses strong administrative integration capabilities and a robust technical support framework, it still faces structural shortcomings in terms of cultural value exploration, data sharing mechanisms, and public participation. Therefore, future ancient tree protection urgently needs to achieve systemic transformation and strategic upgrading in multiple dimensions.

First, the digitalisation level of ancient tree information management should be further improved. At the perception level, an IoT-based sensor network can be established to collect real-time data on the physiological parameters of ancient trees and environmental changes. At the analysis level, AI recognition technology and UAV remote sensing monitoring systems can be introduced to automatically identify the health status of trees and track their evolutionary trajectories. At the platform level, an intelligent ecological decision-making platform integrated with GIS can be constructed for disaster warning and comprehensive management decision-making.

Second, efforts should be strengthened to recreate and disseminate the cultural value of ancient trees. Drawing on France's experience of incorporating ancient trees into the historical heritage governance framework, Singapore could collaborate across departments to integrate representative ancient trees with historical sites and community memories, developing a 'story-based ecological interpretation' system to enhance social recognition and emotional belonging. Especially in a multi-ethnic context, ancient trees can serve as symbols of shared cultural assets, reinforcing national identity and social cohesion.

Finally, a multi-stakeholder governance platform should be established to expand public participation. Drawing on the UK's open-access databases and citizen science mechanisms, Singapore could gradually relax access restrictions on ancient tree data, encouraging universities, communities,

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and non-governmental organisations to jointly participate in ancient tree monitoring, science popularisation, and environmental education, forming a 'government-public-research' tripartite collaborative network. This mechanism would enhance governance transparency, promote knowledge sharing, and strengthen institutional resilience and sustainability.

5. Conclusion

This paper takes Singapore as a core case study, systematically reviews its ancient tree protection policies, and compares them with experiences from France and the United Kingdom to explore the composite ecological and cultural value of ancient trees and the evolution of their governance mechanisms. In terms of research methods, this paper primarily relies on authoritative policy documents, national-level databases, and core academic literature, focusing on four dimensions—institutional framework, technical support, cultural integration, and social participation—to conduct assessments and analyses, aiming to reveal the ecological logic and policy intentions underlying institutional differences.

The study shows that Singapore has established a centralised governance system led by the National Parks Board, which has achieved high administrative efficiency and technical precision through the 'heritage tree' system. Its advantages are mainly reflected in its clear legal basis, comprehensive technical support, and strong enforcement capacity. However, compared with France's emphasis on the continuity of historical landscapes and the UK's promotion of citizen science participation, Singapore still has room for improvement in terms of the depth of public participation, the integration of cultural narratives, and the openness of information. France's 'ecological-cultural co-construction' approach and the UK's 'data democratisation' mechanism provide important references for institutional optimisation in Singapore.

Overall, ancient tree protection, as a special issue within ecological governance, has transcended the traditional scope of nature conservation, exhibiting a high degree of intertwining between ecological, historical, cultural, and social systems. This study demonstrates that effective ancient tree protection requires the integration of diverse institutional frameworks, the upgrading of technical means, and the collaborative participation of social actors.

Future research could further explore quantitative data assessment approaches, combining remote sensing, AI monitoring, and ecological modelling techniques to evaluate the dynamic functional value of ancient trees in different urban ecosystems. Alternatively, studies could delve deeper into the social perception of ancient trees as 'living history' from cultural anthropology and memory politics perspectives, aiming to achieve integrated governance that harmonises natural and humanistic values. This not only enhances the overall effectiveness of policies but also provides theoretical foundations and practical pathways for global ecological civilisation construction.

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