The temporal and spatial distribution of Chinese old trees and its analysis

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Abstract. The oldest old trees in China are distributed in remote and high-altitude areas. Studying the distribution and characteristics of old trees in China is conducive to understanding the impact of human activities on the survival of old trees and plays a great role in the protection of old trees. In this paper, combined with the old tree data set compiled by Jiajia Liu et al., the geographical population boundary of China, etc., the distribution and characteristics of first-class old trees are analyzed and discussed. The results show that: the first-class old trees are generally distributed on the mountains; they are basically distributed on the left side of the population boundary; from the tree species, they are mostly Juniperus przewalskii, Juniperus tibetica, Chamaecyparis obtuse, Cunninghamia lanceolate, Pinus armandii, Tsuga dumosa, Picea likiangensis and Larix sibirica.

1. Introduction
In China, trees that are more than 100 years old are old trees. They record information about the changes of the surrounding environment, and their tree ring structure shows the changes of climate, hydrology, geology, geography, biology and ecology over the long years [1]. The existence of old trees shows the evolution of natural changes in climate, geography, vegetation, and ecology over thousands of years[2]. At present, the factors considered in the evaluation of the value of old and famous trees mainly include: basic value, ecological value, scientific research value, cultural value, landscape value and social value. Foreign research favors field investigation and experimental research, and domestic research on old trees. The level is still at a relatively basic stage, mainly focusing on the three aspects of resource investigation, protection and popular science knowledge[3-5].

According to the "National Old and Famous Trees Census and File Technical Provisions" issued by China -- the classification and standards of old and famous trees: Old trees are divided into national first, second and third levels; national first level old trees are more than 500 years old; national second level old trees are 300-499 years old; national third level old trees are 100-299 years old[1]. As a precious treasure left by nature to mankind, old trees are an important way to study the historical changes of local climate, soil, biology and humanities[2-3]. In recent years, researchers have paid more attention to the natural and humanistic value of old trees. For example, Wang analyzed the value composition of old and famous trees and found that the value composition of old and famous trees includes natural value and
cultural (humanistic) value[1]. By compiling a data set of tree rings, Liu et al. determined the age and growth environment of the oldest old trees in China[3]. However, current research has not yet correlated the distribution of old trees with human activities, ignoring the impact of human activities on them. The influence of the characteristics of old tree species on it. In this study, the distribution of old trees, population distribution, and characteristics of old tree species were analyzed to provide new ideas and foundations for later research on human activities and climate change.

2. Materials and Methods

2.1. Data Sources
The research data used in this paper is the data set (www1.ncdc.noaa.gov/pub/data/paleo/treering) collected by Jiajia Liu et al. from 56 tree-ring studies and the data set compiled by information from 49 recently published articles, downloaded from (https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/fee.2046#support-information-section). Extract and classify the required data through data classification and filtering.

2.2. Methods

2.2.1. Analysis of the distribution of old trees
This study adds geographic population boundaries on the spatial scale to analyze the relationship between the distribution of first-class old trees and population distribution. First, classify according to the data obtained by screening, classify from time and space, and find out the specific location accurately (to the county and city level) based on the predecessors to obtain the spatial distribution of old trees; on the time scale, The first-class old trees are divided into two scales of millennium old trees and greater than 500 and less than 1000 according to their ages, and then the spatial distribution of millennium old trees and other first-class old trees is compared with the geographical population distribution, and the ancient Correlation between tree distribution and population distribution.

2.2.2. Analysis of characteristics of old tree species
In this study, the correlation analysis of old tree species and characteristics (main distribution areas) of old tree species was carried out. First, the old tree species is obtained through data sets and statistics, and then the characteristics of the tree species are found, and then the correlation analysis is carried out according to the characteristics of the tree species and the location of the old tree distribution.

2.2.3. Topography and elevation analysis of old tree distribution
This research analyzes the topography and altitude of the distribution of old trees, and analyzes the relationship between the distribution of old trees and human activities from the altitude and topography of the location of the old trees.

3. Result and Discussion

3.1. The relationship between the distribution of old trees and the distribution of population
In terms of space and age of old trees, the thousand-year-old old trees among the first-class old trees are basically distributed on the left side of Hu Line(Figure.1).

3.2. Distribution of Old Trees and Characteristics of Old Tree Species
From the perspective of old tree species, there are three main species of old tree species: Juniperus przewalskii, Juniperus tibetica, Chamaecyparis obtuse (Table 1). The other first-class old trees are Cunninghamia lanceolate, Pinus armandii, Tsuga dumosa, Picea likiangensis and Larix sibirica (Table 2).
Table 1: Basic information of thousand-year-old trees

| Province | Longitude | Latitude | Tree age | Elevation | Species            |
|----------|-----------|----------|----------|-----------|--------------------|
| 1        | Qinghai   | 98.3     | 37       | 1045      | 3800               | Juniperus przewalskii |
| 2        | Qinghai   | 98       | 36       | 1621      | 3800               | Juniperus przewalskii |
| 3        | Qinghai   | 97.13    | 37.28    | 1174      | 3780               | Juniperus przewalskii |
| 4        | Qinghai   | 97.32    | 37.27    | 1598      | 3920               | Juniperus przewalskii |
| 5        | Qinghai   | 98.03    | 37.26    | 1437      | 3800               | Juniperus przewalskii |
| 6        | Qinghai   | 97.47    | 37.27    | 1181      | 3700               | Juniperus przewalskii |
| 7        | Qinghai   | 98.24    | 37.19    | 1029      |                    | Juniperus przewalskii |
| 8        | Qinghai   | 98.38    | 37.02    | 1147      |                    | Juniperus przewalskii |
| 9        | Qinghai   | 98.4     | 37.02    | 1074      | 3700               | Juniperus przewalskii |
| 10       | Qinghai   | 98.13    | 36.45    | 1221      | 3720               | Juniperus przewalskii |
| 11       | Qinghai   | 98.25    | 36.41    | 1102      | 3700               | Juniperus przewalskii |
| 12       | Qinghai   | 97.45    | 37.15    | 2230      | 4175               | Juniperus przewalskii |
| 13       | Qinghai   | 99.2     | 38.34    | 1100      | 3517               | Juniperus przewalskii |
| 14       | Qinghai   | 99.52    | 38.12    | 1224      | 3500               | Juniperus przewalskii |
| 15       | Taiwan    | 121.23   | 24.32    | 1101      |                    | Chamaecyparis obtusa  |
| 16       | Qinghai   | 100.37   | 38.13    | 1091      | 3350               | Juniperus przewalskii |

Table 2: Basic information of other first-class old trees

| Province | Longitude | Latitude | Tree age | Elevation | Species                  |
|----------|-----------|----------|----------|-----------|--------------------------|
| 1        | Yunnan    | 99.45    | 28.54    | 515       | 3980                     | Juniperus przewalskii |
| 2        | Yunnan    | 99.56    | 28.59    | 626       | 3750                     | Cunninghamia lanceolata |
| 3        | Yunnan    | 99.16    | 27.22    | 525       | 3050                     | Cunninghamia lanceolata |
| 4        | Yunnan    | 99.18    | 27.2     | 660       | 3040                     | Cunninghamia lanceolata |
| 5        | Yunnan    | 99.18    | 27.2     | 660       | 3060                     | Cunninghamia lanceolata |
| 6        | Yunnan    | 99.21    | 27.35    | 538       | 3240                     | Picea schrenkiana       |
| 7        | Yunnan    | 98.59    | 28.02    | 613       | 3100                     | Tsuga dumosa           |
| 8        | Tibet     | 91.58    | 29.18    | 614       | 3730                     | Juniperus tibetica     |
| 9        | Tibet     | 93.57    | 29.04    | 947       | 3780                     | Juniperus tibetica     |
| 10       | Tibet     | 97.02    | 31.07    | 589       | 4450                     | Picea likiangensis     |
| 11       | Sichuan   | 100.16   | 30.14    | 702       | 4050                     | Juniperus tibetica     |
| 12       | Xinjiang  | 88       | 47.5     | 523       | 2430                     | Larix sibirica         |

Table 3: Main Thousands Year Old Tree Species and Distribution Area

| Species                    | Distribution area          |
|----------------------------|---------------------------|
| Juniperus przewalskii      | Gansu, Sichuan, Qinghai  |
| Juniperus tibetica         | Gansu, Sichuan, Qinghai, Tibet |
| Chamaecyparis obtusa       | Taiwan                    |

It can be seen that the distribution of the thousand-year-old tree is consistent with the main distribution of the tree in China, and the three old trees are endemic to China (Table 3).

3.3. The relationship between the distribution of old trees and topography and altitude

From the topography and altitude, most of the first-class old trees are distributed on the mountains (Figure 2). Among them, the altitude of Juniperus przewalskii is between 3000-4000. Among the other first-class old trees, the altitude of Juniperus tibetica is between 3700-4100, the altitude of Cunninghamia lanceolata, Tsuga dumosa, and Picea likiangensis are between 3100-4500, and the altitude of Larix sibirica is about 2430 (Table 2, Table 3). All old trees are located at high altitudes.
4. Conclusion

This paper uses the data obtained from the old tree ring data set and the geographical population boundary of China to analyze the distribution and characteristics of millennium old trees and first-class old trees, and draw the following conclusions:

(1) From the perspective of age and space of old trees, millennium old trees are generally distributed on the left side of the geographic population boundary. Except for the millennium old trees in Taiwan, they are all distributed in places with low population density.

(2) From the perspective of tree species, the thousand-year-old trees are all Sabina vulgaris, Qilian Sabina and Taiwan Sabina, all belonging to the Cupressaceae. Among them, all those distributed in Qinghai Province are Juniperus przewalskii, Juniperus tibetica is located in Tibet, and Chamaecyparis...
obtusa is located in Taiwan; the other first-class old trees include Larix sibirica, Tsuga dumosa, and Picea likiangensis (the above three are all Belongs to Pinaceae), Cunninghamia lanceolata (Taxodiaceae).

(3) From the perspective of topography and altitude, first-class old trees are distributed on the mountains, and most of them are distributed in high altitude areas.

Based on tree data sets, this paper analyzes the distribution of old trees, research has shown that old tree distribution in less populated areas, this may be due to the population density of the local population, and higher use value of the trees, all man-made damage probability for quite a long time, so the level of old trees located at the side of the population is less, and the location is a high altitude old trees on the mountains of. In the later period, other human activities can be studied to understand the impact of human activities on old trees and climate.

References
[1] Wang B.(2009)( Master Thesis, Nanjing Agricultural University) Research on the Cultural Value of Chinese old Trees. https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD201301&filename=1012490302.nh
[2] Duan Y.(2010). An Analysis of Chinese Old tree Research Documents. Forestry Science and Technology Information, 03: 8-11.
[3] Liu, J., Yang, B., & Lindenmayer, D. B. (2019). The oldest trees in china and where to find them. Frontiers in Ecology and the Environment, 17(6): 319-222.
[4] Haneca, K., Čufar, K., & Beeckman, H. (2009). Oaks, tree-rings and wooden cultural heritage: a review of the main characteristics and applications of oak dendrochronology in Europe. Journal of Archaeological Science, 36(1): 1-11.
[5] Wang B., Lan S.(2016) Summary of Research on Value Evaluation of Old and Famous Trees. Forestry, 03: 42-47.