Study on Plant Carbon Sequestration Capacity and Ecological Landscape Configuration

Wang Dan
Research Institute of Highway Ministry of Transport
Beijing city Haidian District Xitucheng Road No. 8, Beijing, China
d.wang@rioh.cn

ABSTRACT

Greening plants have carbon sequestration and oxygen release capacity, air purification and water conservation. Planting high carbon sink plants in the highway land area is one of the important measures to make the whole life cycle low-carbon. Determination of oxygen release capacity of carbon sequestration through 14 kinds of greening plants in Guangdong in northern Guangdong, the quantitative study of carbon sequestration and oxygen release ability of different plants and sorting, analysis of plant functional characteristics of the space of expressway service area, service area and study the plant carbon sequestration combination mode of different use requirements based on the results of this study. It lays a foundation for the research of the green road.

KEYWORDS: carbon sequestration capacity, estimation method, service area, green space, plant configuration

1 INTRODUCTION

The results showed that forest carbon absorption capacity significantly, the growth of trees per 1 cubic meter, can absorb 1.83 tons of CO2, released 1.62 tons of O2. Compared with industrial emission reduction, forest carbon sequestration has the characteristics of less investment, lower cost, higher comprehensive benefit, more economic feasibility and practical operation. Therefore, the investigation and analysis of carbon sequestration capacity and the study of combination mode in expressway service facility area can make ecological environment protection and increase carbon sink as the main idea to inculcate the design and construction of greening along the highway. Under the premise of ensuring driving safety and functional requirements, we should take tree as the main form and create forest landscape. We should take carbon fixation capacity of trees as the primary index for tree species selection and at the same time, achieve maintenance free and reduce daily maintenance costs.

2 EFFECTIVE MEASURES TO CONSTRUCT LOW-CARBON ECOLOGICAL LANDSCAPE

2.1 The enhanced configuration of plant carbon sequestration capacity

The carbon sequestration function is one of the main functions of Road area and service area landscape so low-carbon ecological landscape and give full play to the carbon sink ability of garden plants, greenhouse gases in the air collected, stored in the root or soil, which
is one of the most carbon reduction method the vegetation and soil is the main component of the green carbon sequestration function play so in order to carbon sink function of city green area, must be reasonable planting, planting, maintenance, avoid carbon release too quickly. Green garden should be different in different depth of root, root of plant collocation planting, increasing the amount of carbon sequestration per unit area of the largest limit. In addition, planting a variety of ages in the same green trees can enhance carbon sequestration stability of green space. In addition, reduce mechanical weeding in the curing process, removing leaves some unnecessary maintenance behavior, not only can In order to make plants grow naturally, they can also maximize their carbon sequestration capacity.

2.2 The ecological diversity is valued by all the low-carbon ecological landscape

The ecological diversity is the ecological environment with simple structure, the more complex the morphological structure, the stronger the stability of the period, the stronger the self-existence development ability. The low-carbon ecological landscape emphasizes the diversity of the ecological arrangement, so as to improve the self-existence, adjustment, recovery and development of the landscape of the road and service areas.

2.3 Reduce the carbon cost of maintenance of ecological landscape

Ecological landscape design methods selection of materials of the ecological landscape planning and management will affect the ecological landscape carbon cost required for maintenance. During the construction of the project cost of carbon is usually a one-time cost, and the maintenance period of the carbon is constant: it can last more than ten years, decades or even centuries. Green plants in nature are continuing to grow and change, but the highway ecological landscape construction in order to meet the water conservation function and aesthetic requirements, they often need to be kept in a certain state, usually applies to irrigation, fertilization, pruning and other means for long-term maintenance, which will bring continuous carbon dioxide emissions. If more consideration of the principles of landscape ecology in the design stage, to adapt to the changes of the ecological system, it may be the way domain and service area of ecological landscape. The concept of carbon costs required to maintain control under a relatively low standard. For example, the designer can replace the artificial turf grass to increase plant diversity, three-dimensional green, more trees, plant varieties suitable for extensive management, which can effectively reduce the cost of supporting the green dimensional carbon required, at the same time they can maintain the openness and accessibility of the garden.

3 THE METHOD FOR ESTIMATING THE SOLID CARBON CAPACITY OF THE MAIN GREENING TREE SPECIES IN THE SERVICE AREA

3.1 Estimates the solid carbon release capacity of the plants through the photosynthetic efficiency

According to the mechanism of carbon sequestration afforestation tree species, daily assimilation can be measured by the photosynthesis of plants, and then calculate the plant fixed date of the amount of CO2 and the release amount of O2. The general can determine the
apparatus to measure the instantaneous light use efficiency and plant photosynthesis, and the
net amount of the same formula species day net assimilation amount.

In the diurnal variation curve of tree photosynthesis, the assimilation amount is the
area of net photosynthetic rate curve and time horizontal axis. Based on this, the calculation
formula of net assimilation quantity on the day of tree species is as follows:

\[ P = \sum_{i=1}^{j} \left[ (P_{i+1} + P_{i}) \times 2 \times (t_{i+1} - t_{i}) \right] \]  

(1)

Type (1), the total amount of garden trees on P assimilation
\( \text{mmol} \cdot \text{m}^{-2} \cdot \text{d}^{-1} \); \( P_{i} \) refers to the instantaneous light and rate at the initial measurement
point. \( P_{i+1} \) is the time and rate of the next measuring point. \( t_{i} \) is the instantaneous time of the
initial measurement point. \( T_{i+1} \) is the time of the next measurement point in h; \( j \) is the number
of tests. By calculating the total amount of day assimilation \( P \) of the garden tree species, the
amount of the daily fixed \( \text{CO}_2 \) and the amount of \( \text{O}_2 \) released on the day are measured as follows:

\[ W_{\text{CO}_2} = P \cdot \frac{44}{1000} \]  

(2)

In formula (2), 44 is the molar mass of \( \text{CO}_2 \) (g·mol\(^{-1}\)), \( W_{\text{CO}_2} \) is the quality of the blade
fixed on the unit surface area \( \text{CO}_2 \) (g·m\(^{-2}\)·d\(^{-1}\) ). The method for estimating the amount of
solid carbon released oxygen by measuring the photosynthetic efficiency of the tree species,
which is suitable for June to August of each year, is a method for determining the solid
carbon release amount of a single plant.

3.2 Estimating the carbon sequestration capacity of garden tree species through leaf
area index

The leaf area index tree based, derived morphological indexes of the independent city
landscape trees ecological benefit calculation model of general equation for the formula:

\[ Y = ab \]  

(3)

\[ b = \pi cd^2/4 \]  

(4)

Type (3~4), \( y \) is a plant, carbon fixation and oxygen release value (g), \( a \) is the unit leaf area,
carbon fixation and oxygen release value (g·m\(^{-2}\)), \( b \) is also the plant total surface area (m\(^2\)),
\( C \) is the leaf area index (m), \( D \) for the crown. Type (4) · (3), gets into:

\[ Y = \pi acd^2/4 \]  

(5)
From equation (5) can be seen, with the increase of C in canopy leaf area index, under certain circumstances, the carbon sequestration capacity of trees is increasing. This method estimates the carbon sequestration of garden tree species by leaf area index, the data is still the fixed carbon content in plant species.

4 THE CARBON SEQUESTRATION CAPACITY OF THE MAIN GREENING TREE SPECIES IN THE SERVICE AREA

The photosynthetic benefit and carbon sequestration ability of the main greening tree species in north Guangdong were studied by referring to the existing literature, and combined with the green demand of relying on engineering. The carbon sequestration value of the main greening tree species in this study was obtained. According to the data collection, the carbon sequestration and oxygen releasing ability of some garden tree species were summarized in Table 1.

Table 1: Carbon sequestration and oxygen release capacity of garden tree species

<table>
<thead>
<tr>
<th>number</th>
<th>kind</th>
<th>dextrad</th>
<th>type</th>
<th>Carbon sequestration per unit surface area /g·m⁻²·d⁻¹</th>
<th>Oxygen release per unit surface area /g·m⁻²·d⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>camphor tree</td>
<td>Cinnamomum camphora</td>
<td>tree</td>
<td>16.59</td>
<td>12.07</td>
</tr>
<tr>
<td>2</td>
<td>Dendrobert hongkongensis</td>
<td>Cornus hongkongensis</td>
<td>shrub</td>
<td>9.73</td>
<td>7.08</td>
</tr>
<tr>
<td>3</td>
<td>oak</td>
<td>Cyclobalanopsis glauca</td>
<td>tree</td>
<td>11.89</td>
<td>8.65</td>
</tr>
<tr>
<td>4</td>
<td>Elaeocarpus sylvestris</td>
<td>Elaeocarpus sylvestris</td>
<td>tree</td>
<td>16.62</td>
<td>12.09</td>
</tr>
<tr>
<td>5</td>
<td>Photinia fraseri</td>
<td>Photinia parvifolia</td>
<td>shrub</td>
<td>6.28</td>
<td>4.57</td>
</tr>
<tr>
<td>6</td>
<td>holly</td>
<td>Ilex rotunda</td>
<td>tree</td>
<td>4.93</td>
<td>3.59</td>
</tr>
<tr>
<td>7</td>
<td>Melia azedarach</td>
<td>Melia azedarach</td>
<td>tree</td>
<td>2.11</td>
<td>1.53</td>
</tr>
<tr>
<td>8</td>
<td>wintercreeper</td>
<td>Euonymous fortunei</td>
<td>shrub</td>
<td>9.10</td>
<td>6.62</td>
</tr>
<tr>
<td>9</td>
<td>root-bark</td>
<td>Schima superba</td>
<td>tree</td>
<td>15.80</td>
<td>11.49</td>
</tr>
<tr>
<td>10</td>
<td>Sloanea sinensis</td>
<td>Sloanea sinensis</td>
<td>tree</td>
<td>15.89</td>
<td>11.56</td>
</tr>
<tr>
<td>11</td>
<td>Ixora chinensis</td>
<td>Ixora chinensis</td>
<td>shrub</td>
<td>3.99</td>
<td>2.90</td>
</tr>
<tr>
<td>12</td>
<td>Sapium discolor</td>
<td>Sapium discolor</td>
<td>tree</td>
<td>5.46</td>
<td>3.97</td>
</tr>
<tr>
<td>13</td>
<td>Orchid Tree</td>
<td>Bauhinia purpurea</td>
<td>tree</td>
<td>10.15</td>
<td>7.38</td>
</tr>
<tr>
<td>14</td>
<td>Rhizoma Anemones</td>
<td>Eurya chinensis</td>
<td>shrub</td>
<td>4.8</td>
<td>3.49</td>
</tr>
</tbody>
</table>
Through the comparison of 14 species of carbon fixation and oxygen release capacity analysis, we can see that Elaeocarpus sylvestris, Cinnamomum camphora, Schima superba and Sloanea sinensis in carbon fixation and oxygen release has very good performance. At the same time, the plant with high carbon sequestration is also relatively high oxygen release. On the other hand, plants with low carbon sequestration have relatively low oxygen release. For example, Ginkgo biloba, Livistona chinensis. In the shrubs, Cornus hongkongensis, and Euonymus fortunei was good. Both carbon fixation and oxygen release were in the front position. Neem, Ixora etc. deciduous trees in carbon fixation and oxygen release two aspects of poor performance.

5 THE ALLOCATION MODEL OF GREENING TREE SPECIES IN SERVICE AREA BASED ON LOW CARBON CONCEPT

According to the research conclusion of carbon sequestration ability of main greening tree species in service area and the need of ecological landscape in service area, on the basis of classifying the internal function space of service area, according to the service function characteristics of each function space. The main greening plant allocation model of service area based on ecological landscape requirement is put forward.

Table 2: Summary of carbon sequestration and oxygen release allocation of main ecological landscape tree species

<table>
<thead>
<tr>
<th>Composite factor</th>
<th>function requirement</th>
<th>ecology environment</th>
<th>landscape requirements</th>
<th>Recommendation of the backbone plant combination model</th>
</tr>
</thead>
</table>
| Main auxiliary road separation zone | separate | Sound absorption, dust absorption | Evergreen trees with full crown | Model 1: **camphor tree + schima root-bark + Cassia bicapsularis + bougainvillea**  
Model 2: **schima root-bark + Elaeocarpus sylvestris + Hibiscus mutabilis + azalea** |
| Parking area | separate | Shade | evergreen trees dominate, tree - shaped | Model 1: **camphor tree + Dendrobenthamia hongkongensis**  
Model 2: **Sloanea sinensis + Photinia fraseri**  
Model 3: **Alstonia scholaris + fragrans** |
| Comprehensive Building perimeter | Beauty, service | Shading | Trees, shrubs combined, graceful, aromatic, suitable for people to stop | Model 1: **camphor tree + maidenhair tree + Ixora sinensis Lam**  
Model 2: **Orchid Tree + Photinia fraseri**  
Model 3: **Lagerstroemia speciosa + Pomegranate flower** |
Perimeter of the gas station | Greening cover | Root system does not affect use function | Greening cover | Model 1: Photinia fraseri + grass  
Model 2: Dendrobenthamia hongkongensis + Photinia fraseri  
Model 3: Michelia chapensis + Dendrobenthamia hongkongensis + Ixora sinensis Lam  

leisure viewing area | Sightseeing, leisure | Shade, plants are harmless to the human body | Comfortable, beautiful, fragrant, suitable for stopping | Model 1: camphor tree + Hibiscus mutabilis + azalea  
Model 2: Orchid Tree + Photinia fraseri + wintercreeper  
Model 3: Michelia chapensis + Dendrobenthamia hongkongensis + Ixora sinensis Lam

## 6 CONCLUSION

This paper presents a method for estimating carbon sequestration capacity of main afforestation tree species, based on the calculation of 14 kinds of tree species in northern area of carbon sequestration, combined with the spatial features of expressway service area, studied the concept of low carbon service area greening combination mode based on. Although in different regions of China for road greening plants of different varieties, service area green space layout form also has the obvious difference, but the research methods and research results in this paper is still on the green road in other areas of carbon sequestration in plant configuration has theory significance.

## REFERENCES