

## Study on the Value Assessment and Dynamic Change of the Dust Detainment of Hangzhou Scenic Forestland

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**Abstract:** With the rapid development of urbanization and the acceleration of the process of industrialization, environmental pollution is becoming more and more serious. Smoke, dust and dirt are major air pollutants. Urban scenic forestland has the ability to filter and absorb the smoke, dust, dirt and other air pollutants effectively. Dust detainment is an important service function of the ecology system in urban green space. This study makes dynamic evaluation and comparison on the dust detainment of Hangzhou urban forestland in different periods, which shows the value of the dust detainment in Hangzhou urban forestland during the period of the Ninth Five-year Plan, Tenth Five-year Plan and Eleventh Five-year Plan are 8.742 million yuan/a, 9.975 million yuan/a and 9.924 million yuan/a, respectively. The result shows an up trend from the Ninth Five-year Plan period to the Tenth Five-year Plan period, but a down trend from the Tenth Five-year Plan period to the Eleventh Five-year Plan period. Furthermore, in the list of the total value of the annual dust detainment for different community types, the top 3 are broad-leaved evergreen forest, evergreen deciduous broad-leaved mixed forest and deciduous broad-leaved forest, the last one is bamboo and broad-leaved mixed forest. And this result has a close relationship with the green space area and dust detainment ability of different community types.

**Keywords:** Dust detainment, dynamic change, Hangzhou, urban scenic forestland, value assessment

### INTRODUCTION

With the rapid development of urbanization as well as the acceleration of the process of industrialization, the natural environment has been changed, dust and smoke also have increased, which influences people's health greatly. According to relevant data, the annual dust detainment in a square kilometer in a general industrial city is about 500 t and the dust in the city with more serious air pollution is much more. With the development of industry, environmental pollution is becoming more and more serious. Besides taking some measures to reduce the pollution, using plants to absorb pollutants is also an important measure to purify the environment. Smoke, dust and dirt are major air pollutants. Lawrence *et al.* (2012) analyses growth and mortality in a subtropical urban forest ecosystem. Warren *et al.* (2011) study the social and institutional factors associated with land use and forest conservation along two urban gradients in Massachusetts. Baumgardner *et al.* (2012) analyses the role of a peri-urban forest on air quality improvement in the Mexico City megalopolis. Chen *et al.* (2006) study the dust-retention effect of ornamental green land in urban industrial area: A case study in Wuhan Iron and Steel Company workshop area. Vega-Garcia *et al.* (2011) have a research of the social valuation of scenic beauty in catalonian beech forests. Ribe (2009) study the in-stand scenic beauty of variable retention harvests and

mature forests in the US Pacific Northwest: The effects of basal area, density, retention pattern and down wood.

Plants mainly use their branchlets and leaves on the crown to slow down the wind and detain the dust. With big and dense foliage, shrubs or trees have the ability to slow down the wind, thus making the large dust fall down on the ground due to its gravity and weaker wind. Due to the rough and fluffy surface with grease and viscous substances, leaves can absorb, retain and stick some dust so as to reduce the dust in the atmosphere and improve the air quality, which is beneficial to human health. Urban scenic forestland can detain, filter and absorb the smoke, dust, dirt and other air pollutants effectively, so dust detainment is an important service function of its ecology system. This study makes dynamic evaluation and comparison on the dust detainment of Hangzhou urban forestland during the period of the Ninth Five-year Plan (1999 as the representative), Tenth Five-year Plan (2004 as the representative) and Eleventh Five-year Plan (2009 as the representative).

### SITUATION OF STUDY AREA

The ancient name of Hangzhou is Qiantang. In the ninth year of building Sui dynasty (589 A.D.), Qiantang was changed to Hangzhou. Thus, there is a Hangzhou city in the history. Hangzhou is a beautiful city, which is not only one of the seven ancient capitals in China but

also the provincial capital of Zhejiang Province. Hangzhou has a long history, which can be traced back to 2200 years ago when it was named Qiantang in Qin dynasty. Hangzhou is one of the birthplaces of Chinese civilization. As early as 4700 years ago, mankind began to live here and produced the Liangzhu Culture called the Dawn of Civilization.

Hangzhou has always been recognized as the famous city in southeast of China, the land of fish and rice, the city of silk and the country of historical relics and has always been named as “Paradise on Earth” for its material wealth and long standing cultural art. After 2000 years of protection, development and construction, Hangzhou has become a national historical and cultural city, famous landscape tourism resort, modern political and economic center in the southeast coastal area, transportation hub and cultural city with a good natural environment and rich humanity background from a county in the mountain. It has received many honorary titles, such as “China Top Tourist City”, “Oriental Leisure Capital”, “International Garden City”, “National Garden City”, “China Top Tourist City”, “National Environmental Protection Model City”, “UN Habitat Award” and “National Forest City”.

The city center of Hangzhou is at 30°16' north and 120°12' east. In Hangzhou city, there are 8 districts, including Shangcheng, Xiacheng, Jiangan, Gongshu, Xihu, Binjiang, Xiaoshan and Yuhang; 3 county-level cities, including Jiande, Fuyang and Linan; and 2 counties, including Tonglu and Chunan. The city covers an area of 16,596 square kilometers, including 3,068 square kilometers of urban area. The population of Hangzhou is about 6.6 million, which is one of the cities with high densities of population in China.

Currently, there are 5731.48 ha of urban forestland in Hangzhou. According to the divisional principle and classification system in The Vegetation of China, Zhejiang Forest as well as the related research results from the phytobiocoenose in Hangzhou scenic forestland can be divided into 7 major types: broad-

leaved evergreen forest, evergreen deciduous broad-leaved mixed forest, deciduous broad-leaved forest, coniferous broad-leaved mixed forest, bamboo forest, bamboo and broad-leaved mixed forest as well as coniferous forest.

## RESEARCH METHOD

The area-absorbing ability method is usually used to measure the ecological benefit of a large area of plants, which is also used to estimate the dust detainment of urban scenic forestland.

The worth of dust detainment of urban scenic forestland can be calculated through the following equation:

$$W_{\text{dust}} = Q_{\text{dust}} A C_{\text{dust}} \tag{1}$$

In the formula,  $W_{\text{dust}}$  is the annual worth of the dust detainment in urban forestland, whose unit is yuan/a;  $Q_{\text{dust}}$  is the dust detainment quantity of a unit area in urban forestland, whose unit is kg/(hm<sup>2</sup>/a);  $A$  refers to the area of the urban forestland, whose unit is hm<sup>2</sup>;  $C_{\text{dust}}$  refers to the cost for controlling dust, whose unit is yuan/kg.

According to the charge standard of dust discharge fee in the 31<sup>st</sup> order Levy Standard and Calculation Method of Pollutant Discharge Fee issued by the National Development and Reform Commission and other three commissions in 2003, the discharge fee of dust is 0.15 yuan/kg.

According to National Biodiversity Conditions Report (1997) and relevant research results (Xiaorong, 2007), in China, the dust detainment ability of coniferous forest is 33.20t/ (hm<sup>2</sup>/a) on average, that of the coniferous broad-

leaved mixed forest is 21.67t/ (hm<sup>2</sup>/a), that of broad-leaved forest is 10.11t/ (hm<sup>2</sup>/a), that of the bamboo forest is 10.83t/ (hm<sup>2</sup>/a), that of the bamboo and broad-leaved mixed forest is 10.47t/ (hm<sup>2</sup>/a).

Table 1: The dust detainment value for different community types in urban green space and their dynamic changes

Community types	Year	Annual quantity of dust detainment (kg/a)	Total value of dust detainment (yuan/a)
Coniferous forest	1999	3352316.9	502847.5
Coniferous forest	2004	3825290.7	573793.6
Coniferous forest	2009	3805702.7	570855.4
Coniferous broad-leaved mixed forest	1999	8752374.3	1312856.1
Coniferous broad-leaved mixed forest	2004	9987234.9	1498085.2
Coniferous broad-leaved mixed forest	2009	9936093.7	1490414.1
Broad-leaved evergreen forest	1999	19395980.4	2909397.1
Broad-leaved evergreen forest	2004	22132533.0	3319879.9
Broad-leaved evergreen forest	2009	22019199.9	3302880.0
Deciduous broad-leaved forest	1999	9697990.2	1454698.5
Deciduous broad-leaved forest	2004	11066266.5	1659940.0
Deciduous broad-leaved forest	2009	11009599.9	1651440.0
Evergreen deciduous broad-leaved mixed forest	1999	12760513.4	1914077.0
Evergreen deciduous broad-leaved mixed forest	2004	14560877.0	2184131.5
Evergreen deciduous broad-leaved mixed forest	2009	14486315.7	2172947.4
Bamboo forest	1999	2733854.8	410078.2
Bamboo forest	2004	3119570.7	467935.6
Bamboo forest	2009	3103596.4	465539.5
Bamboo and broad-leaved mixed forest	1999	1585787.2	237868.1
Bamboo and broad-leaved mixed forest	2004	1809523.8	271428.6
Bamboo and broad-leaved mixed forest	2009	1800257.9	270038.7

**RESULTS AND ANALYSES**

**Analysis on the dust detainment value of urban scenic forestland during different periods:** The value of the dust detainment in Hangzhou urban forestland during the period of the Ninth Five-year Plan, Tenth Five-year Plan and Eleventh Five-year Plan are 8.742 million yuan/a, 9.975 million yuan/a and 9.924 million yuan/a, respectively. The value was rising from the Ninth Five-year Plan period to the Tenth Five-year Plan period, but descending from the Tenth Five-year Plan period to the Eleventh Five-year Plan period. Table 1 shows the dust detainment value for different community types in urban green space and their dynamic changes. Figure 1 shows the comparison on the dust detainment value for different community types in scenic forestland. Figure 2 shows the comparison on the total dust detainment value scenic forestland during different periods. Figure 3 shows the proportion of the dust detainment value for different community types in scenic forestland.

**Comparison on the total dust detainment value for different community types:** Seen from the total dust detainment value for different community types in urban scenic forestland, the value is in the following order: broad-leaved evergreen forest>evergreen deciduous broad-leaved mixed forest>deciduous broad-leaved forest>coniferous broad-leaved mixed forest>coniferous forest >bamboo forest>bamboo and broad-leaved mixed forest. The top 3 are broad-leaved evergreen forest, evergreen deciduous broad-leaved mixed forest and deciduous broad-leaved forest, the last one is bamboo and broad-leaved mixed forest, which has a close relationship with the green space area and dust detainment ability of different community types.

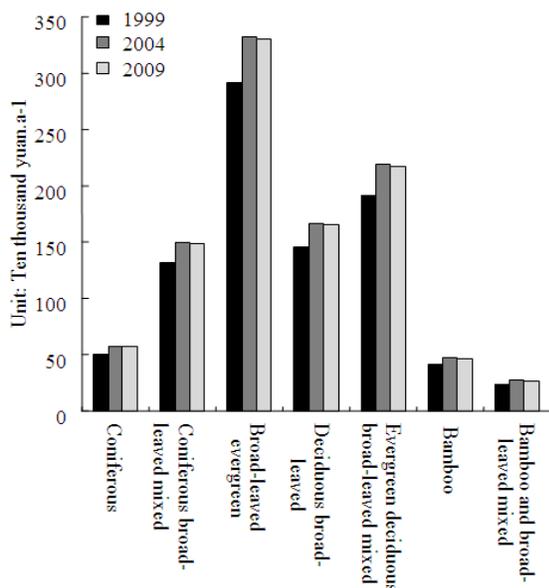


Fig. 1: Comparison on the dust detainment value for different community types in scenic forestland

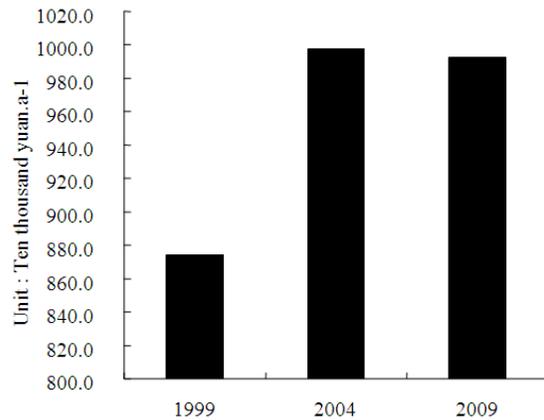


Fig. 2: Comparison on the total dust detainment value scenic forestland during different periods

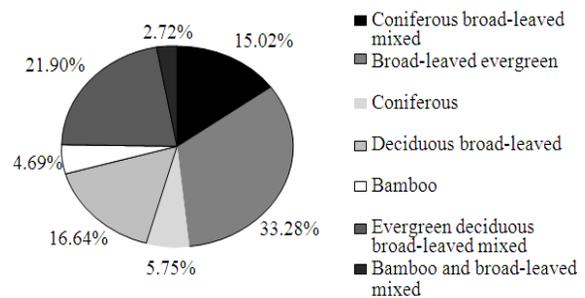


Fig. 3: The proportion of the dust detainment value for different community types in scenic forestland

**Analysis on the proportion of the dust detainment value for different community types:** The proportion of the dust detainment value for different community types in scenic forestland is in the following order: broad-leaved evergreen forest>evergreen deciduous broad-leaved mixed forest>deciduous broad-leaved forest>coniferous broad-leaved mixed forest>coniferous forest>bamboo forest> bamboo and broad-leaved mixed forest. The top 2 are broad-leaved evergreen forest (33.28%) and evergreen deciduous broad-leaved mixed forest (21.90%), the last one is bamboo and broad-leaved mixed forest (2.72%).

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