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Effects of Street Trees on $PM_{2.5}$ Reduction in Seoul

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Extended Abstract

Fine particulate matter less than 2.5 microns ($PM_{2.5}$) could exacerbate bronchitis and cardiac conditions. $PM_{2.5}$ concentration has been globally increasing due to operation of power plants and vehicles. Recently, annual $PM_{2.5}$ concentration in Seoul, Korea averaged 24.5 $\mu g/m^3$, higher than the World Health Organization (WHO)'s annual reference level of 20.0 $\mu g/m^3$ [1]. There is rising concern on urban tree planting to help reduce the level of atmospheric $PM_{2.5}$ [2]. However, little is known about $PM_{2.5}$ reduction by urban trees in the city. The purpose of this study was to quantify annual $PM_{2.5}$ reduction by street trees in Seoul and to suggest desirable planting and management strategies to improve effects of $PM_{2.5}$ deposition.

Data on street trees were collected on plots which were located using a stratified sampling method on aerial photographs with a scale 1:1,000 [3]. Eight straight lines radiating from the center of the study city were drawn in eight different directions, and subsequently circles were drawn 40 cm apart. This study sampled a total of 50 points at which the circles and lines coincided. A survey plot for each point was established up to 80 m in length from the point and to building boundaries of both sidewalks in width. The number of samples was a compromise between the competing concerns for a large sample size and the availability of expense. Field-surveyed data included species, stem diameter, height, crown width, and density of street trees. These data were used to produce an average estimate per unit area on annual $PM_{2.5}$ reduction by street trees. The $PM_{2.5}$ reduction was quantified applying a dry deposition model [2, 4] based on deposition velocity, total leaf area, and resuspension ratio by wind speed. Total $PM_{2.5}$ reduction by street trees was computed using total street area in the study city.

The structures of street trees in the study city were characterized by single-layered and single-aged planting. Mean stem diameter of street trees was 25.5 cm (at breast height of 1.2 m) and annual $PM_{2.5}$ reduction per street tree averaged approximately 47.2 g/yr. Annual $PM_{2.5}$ reduction per unit area by street trees was approximately 4.2 kg/ha/yr, and total $PM_{2.5}$ reduction of the entire street area was about 32.8 t/yr. Total annual emissions of $PM_{2.5}$ from energy consumption was about 1,300 t/yr in the study city [5]. Street trees annually offset the total $PM_{2.5}$ emissions by 2.5%. Thus, street trees played an important role in reducing the level of atmospheric $PM_{2.5}$. This study suggested desirable planting and management strategies including multi-layered and multi-aged tree planting, supply of the space for normal crown and root growth, and avoidance of severe pruning. The results from this study are expected to contribute to internationally sharing the role and importance of urban trees in reducing $PM_{2.5}$ concentration.

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References

[1] WHO (World Health Organization), (2018, January 15). *Ambient (Outdoor) Air Quality and Health.* [Online]. Available: http://www.who.int/mediacentre/factsheets/fs313/en

[2] D. J. Nowak, S. Hirabayashi, A. Bodine and R. Hoehn, "Modeled $PM_{2.5}$ removal by trees in ten U.S. cities and associated health effects," *Environmental Pollution*, vol. 178, pp. 395-402, 2013.

[3] H. K. Jo, J. Y. Kim and H. M. Park, “Carbon storage and uptake by street trees in Seoul,” *J. Forest and Environmental Science*, in press, 2018.
[4] H. K. Jo, *Indicator for CO_2 Uptake and Atmospheric Purification Evaluation of Vegetation. Development of Eco-Indicators for Sustainable Development*. Seoul: Ministry of Environment, 2001.
[5] NIER (National Institute of Environmental Research), (2018, January 30), *Annual Emissions of Air Pollutants*. [Online]. Available: http://airemiss.nier.go.kr/module/statistics/pollutantsStatistics.do?siteId=airemiss&id=airemiss_030400000000