Agriculture and Natural Resources 50 (2016) 114–119

Contents lists available at ScienceDirect

Agriculture and Natural Resources

journal homepage: http://www.journals.elsevier.com/agriculture-and-natural-resources/

Original article

Effect of gases and particulate matter from electricity generation process on the radial growth of teak plantations surrounding Mae Moh power plant, Lampang province

Narapong Sangram,[a, b] Khwanchai Duangsathaporn,[b, *] Roongreang Poolsiri[c]

[a] The Graduate School, Kasetsart University, Bangkok 10900, Thailand
[b] Laboratory of Tropical Dendrochronology, Department of Forest Management, Faculty of Forestry, Kasetsart University, Bangkok 10900, Thailand
[c] Department of Silviculture, Faculty of Forestry, Kasetsart University, Bangkok 10900, Thailand

ARTICLE INFO

Article history:
Received 9 June 2015
Accepted 11 July 2015
Available online 9 June 2016

Keywords:
Gases
Growth
Mae Moh power plant
Particulate matter
Teak

ABSTRACT

The objectives of this study were to investigate radial growth patterns and influences of polluting gases and particulate matter on the radial growth of teak plantations surrounding the Mae Moh Power Plant. Twenty-four 32-year-old teak trees were selected from Mae Jang and Mae Moh plantations, which were 5 km and 15 km from the Mae Moe power plant, respectively. Forty-eight sample cores were collected from the 24 trees (two cores per tree). The growth patterns of all the cores were analyzed following the standard methods of dendrochronology. The relationships between the growth pattern and the amounts of sulfur dioxide, nitrogen dioxide, carbon monoxide and particulate matter were measured as average daily rates and then analyzed. The study showed that the best-fit model for the relationship between the radial current annual increment at breast height (CAI_{dbh}) and time (Y) was an exponential equation. The fitted equations were: $CAI_{dbh} = 10.657e^{(-0.031Y)}$ for Mae Moh plantation and $CAI_{dbh} = 12.518e^{(-0.032Y)}$ for Mae Jang plantation. The coefficient of determination for the fitted equations was 0.410 and 0.423 for the Mae Moh and Mae Jang plantations, respectively. Moreover, carbon monoxide (CO) and sulfur dioxide (SO_2) had a statistically significant effect on radial teak growth (RT) in the Mae Jang plantation, with a coefficient of determination of 0.69 ($RT_{mj} = 0.571 + 0.429(CO) - 0.023(SO_2)$).

Copyright © 2016, Production and hosting by Elsevier B.V. on behalf of Kasetsart University. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Introduction

Electrical power is important for human communities and is derived from a variety of manufacturing processes using charcoal fuel, water, wind and solar sources which can have different impacts on the surrounding environment (Breeze, 2014). The combustion of charcoal fuel, which is commonly used in central and northern Thailand, causes pollution from sulfur dioxide (SO_2), carbon monoxide (CO) and nitrogen dioxide (NO_2) (College of Public Health Sciences, 2001). For example, the extreme air pollution that was emitted from the Mae Moh Power Plant in Lampang province, Thailand in 1992 and 1997 (Pollution Control Department, 2000) affected human health and property, animals and plants in the surrounding area. In those cases, the Thai government compensated for losses of over USD 35,000 million (College of Public Health Sciences, 2001). Generally, the study of the effect of air pollution from the combustion process in Thailand has focused only on human health, not on tree health. In the current study, dendrochonological techniques were used due to their high accuracy (Schweingruber, 1996) and appropriateness for studying the correlation between air pollution and growth (Marco et al., 2002). For example, in a study involving a charcoal fuel power plant in Penzberg, Germany, tree rings of silver fir were used to investigate the effect of pollution on plant health and on missing rings during the emission period (Elling, 2001). Another study involved analysis of the growth pattern of *Pinus thunbergii* near a chemical plant in South Korea that reported growth had significantly decreased after the establishment of the plant (Kim and Fukazawa, 1997).

Teak (*Tectona grandis L.f.*) was selected for the current study as is it one of the most important economic timber trees of Thailand that is indigenous in northern Thailand (Paoin, 1993) and it has distinct annual growth rings (Palakit et al., 2012). Both genetic and environmental factors (rainfall, air temperature and air pollution) affect teak growth (Brandan et al., 2007). Thus, it is reasonable to use tree ring analysis to investigate the effect of pollution on annual teak

* Corresponding author.
E-mail address: fforkcd@ku.ac.th (K. Duangsathaporn).

http://dx.doi.org/10.1016/j.anres.2016.06.001
2452-316X/Copyright © 2016, Production and hosting by Elsevier B.V. on behalf of Kasetsart University. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

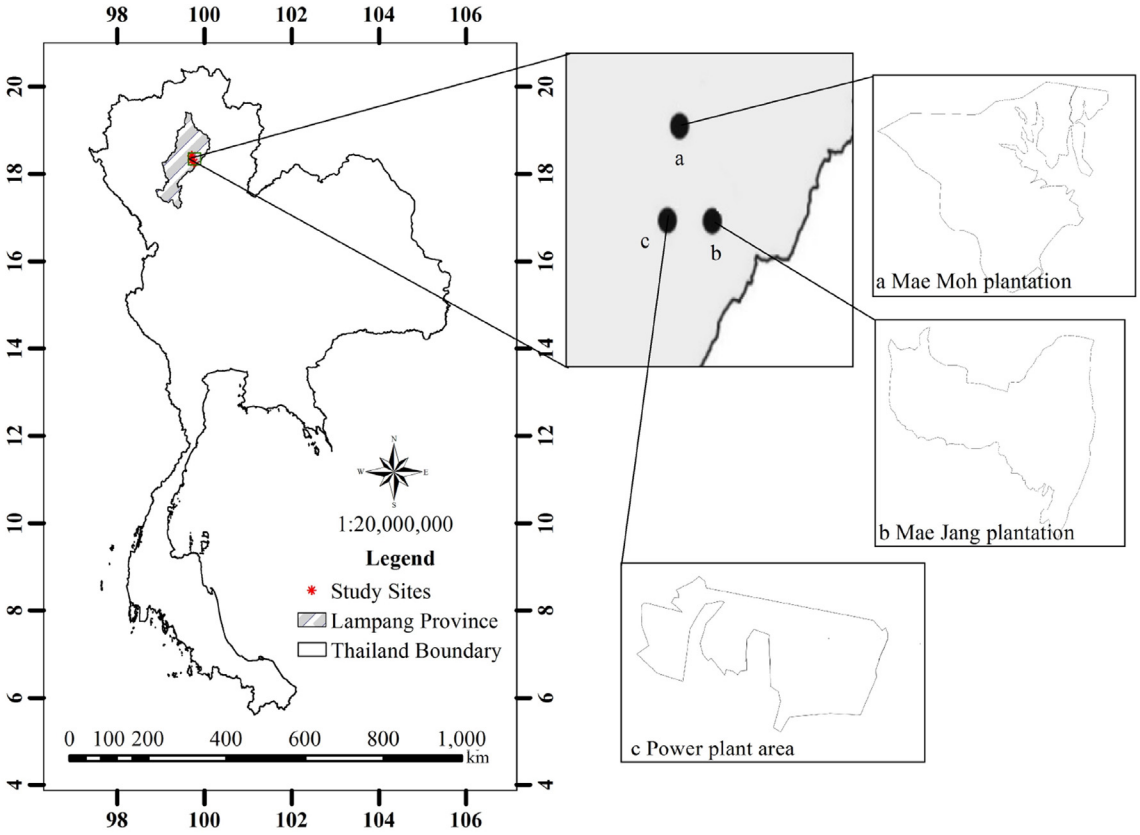

Fig. 1. Study area.

growth. The current study investigated the growth patterns and influence of air pollution gases and particulate matter on teak growth in plantations surrounding the Mae Moh Power Plant, Lampang province, Thailand.

Materials and methods

Study site

Teak trees in the Mae Moh and Mae Jang plantations used in the study were 15 km north and 5 km east of the power plant, respectively. Both plantations belong to the Forest Industry Organization of Thailand and are located in Mae Moh district, Lampang province, northern Thailand, at 2,036,195 N, 576,618 E and 2,019,739 N, 580,309 E, respectively (Fig. 1) The teak trees in this study were planted in 1979 and were aged 32 yr at the time of measurement. The spacing was 4 m × 4 m with similar topography, silvicultural systems and elevations above mean sea level in the two plantations (Tables 1 and 2).

Air pollution concentration data

The air pollution concentration data were obtained from the Soppat air quality monitoring station (5 km south of Mae Jang plantation) and the Tarsee air quality monitoring station (5 km north of Mae Moh plantation) for analysis of the tree growth data from the Mae Jang and Mae Moh plantations, respectively, which are under the control of the Pollution Control Department, Thailand. Data were obtained as a time series of averages of daily air pollution concentration data consisting of sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2) and particulate matter. Data for a 14 yr period from 1998 to 2011 were obtained (Table 3).

Tree core collection

The distribution of diameter at breast height (1.3 m) over bark (DBH) of teak (Table 4) in both plantations was determined from a forest inventory using the systematic random sampling method (Wilks, 2006). In total, 292 and 370 trees were sampled from Mae Moh and Mae Jang plantations, respectively. Sample sizes for both plantations were calculated using Equation (1) (Shiver and Borders, 1996) as 290 and 296 teak trees, respectively. The optimal number of sample trees from the forest inventory should be higher than the calculation.

$$n = \frac{t^2(\mathrm{cv})^2}{\mathrm{AE}^2} \quad (1)$$

Table 1
Silvicultural practices in Mae Moh and Mae Jang plantation.

Plantation	Silvicultural practice			
	Spacing (m)	Thinning		Final cutting (year)
		First (year)	Second (year)	
Mae Moh	4 × 4	23	24	32
Mae Jang	4 × 4	23	30	32

Table 2
Topography and climate of Mae Moh and Mae Jang plantations.

Plantation	Elevation above mean sea level (m)	Mean annual rainfall (mm)	Mean annual temperature (°C)
Mae Moh	300–500	1212	25.31
Mae Jang	300–450	1200	26.00

Download English Version:

https://daneshyari.com/en/article/83084

Download Persian Version:

https://daneshyari.com/article/83084

Daneshyari.com