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Spatial and Temporal Variations of Satellite-Derived PM10 of Chiang Mai: An Exploratory Analysis

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Abstract

Seasonal haze pollution is a big issue in northern part of Thailand for last decade. It normally happens in dry season during February to May annually. Chiang Mai is one of effected city and become economics and health concerns for local people seriously. Thus, haze pollution monitoring remains a challenge. PM10 value is the key indicator of air quality. Many publications have been reported the relationship between PM10 value and the aerosol optical thickness (AOT) which can be analyzed by MODIS Aerosol Product. This study examined the temporal and spatial distribution of PM10 base on a long-term monitoring data (2007-2016) using Terra-MODIS MOD04_3K product with 3 km resolution. The images were analyzed and calculated AOT and PM10 using existing model. The results were converted to air quality index according to standard of Thailand Pollution Control Department as good, moderate, unhealthy, very unhealthy, and hazardous. The result showed that high PM10 values (> 120 µg/m3) which unhealthy for sensitive groups and very unhealthy levels were exposed in February, March, and April for some areas. The highest PM10 value was found in February and has been continuously decreasing in March, April and May, respectively. These results are useful for haze resilience against impact in the near future.

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Keywords: Haze pollution; MODIS, PM10; Air Quality Index (AQI); Aerosol Optical Thickness (AOT); Chiang Mai

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1. Introduction

Haze pollution has caused adverse health and economic impact in many Southeast Asia countries such as Brunei Darussalam, Indonesia, Malaysia, Singapore, Myanmar, Laos, Cambodia, and Thailand. The haze pollution in northern Thailand is caused by a combination factors. The biomass burning from agriculture residue and seasonal forest fire are the main season which common over the countries in this region including Myanmar and Laos. Chiang Mai in particular experiences extreme haze pollution effects because of its location in the Chiang Mai-Lamphun valley, where smoke from neighboring Myanmar and Laos is prone to settle. It has been a crisis not only in Chiang Mai area but also in the whole of northern Thailand and border countries which related to large scale air pollution problem [1]. Asian transboundary haze and it has been recorded almost every year since 1972. Particulate matter (PM) or aerosol is an important air pollutant, which is associated with adverse human health effects, deterioration in visibility, and uncertain impacts on climate change and PM10 is particulate matter 10 micron or less in diameter [2]. Air quality index (AQI) is a number used by government agencies to communicate to the public on how polluted the air currently is or how polluted it is forecast to become.

The Moderate Resolution Imaging Spectroradiometer (MODIS) has been widely applied in haze analysis due to its spatial and temporal coverage. MODIS product is a powerful dataset for PM10 monitoring, especially in remote area with no ground-based station, which has been evaluated and used in several studies [3-8]. Aerosol optical thickness (AOT) is the integration of the aerosol extinction coefficient from the earth's surface to the top of the atmosphere, and it represents the attenuation of solar radiation caused by aerosols. The advantage of MODIS product is both in term of spatial and temporal resolution. The aerosol optical thickness (AOT), which is the extinction of radiation caused by aerosol in the atmospheric column under observation. By using satellite data, AOT is the principal data product used for assessment of the PM10 pollution, which is normally created from relationship between satellite data and ground based air pollution station. Many researchers have demonstrated their models for estimating PM10 value such as Leelasakultum and Kim Oanh [9] developed simple linear regression model for PM10 estimation (with $R^2 = 0.51$) from a relationship between AOT and 4 ground based stations in Northern Thailand during dry season (February – April) using MODIS product. Similar work to Kheatkanya [10] which also developed PM10 estimation model in Chiang Mai ($R^2 = 0.86$) with non-linear regression model. The main objective of this study was to examine pattern of PM10 during 2000 – 2016 from MODIS AOT product in Chiang Mai Province, which will be useful for assessing the effective in burning control enforcement in the near future.

2. Materials and methods

2.1. Study area

The study area is Chiang Mai Province, Thailand. It is located between 18°50′N and 98°58′E in Northern Thailand with Myanmar as its Northern neighbor (Fig 1). It covers an area of approximately 20,107 km2 (8,000 sq mi). The area consists of mountains covered with forest, agricultural activities and residential area. The climate of this region is tropical monsoons. The period from mid of February until mid of May can be defined as a transitional period between winter and summer seasons. The hottest temperature mostly found in March – April and this time the forest fire and biomass burning are reported [9].