The Inhalation Exposure of Fine Dust (PM$_{10}$) of Year 2022 in Phitsanulok City site, Thailand

Suttabongkoch Aulpathorn, Supawan Srirattana, and Pajaree Thongsanit

Suttabongkoch Aulpathorn, Master Student of Environmental Engineering Program, Faculty of Engineering, Naresuan University, Thailand, 65000

Supawan Srirattana, Dr. and Lecturer of Environmental Engineering Program, Faculty of Engineering, Naresuan University, Thailand, 65000

Pajaree Thongsanit, Assistance Professor Dr. of Environmental Engineering Program, Faculty of Engineering, Naresuan University, Thailand, 65000

Abstract: *The inhalation exposure of fine dust PM10 (particulate matter less than 10 µm in size) at Phitsanulok city station that is under of Thailand's Pollution Control Department. The three objectives of the research are as follows. The first aim is to study level PM10 concentrations at Phitsanulok city station. The second aim is to assess exposure to PM10 among people near the station. The third aim is to assess the risk of PM10 dust to people near the station. The PM10 samples were collected from the Pollution Control Department website. http://air4thai.pcd.go.th/webV2/history/ of the year 2022. The inhalation exposure of the people near the station was evaluated, and the health risk was determined based on the hazard quotient (HQ). The results indicated that the highest daily PM10 concentrations were detected at main road in front of the Phitsanulok city roadside, with PM10 concentrations of 19.00 and 72.16 µg/m3, respectively. Exposure to PM10 dust range 8.61x10-6 to 4.18x10-3mg/kg-day. The evaluation of HQ (Hazard Quotient is less than 1, meaning that people who stay near measurement point do not have an impact on their health. The station is set in the garden area near Nan River. In front of Phitsanulok College, Phitsanulok people's health do not at risk from exposure to fine dust of Year 2022*

Keywords: *PM$_{10}$, Inhalation Exposure, Phitsanulok City*

1. Introduction

Phitsanulok city is a big municipality in the downtown Phitsanulok province, located at the South of the Northern part of Thailand, 370 km from Bangkok. It is an important economic city in which there is a rapid growth of industrial, transportation and construction activities. The data from the department of provincial administration, ministry of interior of year 2024, shows that the population in Phitsanulok municipality is estimated to be about 62,089 in an area of 18 km2.[1] Many activities such as traffic, industrial, agricultural, building, commercial, and others were considered as main sources of Particulate Matter (PM) including those having sizes smaller than 10 micron (PM10). Several reports indicated that the quantity of roadside PM10 samples was higher than the Thai Ambient Air Quality Standard (NAAQS) 120 µg/m3 Ambient PM10 has effect on human and it has been found to be associated with the daily mortality rate [2],[3]. Roadside particles were one of the main outdoor sources. The dust particles, which are smaller than 10 µm in size, are less than 5% of all

dusts found on the road surface. The accumulation of the dust can be described by linear or non-linear equations. Moreover, there are equations describing the loss of dust which its mechanism depends on the height of road edge, vehicle speed, and the wind speed. [4] The three objectives of the research are as follows. The first aim is to study PM10 concentrations at Phitsanulok city station. The second aim is to assess exposure to PM10 dust among people near the station. The third aim is to assess the risk of PM10 dust to people near the station.

2. Research Method

2.1.   Sampling Site

The sampling site located at the south of the northern part of Thailand, namely Phitsanulok province. Phitsanulok is a city, municipality, the capital and the largest populated place of the Thai province of Phitsanulok. It is also the headquarters of the Mueang Phitsanulok District. Phitsanulok is the second–largest cities by population in the lower northern Thailand. The city is one of the center of Thailand's tourism industry, and it is a historic city in the country.

The dust samples were collected 365 samples in a year in the Phitsanulok municipality area of Phitsanulok province. Map in figure 1 showed the area of Suan Chom Nan In front of Phitsanulok College. The duration of sampling the project was determined from 1 January year 2022 to 31 December year 2022.

Fig. 1 Maps of Thailand and Phitsanulok sampling site

2.2.   Sampling Method

The researcher collected the daily PM10 samples through the website http://air4thai.pcd.go.th/webV2/history/ The air quality measuring station using PM10 measurement under the Thai national standard, set in Suan Chom Nan Chaloem Phrakiat, Phitsanulok vocational College, closing of the Nan River. The dust which provides estimated PM10 data for Phitsanulok Province. During the period from 1 January year 2022 to 31 December year 2022, a total of 12 months.
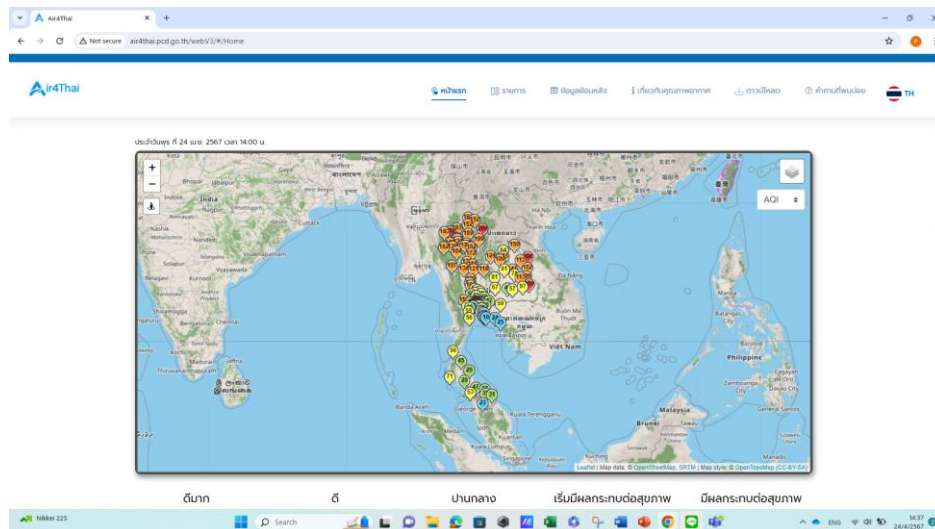
Fig. 2 Web page of air4thai (http://air4thai.pcd.go.th/webV3/#/Home))[6]

- Publisher: World Academic Press
- Conference host: UK Association of Sports Mathematics and Engineering, etc.

Following is an example of a graphic and caption ("Figure" style).

Fig. 1: Use "Figure/picture" style used here.

2.3. Assessment the Exposure of PM$_{10}$

The sample population consisted of individuals who lived near the sampling site. The 200 questionnaires were collected to assess the exposure. The data, such as exposure time (ET), exposure frequency (EF), exposure duration (ED), and body weight (BW), were collected and analyzed using descriptive statistics (mean and maximum).[6], [7], [8].

An exposure assessment is a method for involves estimating or quantifying the concentration of a substance. It which consists of the following steps as follows:

Step 1. gathering the data of the concentration of PM10 concentration data of each location and the data from the questionnaires as explained in study population [9].

Step 2. assessing the exposure to PM10 through inhalation using the quantity of average daily intake (ADI), as expressed in the equation below [10].

$$ADI = \frac{CA \ x \ IR \ x \ ET \ x \ EF \ x \ ED}{BW \ x \ AT} \qquad Equation\ 1$$

Where ADI is the average daily exposure.
   (mg/kg-body weight/day)
  CA is the concentration of dost in the air (mg/m^3)
  IR is the breathing rate (m^3/hr.)
  ET is time of exposure (hrs./day)
  EF is the frequency of exposure (day/year)
  ED is the duration of exposure (years)

(Average life expectancy of the population–age of passengers)

BW is body weight (kg)

AT is the exposure time (days)

(EDX365 days/year), which was constant for the parameters.

Risk assessment of PM$_{10}$

Risk level was calculated to explain the health effects from PM$_{10}$ exposure in term of Hazard Quotient (HQ) according to the equation below [9]. expressed as:

$$\text{Hazard Quotient (HQ)} = \frac{\text{Exposure (mg/kg/day)}}{\text{RfC (mg/kg/day)}} \quad \text{Equation 2}$$

Where   HQ (Hazard Quotient) is risk ratio

Exposure is daily exposure value (mg/kg/day)

RfC (Reference Concentration) is the reference.

Concentration of the pollutant or the amount that enters the body through inhalation without causing Health Hazard(mg/kg/day)

3. Results and Discussion

The PM10 concentration of Phitsanulok samples that measured during year 2022, total of 12 months, the data was collected through the Air Quality and Noise Management, website of the Pollution Control Department of Thailand. The PM10 concentration data was recorded as 24 hours. From the study, the results can be summarized in figure 3. The highest of data is 72.16 µg/m3 in December of year 2022. PM10 samples was not higher than the Thai Ambient Air Quality Standard (NAAQS) 120 µg/m3. The study found that the main sources of dust were from burning for agriculture. and the occurrence of forest fires.

Fig.3 PM$_{10}$ concentration in 12 months at Phitsanulok site

The Inhalation exposure of PM10 is shown in figure 4. The monthly average of PM10 range of 19.00 µg/m^3 to 72.16 µg/m^3. The dust concentrations were calculated the quantity of average daily intake (ADI). It was found that high inhalation exposure during December, April, March and January of year 2022, The period was in the dry season. The highest inhalation exposure in the age range of 1-6 years. The highest exposure was December, 0.0041 mg/kg-day. The inhalation exposure of the age ranges 19-60 years and 61-80 years have low exposure values.
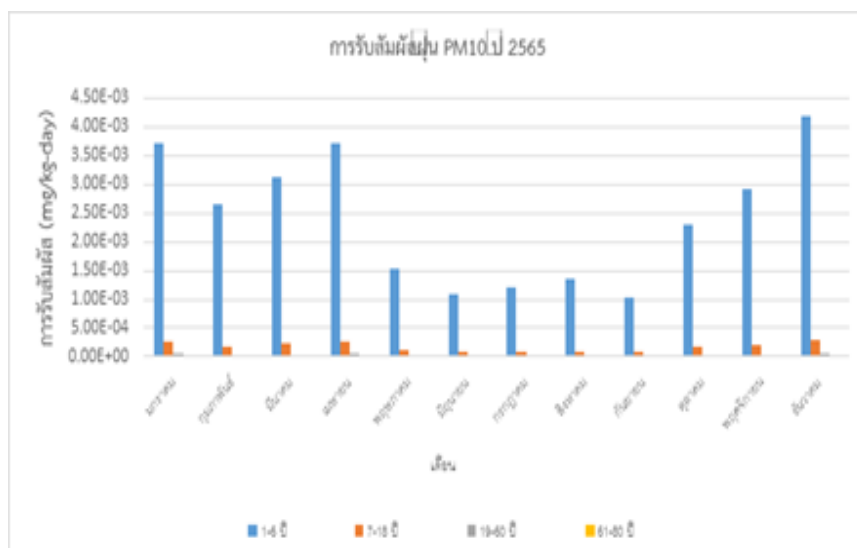
Fig. 4 The Inhalation exposure of PM$_{10}$ in 12 months

Risk level was calculated to explain the health effects from PM10 exposure in term of (HQ). It was found that the risk ratio evaluation for the age range of 1-6 years had the highest risk ratio value. In December it was 0.8368 with a low of risk ratio.

Considering HQ < 0.1 means no danger.

$0.1 \geq HQ \leq 1.0$ means there is a low level of danger.

$1.1 \geq HQ \leq 10$ means there is a moderate level of danger.

HQ > 10 means there is a high level of danger.

From the HQ evaluation, it was found that the value was in the range of 0.0011 - 0.8368, which was less than 1, meaning that people living in the Suan Chom Nan in front of Phitsanulok college. There is no risk from exposure to PM$_{10}$ dust, so it does not affect health. However, the Nan viewing area. It is a public area and next to the road for traffic. People used Suan Chom Nan and exposure dust throughout the day. The PM$_{10}$ dust concentration does not exceed the national standard. People in the area of Suan Chom Nan must therefore be no danger. (Figure5)

Fig.5 The HQ of PM$_{10}$ in 12 months

4. Conclusion

PM_{10} concentrations of 19.00 and 72.16 µg/m³, respectively. Exposure to PM_{10} dust range 8.61×10^{-6} to 4.18×10^{-3} mg/kg-day. The evaluation of HQ (Hazard Quotient is less than 1, meaning that people who stay near measurement point do not have an impact on their health. The station is set in the garden area near Nan River. In front of Phitsanulok College, Phitsanulok people's health do not at risk from exposure to PM10 dust in Year 2022. The suggestions of this research were the first is study of impacts and health of people living in the area should be studied for data analysis. The second study of the population, age, and data used to calculate exposure of people living in the area for data analysis.

5. Acknowledgment

6. References

[1] Phitsanulok Municipality
https://phsmun.gdcatalog.go.th/dataset/people1/resource/d337a3bf-c441-4b1b-b3fe-336cab94e2e1, 2024.
[2] Department of Health and Department of Disease Control Ministry of Public Health. Guidelines for monitoring risk areas. from air pollutionIn the case of small dust particles. Retrieved from www.enhealthplan.anamai.mail.go.th, 2015.
[3] Pakorn Pimsang, Problems of road traffic accidents in Naresuan University and surrounding areas. (thesis) Faculty of Agriculture, Natural Resources and Environment Naresuan University, 2020.
[4] V. Novotny and H. Olem, Water Quality Prevention Identification and Management of Diffuse Pollution, New York, 1994
[5] Pollution control Department, Webpage of Air 4 Thai (http://air4thai.pcd.go.th/webV3/#/Home), 2024
[6] U.S. Environmental Protection Agency, "Risk Assessment Guideline for Superfund Volume I Human Health Evaluation Manual (Part A)," 1989.
[7] U.S. Environmental Protection Agency, "Guidelines for Human Exposure Assessment," 2016.
[8] U.S. Environmental Protection Agency, "Standard Operating Procedure for Particulate Matter (PM)Gravimetric Analysis," 2008.
[9] World Health Organization, "Ambient (outdoor) air quality and health," 2018.
[10] N. D. L. Thabethe, J. C. Engelbrecht, C. Y.Wright, and M. A. Oosthuizen, "Human health risks posed by exposure to PM10 for four life stages in a low socioeconomic community in South Africa" Pan African Medical Journal, Vol 18:206, 2014

Suttabongkoch Aulpathorn is master student of environmental engineering program, faculty of engineering, Naresuan University, Thailand. She received a bachelor's degree from Rang sit university, Thailand in Industry Engineering. Her research is focused on air pollution innovative research in Thailand.

Dr. Supawan Srirattana earned a Ph.D. in Environmental Engineering from Naresuan University and has been a lecturer for 5 years in the Faculty of Engineering at Naresuan University, Thailand. Dr. Supawan received a bachelor's degree and master 's degree from Naresuan University, Thailand in Environmental Engineering. Her research is focused on air pollution and outdoor air quality in Thailand, with more than 10 publications in this area.

Assist. Prof. Dr. Pajaree Thongsanit earned a Ph.D. in Environmental Engineering from Chulalongkorn University in 2002 and has been a lecturer for 26 years in the Faculty of Engineering at Naresuan University, Thailand. Pajaree was born on October 30, 1971 and received a bachelor's degree from Mahidol University, Thailand in Public Health and a master's degree in Environmental Engineering from Kasetsart University, Thailand. Her research is focused on air pollution and indoor and outdoor air quality in Thailand, with more than 50 publications in this area.