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Occupational health and safety management case study: Establishment of PM_{10} Contour map

Nopagon Usahanunth *

Department of Occupational Health Safety and Environment, Faculty of Public Health, Western University, Kanchanaburi Campus, Thailand.

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Abstract

Atmospheric dust is a significant air pollution problem. Particulate matter is small solid particles floating in the air. It is caused by objects that have been smashed, hit, crushed, and crushed until they break down into small parts. When blown by the wind, it will spread in the air. And fell to the ground the fall time is slow or fast depending on the dust particles' weight. Dust is divided into large dust, including small dust called PM_{10} (dust with a diameter from 10 microns down). The stone mill problem has been a long-time problem. Many related government agencies try to fix the problem of dust pollution and health safety.

PM_{10} disperse from the source to the community nearby the stone mill was measured by the low-cost dust monitoring device. The result found that the 24-hour mean PM_{10} particulate matter was 0.090 mg/m^3, which was also lower than the statutory permissible 24-hour Mean PM_{10} at no more than 0.12 mg/m^3. The PM_{10} dust contour map can be used for health risk management planning, primarily to mitigate the pollution to the community environment and their health under some usage limitations changes.

Keywords: Particulate Matter (PM_{10}); PM_{10} Contour map

1. Introduction

The stone crushing factory that processes stone to different sizes will be transformed into smaller sizes according to the user's order, whether used in construction or other forms of work, the stone according to its characteristics and delivering it to the customer who made the order. Each step of the process caused dust dispersion. These dust sources are obtained from mountain blast rocks and processed by sieving them on a sieve for different sizes, the stone used as building materials. Buildings, roads, roads, and other utilities, but at the same time, there are environmental problems and impacts on the community regarding noise—pollution and safety matter.

The environment is significantly affected by air quality. Many studies try to expose the relationship between air pollution and the quality of life and health. Air pollution fades respiratory functions and cardiovascular problems and increases asthma rates [1]. The air pollutants indicate powerful flexibility; their intensities vary according to region. Each pollutant's inconsistency is also high because of various factors, such as pollutant type and atmospheric circumstances [2–5].

Sensor technology generates data at an unprecedented rate and scale to the rapid adoption of low-cost dust monitor for air quality monitoring. The measurements of all target devices, which were corrected according to the reference device,

* Corresponding author: Nopagon Usahanunth
Department of Occupational Health Safety and Environment, Faculty of Public Health, Western University, Kanchanaburi Campus, Thailand.

provided accurate values at $PM_{2.5}$ concentrations of ≥ 40 μg/m^3. The statistical analysis results suggest that the evaluated devices are more reliable than the conventional numerical-analysis-based monitoring system [6].

A Low-Cost Particulate Matter (PM_{10}) Smart Sensor was modeled and applied for environmental risk assessment from the stone crushing industry in Kanchanaburi province, Thailand.

Dust distribution and environmental problems in this area are considered one of the issues that the researchers wanted to communicate with interested parties and those affected by dust pollution. Find out from the research results to guide the use of the PM_{10} Contour map. This information will be used as a guideline for planning the operations, Preventing and correcting the problem from PM10 effect from dust source to the nearby community in the future.

2. Material and methods

2.1. Measurement Tools

A Low-Cost Particulate Matter Measuring Device with Smart Sensor model PMS-5003 [7] is shown in Fig. 1.

Figure 1 Low-Cost Particulate Matter Measuring Device

2.2. Method of measurement

- Preparing of the Measurement device and person who had to use this device, set up the measurement plan such as
- Time and period to measure and locations for measuring.
- Measuring follows the planning
- Collecting, Analyzing, and summarize from data
- Evaluate the air quality against Thai regulation.

3. Results and discussion

3.1. Data sampling and measurement result at the located points below Table 1.

Table 1 Location and the average 24 hours of PM_{10} measurement results

No.	N	E	PM_{10} (µg/m^3)	Distance from Source (km)	Temperature (Celsius)	Relative Humidity (%)	Winspeed (m/s)
1	14.3371450	99.8138826	82.76	1.86	29.11	51.11	1.71
2	14.3384302	99.8101415	85.18	2.02	29.18	52.05	1.61
3	14.3388498	99.8146360	87.28	1.29	30.87	53.49	1.74
4	14.3396287	99.8220898	83.05	1.19	31.41	52.38	1.60
5	14.3428770	99.8225880	87.59	0.39	28.44	52.62	1.59
6	14.3410252	99.8070493	81.56	0.52	31.21	52.90	1.62
Source	14.3388040	99.8256510	90.19	0.00	30.15	52.40	1.63
Community	14.3492760	99.8137750	71.37	2.50	29.54	51.95	1.65

3.2. Establishment of PM_{10} contour line

The data obtained from the measurement point was used as data input for a ready-made program for plotting the PM_{10} Contour map shown in Fig.2.

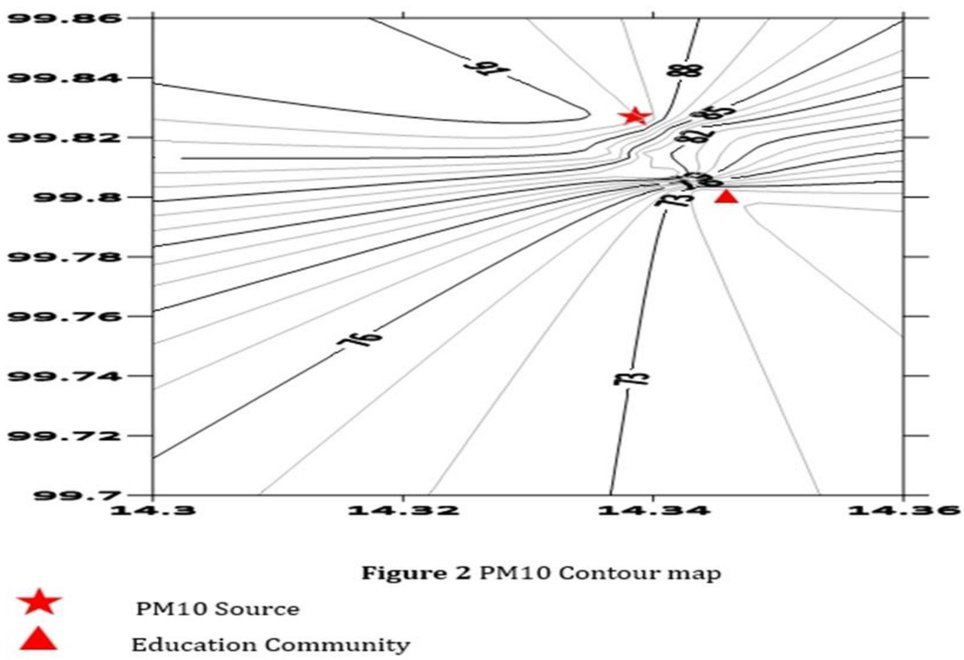

Figure 2 PM_{10} Contour map

3.3. Reliability Test

Measurement at the coordinate shown in the map 3 points of test points and results shown in Table 2.

Table 2 Result of PM_{10} between the device value and the reading value from PM_{10} Contour map

Test No.	N	E	PM_{10} (μg/m^3) measured at the test points	PM_{10} (μg/m^3) Reading from PM_{10} Contour Line	Difference (%)
1	14.33695	99.8241	97	91	6.19%
2	14.33692	99.8236	96	90	6.25%
3	14.33674	99.8202	88	82	6.82%

On the day of checking the PM_{10} Contour Line map usage, the temperature was between 33-34 degrees Celsius, the average relative humidity was between 43-48% and the wind speed was between 1.5-1.9 meters per second, blowing from south to north.

4. Conclusion

PM_{10} contour map illustrated that PM_{10} dust concentration characteristics from dust sources would have the highest value at the commencement of dust. There will be a concentration of dust. However, the PM_{10} value may vary from temperature, humidity, wind speed, and wind direction factors. It depends on the magnitude of the factors affecting to PM_{10} value. But for this research, these factors are less effective than the distance factor from the dust source. Then the PM_{10} Contour Map can present the dust concentration line map is available to use subject to the following conditions: temperature of the area. It should be between 25-32 degrees Celsius, the relative humidity of the site. It should be between 53-83%, and the wind speed should be between 0.93-2.33 m/s. The observed distance should not exceed 2.5 km.

The direction of wind blowing from south to north will give results that work correctly and adequately. However, from the data for the measurement of PM_{10} from dust sources, the 24-hour mean value was 90.19 μg/m^3, still within the allowable regulation limit. That does not exceed the statutory value is 120 μg/m^3 [8]. In contrast, the PM_{10} value measured at the education community, which is far from about 2.5 kilometers of origin, PM10 was found to have a 24-hour mean of 71.37 μg/m^3 that still lower than the legal limit.

Compliance with ethical standards

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Disclosure of conflict of interest

None

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