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Quality Air Monitoring Equipment: The Review Of Air Quality Monitoring Equipment

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Abstract

Air quality is one of the important elements in environmental monitoring such as water quality and noise level monitoring. The result from the in-situ experiment would give direct reading on current existing environment on any propose study area. Nowadays, the invention of air quality equipment is easy to be handle, hand-held, portable and convenience to bring to niche or impossible area to fits in by human. With long life battery allow it operate for 24 hours at field and many divines gases can be monitor with single head. The purpose of the study was to review the equipment that used for air quality monitoring that capable to gives real time reading, cost effective equipment and portable to monitor at site. In this study, Aeroqual Series 500 is an air quality monitoring equipment was used to monitored the PM2.5 and PM10 at three different site studies. The Series 500 air quality is portable handheld monitor and enables to give accurate real time data ether deployed for short term fixed monitoring. The site studies were selected by the environmental consultant to be reviewed. The result of the air quality was accurate in real time respond to monitor air quality. However, another factor such as meteorology condition and topography, slope gradient and land use factor need to be considered to place the equipment in order to avoid any undesirable reading and missing data.

Keyword: *Aeroqual, PM2.5, PM10, air quality monitoring*

Abbreviations:
PM2.5 -particulate Matter 2.5
PM10 = Particulate Matter 10
ST = Air Quality Station

Introduction

Air quality nowadays is an important issue for all human in planning their activities for the days ahead. People now aware the status of the air quality around them and if the air quality are polluted, they will try to get the air quality reading from the government meteorology or from the authorities' government website. However, people who really concern about the air quality around them, they willing to buy the air quality equipment that sold in the market with reasonable price and real time air quality data. The presence of undesired material in air, in huge quantities able to produce harmful effect. The excessive substances including particles, gases and biological molecules. The air pollution may damage human property, vegetation, human health or form hazy and produce unpleasant smell. Measures the air pollution help to determine the level of air pollutants that stay in our atmosphere.

To measure the air quality, must have the best quality air monitoring equipment. The air quality equipment is a diagnostic instrument/tool to measure the level quality of air pollution at surrounding. The device can be place either permanent at one place or portable. It is important to find instrument that meet the various industry standard with better price and meet their requirement

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pollutant measuring instrument. An easy to operate, flexible with a long-term life. The reliable and effective instrument may help to provide better information to government, public and companies to make decision towards better air quality. The objectives of this review paper are to discuss its capabilities and functions of Aeroqual Series 500, to explicate the case study that involving the use of Aeroqual at different activities and to identify the factor of consideration in placing the Aeroqual at the site.

Aeroqual Series 500 An Air Quality Monitoring Equipment

Aeroqual is a portable air quality monitors that can gather information on the surrounding air in accurate real time either in outdoor or indoor air pollutant in a portable handheld monitor. This equipment can be applied to a wide range of activities such as personal exposure studies, monitor the air in short period, validating the air quality models, studies in environmental impact assessment and responding to the public complaint. It contains of 28 different particles and gases sensor to configured by the user. In this research the aeroqual Series 500 monitor or known as S-500, are popular portable air quality in carrying a short-term air quality studies or a short-term fixed monitoring by adding outdoor enclosure. The founder of Aeroqual, Dr Geoff Henshaw and Professor David Williams in year 2001, had come with an air quality prototype sensor and patent the prototype in the same year (Aeroqual, 2019).

Figure 1. Aeroqual Series 500

The S-500 can stored data up to 8,188 records and the data can be downloaded and viewed in Excel. The advantage of the S-500 is the unique sensor head format. The head can be removed and replaced by the user according to the gases that they need to measure. The sensor is housed within the interchangeable cartridge or head that attaches to the monitor base. The equipment will be installed by considering factors need to be avoid interference in concentration measurement result of data collection. The factor that need to be considered are the shape topography of the land, installation of infrastructure such as gases and water pipeline, physical barrier,

The Particulate Matter (PM) that passed through the laser beam was measured using optical counter or laser to measure light scattered from particles passing through the laser beam. The optical sensor transforms scattered light into electrical signals which are processed to provide mass measurements in PM2.5 and PM10. This sensor will measure PM from 0.001-1.000 mg/m3 with an accuracy being +/- (0.005 mg/m3 + 15% of reading). The unit has a response time of 5 seconds. From the sensor head, an electrical signal is passed to the Aeroqual Series 500. The measurement display in micrograms per cubic meter (mg/m^3) on the screen. Lithium battery was use in Aeroqual Series 500 as it is much long life and only takes 3 hours to recharge the battery (Aeroqual, 2019). The battery can long for 24 hours to monitor the air quality. The measurement of the Aeroqual series 500 can be stored on the device or via USB cable to download to a computer.

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Methodology

Application of Aeroqual in Case Study in Malaysia

Three case study were review in this review paper. Each case study are different activities and all case study were occurred before any construction activities being carried out. The case study was done to provide baseline data as reference for future activities. The case study was divided in type of activities: limestone quarry, forest reserve and palm oil plantation.

Air quality at the Limestone Quarry

The quarry industry produces quality ingredients for development project such as roads and highway and also construction. Meanwhile, the quarry dust is important for cement manufacturing industry. The activities such as rock processing and rock quarrying may produce fine particulate matter and able to be transport by wind to other places. In this case study, the quarry project was located at the Bakpur, Kuantan, Malaysia with about 20 hectors of acreage. The study area was located at latitude 03° 45' 30.811" N to 03° 45' 2.213" N and longitude of 102° 50' 10.563" E to 102° 50' 28.735" E shown in figure 2. Within 5 km radius of the project site, there was sensitive receptor such as human settlement and others activity such as palm oil plantation occurred near the study area (Enviroconsult Services, 2018).

Topography and Meteorological Condition

The topography of the study area is undulating hills with elevation between 87 m to 240 m above sea level. On the northwest shown the high elevation wide ranging with 120 meters to 240 meters. The slope percentage are 87% (0-15°) of 17 hectares, 6% (15°-25°) of 1 hectare, 3% (25°-35°) of 0.6 hectare and 4% (more >35°) of 0.7 hectare. Meanwhile, the figure 2 shows the 10 years of annual mean rainfall at the Kuantan meteorological station. The average annual rainfall for the ten years is 3027.5 mm and in year of 2014 recorded as the highest annual rainfall with 3776.0 mm. However, in year 2015 the lowest annual rainfall was recorded about 1947.4 mm. The temperature recorded for 10 years are between 25°C to 28°C where the highest annual mean temperature is 27.6 °C in 2016 and lowest annual mean temperature are 26.6 °C in year 2012.

For the past 10 year of annual mean of relative humidity reading by Kuantan meteorological station showed that annual mean humidity is higher than 80% where the highest annual mean humidity was recorded in 2017 with 87.5%. However, in year 2014 the lowest annual mean humidity was observed with the value of 82.0%. figure 3. showed the wind rose for 10 years from 2008-2017. The wind blow from north and west with mean wind speed is about 1.6 m/s shown in figure 4.

Figure 2: Location of quarry at study area (Source: Department of Survey and Mapping Malaysia)

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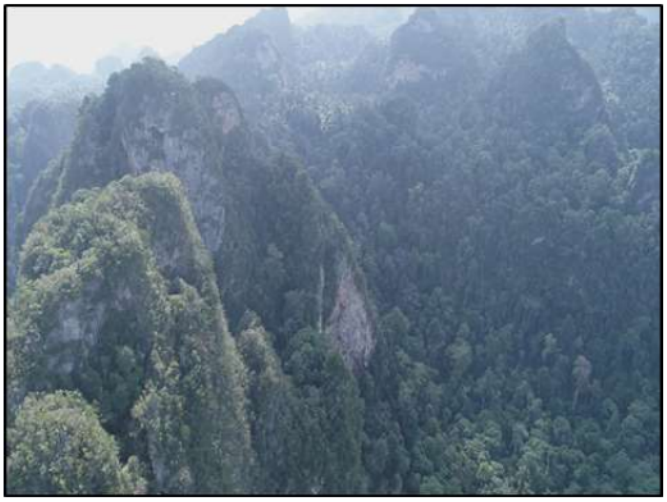

Figure 3: The view of limestone at study area (Source: Enviroconsult Services)

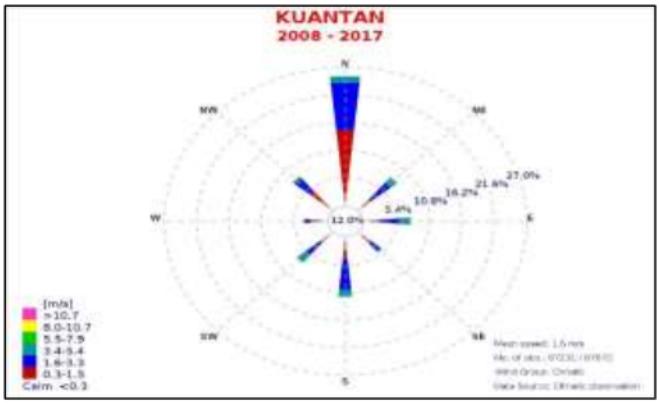

Figure 4. Wind rose for 10 years. (Source: Malaysian Meteorological Department)

Forest Plantation and Air Quality

Malaysia began implementing the forest plantation in 20th century (Appanah and Weinland, 1993). Forest plantation used to rehabilitate, protect and preserve forest resources that apply by many tropical countries after the area were logged for its timber. The study area was located 202 hectares in the Sungai Brok Forest Reserve in Mukim Ulu Nenggiri, Daerah Bertam, Jajahan Gua Musang, Kelantan Malaysia. The figure 5 showed the location of study area and land use that area available. The land use that existed within 5 km radius are plantation and Kg Orang Asli Hendrope located at 10.52 km on the northwest of the study area (Enviroconsult Services, 2019a).

Topography and Meteorological Condition

The project site located on steep and hilly area with 38.9% steep slope in range 25°-40°, follow by 20% slightly steep in range 20°-25° and 21% are on hilly area 12° to 20° and about 2% cover very steep area more than 40°. The meteorological data from Cameron Highland meteorological station and RPS Kuala Betis meteorological station were collected for 15 years.

The highest annual rainfall was 2797.5 mm in year 2011 and the lowest annual rainfall was 2051.7 mm in year 2002 with the highest monthly rainfall 484.1 mm in November 2008. The highest temperature was recorded for 6 years period are 20.1°C in April 2016 and the lowest temperature was 16.8°C in January 2011. The wind speed period used in the study was in year 2015-2016 with 4.4% calm wind, the highest wind speed was 1.6-3.3 m/s as showed in figure 7.

Figure 5. Location of study area forest plantation (Source: Department of Survey and Mapping Malaysia)

Figure 6: The view of forest plantation (Source: Enviroconsult Services)

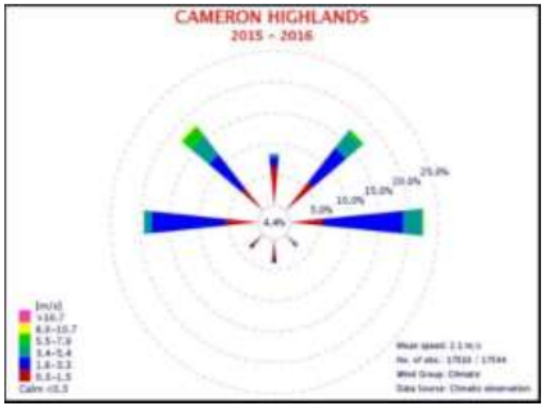

Figure 7: Wind rose from 2015-2016 years. (Source: Malaysian Meteorological Department)

Oil Palm Plantation and Its Air Quality

Oil palm plantation has become the most important commodity crop in Malaysia with seconds largest producer after Indonesia. About 27% of export trade of oils and fats and 11% of the world's oils and fats production has place the Malaysia as the largest exporter and producers of palm oil in the world (Malaysia Palm Oil Council, 2019).

The study area was to plant an oil palm trees on 331.30 hectares of land area at Sungai Charu, Kuantan, Pahang, Malaysia at coordinate latitude 03° 52' 27.247" N to 03° 51' 30.885" N and longitude of 103° 2' 54.827" E to 103° 4'14.788" E shown in figure 8. The land uses available near the study area was other palm oil plantation and several settlements such as Kg. Semeliang, Kg. Kolong Pahat, dan Kg Melayu (Enviroconsult Services, 2019b)

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Topography and Meteorology Condition

Topography features of the study area are flat to hilly and steep area. The elevation about from 60 m to 230 m above mean sea level. The hilly and steep area are located at the north and southeast area of the study area. The data meteorology from year 2009 to 2018 using the Kuantan meteorological station were used to describe the condition meteorology in this study. The mean total annual rainfall for 10 years is 2915 mm with highest annual temperature in May with 28.1°C while the lowest annual temperature was 25.7 °C in month of January. However, the highest mean relative humidity for year 2009 to 2018 occurred in December with 89.1% while the lowest was in April with 82.7%. The wind direction is dominant from north wind with 17% (0.3-1.5 m/s), 9% (1.6-3.3 m/s) and 1% (3.4-5.4) respectively as shown in figure 10.

Figure 8. Location of study area oil palm plantation (Source: Department of Survey and Mapping Malaysia)

Figure 9. The view of oil palm plantation (Source: Enviroconsult Services)

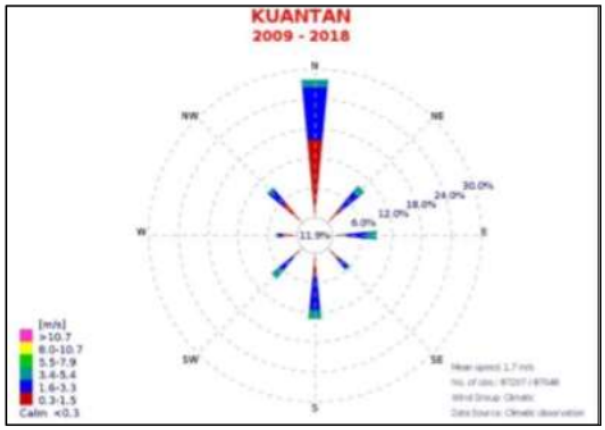

Figure 10. Wind rose for 9 years. (Source: Malaysian Meteorological Department)

Findings and Discussion

In case study of limestone quarry; due to its topography of the study area is undulating hills with elevation between 87 m to 240 m above sea level, decision in placing the Aeroqual in such area must be precise. Other factor such as other ongoing plantation and settlement need to be consider in placing the Aeroqual. The air monitoring was conducted for 24 hours for about 2 weeks period. The first location of air quality station (ST1) was place at coordinate 102° 50' 10.00" E 3° 45' 05.00" N that are close to project boundary and access road. While, the second air quality station (ST2) was placed at coordinate 102° 49' 23.967"E 3° 48' 42.803"N nearby the workers quarry quarters.

At ST1, the Aeroqual was placing at the boundary of the study area to monitor the PM10 and PM2.5 emits from study area. The boundary is near the access road that used by the other local residents every day and it is also the entrance to the study area. Aeroqual are located near the guard house as it is a safe place to sited and easy for collecting data. The ST2 was located at the quarry quarter worker as it is adjacent the local residence of Bakpur and about 2.5km southeast near the Ladang Asia Jaya Sepakat residence.

The result for PM10 and PM2.5 at ST1 and ST2 shown in figure 11. The result of both PM10 was beyond the Malaysian Recommended Air Quality Guidelines 2020 at 100 µg/m^3 and the result of PM2.5 are beyond 35 µg/m^3. The graph for PM10 ST1, PM10 ST2, PM2.5 ST1 and PM2.5 ST2 are slightly plane. The dispersion of PM10 concentration at ST1 and ST2 are above10 µg/m^3 and for PM2.5 concentration is below the 16 µg/m^3. The PM10 concentration value at ST1 and ST2 are below from the recommended limit, 100 µg/m^3 and both, ST1 and ST2 for PM2.5 concentration value is below 35 µg/m^3. The standard deviation for PM10 ST1 is 0.23, PM10 ST2 is 0.13, PM2.5 ST1 is 0.58 and PM2.5 ST2 is 0.56 respectively.

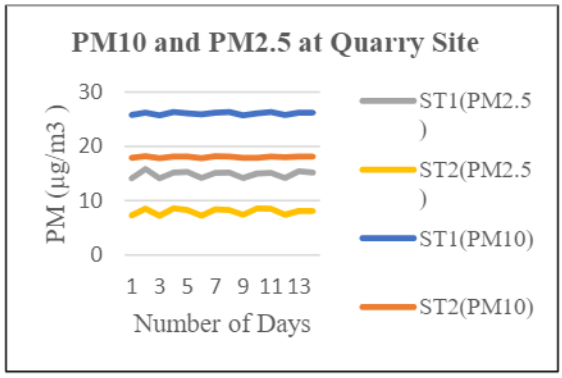

Figure 11. Dispersion of PM10 and PM2.5 at the quarry site

The aim of study was to develop a baseline before any activities such as land clearing, blasting, soil re-suspension or temporary access road were construct at the site. The PM10 and PM2.5 result from Aeroqual will be used as a baseline and will be compared during and after the construction period. Throughout conducting the Aeroqual at the site, none of the industrial activities or significant air pollution sources within the study would adversely contribute to air pollutants. The exhaust emissions from vehicular movement such as car, motorcycle, cycle or truck may contribute temporary air pollution to the study area. The wind roses shown frequently blow from north with 0.3-1.5 m/s (15%), 1.6-3.3 m/s (10%) and 5.5.-7.9 m/s (2%) much of the time. Other wind direction (S, E, NE and NW) comprise 18% (7+11=18%) blow at all wind directions. The wind direction from northwest and southeast are rarely blows. The wind may slightly through minor portion of agriculture area.

In case study of forest plantation; the forest plantation was located in the Sungai Brok forest reserve and above the study area are other plantation occurred. The Aeroqual was placed at the entrance of the study area at coordinate 4° 39' 16.247" N 101° 37' 1.205" E. The equipment was placed there to monitor the dispersion of PM10 and PM2.5 emits from the study area. An Aeroqual was placed for 2 weeks to measure the concentration PM10 and PM2.5 for 24 hours period. Below are the result PM10 and PM2.5 concentration show in figure 12.

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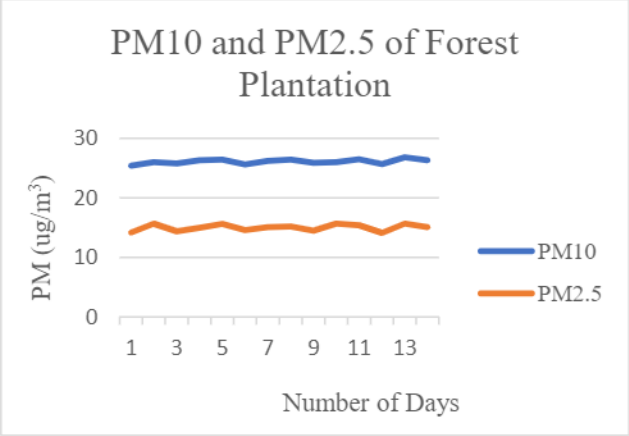

Figure 12. Dispersion of PM10 and PM2.5 at the forest plantation

The Aeroqual are located at the entrance of the study area. It is the only receptor that are potential to have impact. No other activities or residential surrounding the study area. The location also an easy place to monitor and collecting the data.

Figure 13: An Aeroqual at the boundary of forest plantation.

The graph is slightly horizontal showed the result of PM10 and PM2.5 at boundary site that was beyond the Malaysian Recommended Air Quality Guidelines 2020 at 100 µg/m^3 for PM10 and beyond 35 µg/m^3 for PM2.5. The dispersion of PM10 concentration are above 20 µg/m^3 and for PM2.5 concentration is below the 16 µg/m^3. The standard deviation for PM10 is 0.39 and PM2.5 is 0.57 respectively. The wind roses shown frequently blow from East with 0.3-1.5 m/s (5%), 1.6-3.3 m/s (15%) and 5.5 -7.9 m/s (5%) much of the time. Moderate windblown from west with 0.3-1.5m/s (6%), 1.6-3.3 m/s (12%) and 5.5-7.9 m/s (1%) respectively. Other wind direction (NW, NE and N) comprise 42% (18+16+8=42%) blow from three direction. The wind direction from southeast, southwest and south are rarely blowing.

The air quality is slightly horizontal was due emissions of exhaust gases from machineries and moving vehicles that in and out of the study area. The dust from unsealed road will be dispersed and suspended in the air for short period. Other sources of emission are from vehicle and machineries operated inside the project site that may become the main contributor to air pollution. The study take place from the construction begins and the result of air quality was used as the baseline study.

In case study of oil palm plantation; the topography of palm oil plantation was flat and hilly but some certain area is steep. The Aeroqual was place at two location; the first location station was at Kg Semeliang Settlement (ST1) and second location was at the entrance of the study area (ST2). Both stations are monitor the PM10 and PM2.5 for 2 week, 24 hours. The first location was place at Kg

Semeliang settlement area is to monitor the effect of any PM10 and PM2.5 concentration that emit from the study area to the residence. The result from the Aeroqual reading are to control the atmospheric environment of the settlement area.

The second Aeroqual was place at the entrance access road to study area to monitor the emission of PM10 and PM2.5 from moving vehicles and from exhaust machineries occurred in the study area. The result of PM10 and PM2.5 concentration as shown in figure 14. The result shown the plane graph line for all PM10 and PM2.5 at both stations. The PM10 concentration are below the Malaysian Recommended Air Quality Guidelines 2020 at 100 $\mu g/m^3$ for PM10 and beyond 35 $\mu g/m^3$ for PM2.5.

All graph for PM10 and PM2.5 are slightly plane line. The PM10 at ST1 are higher than the PM10 at ST2. Both PM10 at ST1and ST2 are not more than 40 ug/m3 nevertheless not lower than 14 ug/m3. The PM2.5 at ST1 are higher than the PM2.5 at ST2. The PM2.5 are not more than 15 ug/m3 for 2 weeks. All PM10 and PM2.5 concentration is within the standard limit.

The result for PM 10 at ST1 is higher than ST2. This happened because the movement of residents in the settlement area such this settlement that consists of three village that is Kg. Sg. Rimau, Kg. Semeliang and Kg. Sg. Perung shown in figure 14. At ST2, there mining activity occurred near the ST2 point station. However, the PM result shows no any fluctuate graph on air quality that effect from the mining activity. However, the result of PM10 and PM2.5 may happened from the emission of PM10 and PM2.5 from moving vehicles and from exhaust machineries occurred in the study area.

Figure 14. Settlement near the study area

However, the wind roses shown frequently blow from north with 0.3-1.5 m/s (17%), 1.6-3.3 m/s (12%) and 5.5.-7.9 m/s (2%) much of the time. Other wind direction (S, E, NE, NW and SW) comprise 27% (10+9+8=27%) blow at all wind directions. The wind direction from west was rarely blows.

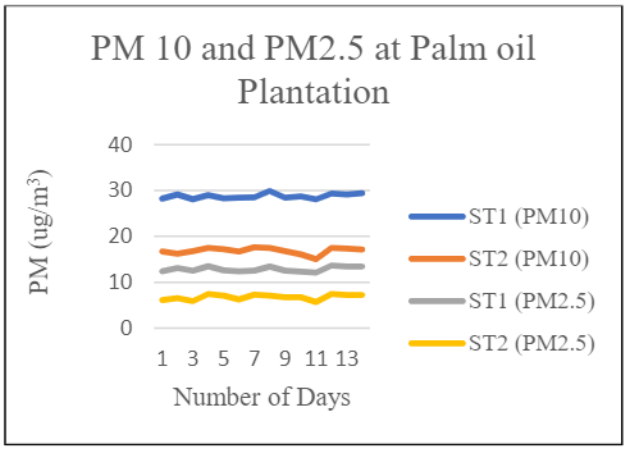

Figure 15. Dispersion of PM10 and PM2.5 at Oil Palm Plantation

Conclusion

Decision making in placing the Aeroqual must be define the source of emission and another factor need to be considered. The factor that need to be considered such as easy to access the equipment at all times and every day to be monitored. Determine the suitable place or location where the dispersion of emission at study area emits lot of pollutant as such inside the operation construction, the access road or at the main entrance of study area.

Adjacent or nearby settlements need to be determined such as school, village, commercial area or other activities such as agriculture, quarry, industrial area or mining that occurred at the surrounding of study area. These will help to control the atmospheric environment of the particular area and to monitor the effect of particulate emission from another project site.

We need to define also the safety of equipment during its installation at study area from being stole by irresponsible person and take note the coordinate carefully before leaving the equipment for several days to avoid missing location of the equipment. The equipment also is expose to the rain and sun where it must stand in the climate of the region where it will be used. Determine the climate of the region will help to choose the type of instrument that will give better result.

Making decision on placing the air quality equipment must be accurate, precise and must consider the safety issues of the equipment and the person that will monitor the equipment during study period. Overall, the Aeroqual are very accurate its data presentation and easy to install the equipment which it can covers numerous site study area in wide period. Aeroqual area able in both outdoor or indoor air quality monitoring. Aeroqual provide flexible, cost effective, and complexity than other traditional air quality analyzer to serve real time data. It help many school, industrial, environmental consultants, contractor and government in making the best decision making for better air quality action.

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