# Ambient Carbon Dioxide in Industrial and Commercial Area Measured by Unmanned Aerial Vehicle (UAV)

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# Ambient Carbon Dioxide in Industrial and Commercial Area Measured by Unmanned Aerial Vehicle (UAV)

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**Abstract**. The $CO_2$ gas is a gas produced from various activities related to industrial activities and people activities in residential or commercial areas. Conventionally, measurements of $CO_2$ concentrations are carried out using the NDIR method with stationary devices. Still, the tool has a disadvantage that is difficult to do in locations that are difficult to reach with height. So this research is intended to measure ambient CO2 in the Industrial Estate and Commercial area using Unmanned Aerial Vehicle (UAV) technology. We sampled in 10 sites at each location. The output of measurements were then plotted with Surfer software to know the spatial distribution. The results of the study show the $CO_2$ concentrations varied between sites. $CO_2$ concentration was higher at industrial area than at commercial area. At Industrial and Commercial area the transport sector may the main causes of high ambient $CO_2$.

## 1. Introduction

Carbon dioxide is a greenhouse gas which accounts for the highest proportion of the greenhouse effect produced by human activities [1]. Carbon Dioxide ($CO_2$) gas emissions come from 3 sources, namely buildings, vehicles, and industry. Office activities, mall (commercial), residential are sources for $CO_2$ emissions from buildings. Emissions generated by vehicles come from vehicle activities that experience complete combustion. While $CO_2$ emissions generated from the industry come from operations in it, such as waste management activities. These emission sources produce various emission loads and concentrations. Based on the research of the Monitoring of Environmental Parameters for $CO_2$ sequestration: a case study of Nagpur City, India, it was found that the highest source of emissions came from industrial activities [2]. The high concentration of carbon dioxide in atmospheric can cause harmful things including outdoor and indoor activities. Rising temperature on earth and impairement of indoor air quality are subjected to rising ambient $CO_2$ concentration. Thus reducing ambient $CO_2$ may have benefits in term of economic and health benefit. The higher the value of a carbon dioxide gas concentration, the higher the temperature on earth [3]. Because carbon dioxide is blocking the transmission of geothermal energy into the atmosphere so that the heat will be reflected.

The use of UAVs has high efficiency and accuracy, so that in recent years, to overcome increasingly severe air pollution, UAVs have been widely used to monitor airborne chemical

pollutants [4]. UAVs have the advantage of being able to reach difficult areas and having flexibility in measurement. This advantage causes the use of UAV's in measuring air quality is very necessary considering the short-term toxic air quality. UAVs usually carry air quality measuring sensors and are connected to the remote control. Various gases measured have available sensors that are inexpensive to transport with UAV's so that they will reduce excessive use of human labor. UAV-based air quality monitoring systems have been developed to measure and display air pollutant concentrations in real-time. The modular design allows the system to carry several different air pollutant sensors and integrate data from all sensors in the UAV with geo-location information in real-time [5]. The main challenge in implementing the UAV system as an environmental monitoring tool is because of the limited flying time affected by the size of the rotor, diameter, rotor configuration when spinning, aircraft loads, and various types of motorcycles [6]. This study aims to analyze plotting $CO_2$ gas concentrations (spatial distribution) based on two distinct land use

## 2. Methodology

This research was conducted to measure $CO_2$ concentrations in two different places based on land used (industrial and commercial area) with a total number of sample points of 10 points in the city of Semarang. The selected industrial area is the Tugu Industrial Estate. The Tugu Industrial Estate is located in the Northern part of Semarang, while the commercial sector i.e ADA Supermall is located in the southern part of Semarang. All these areas are located in the downtown of Semarang. Measurements were taken on July 2019, with measures of morning and evening on each day. Table 1 shows the coordinates of the measurement location.

**Table 1.** Sampling site

| Location | Coordinates |
|---|---|
| Tugu Industrial Area | 6°58'29.84"-6°57'55.73"S<br>110°19'31.43"-110°20'5.24"E |
| ADA Supermall | 7°3'28.88"-7° 3'50.53"S<br>110°24'41.59"-110°24'45.71"E |

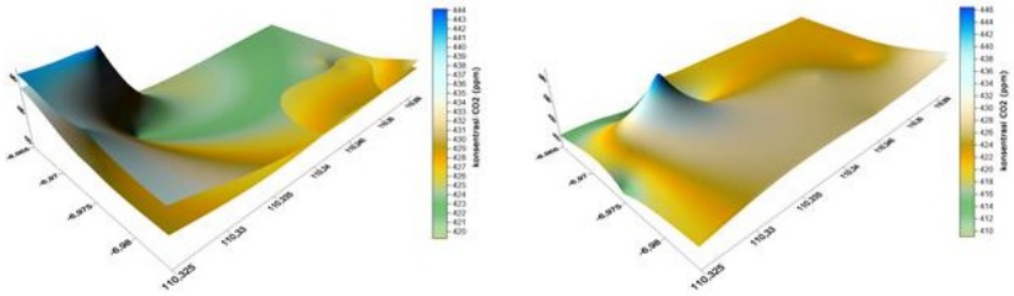
The sampling is done with a calibrated $CO_2$ sensor. This sensor is quite lightweight and can provide response time in the range of seconds. Furthermore, this sensor will be carried by the UAV at the bottom which is quite protected from the UAV propeller rotation. The UAV used is capable of flying more than 3 miles with a duration of flight in the range of 20 minutes. This UAV needs warming up and will be flown by looking at the sampling time. Two people do sampling where one person will record the sampling time while another person operates the UAV. The results of monitoring by the sensor will be downloaded from the MicroSD contained in the sensor. Wind characteristic during sampling was obtained from secondary data on the internet. Traffic counting is also done to see data on the number of vehicles passing through at sampling area.

## 3. Results and discussion

From the results of measuring points at the location, it turns out there are significant differences between points of measurement. The change in concentration between points is quite large given the quite different sampling times. The number of vehicles that passed during sampling also varied greatly from around 12 - 127 motor vehicles and 5 - 68 cars that passed in the industrial area. While in commercial areas around 36 - 108 motor vehicles and 23 - 74 cars pass.

The $CO_2$ gas has an adverse effect if the amount is excessive in the air. Therefore, after knowing the concentration of $CO_2$, it is necessary to mapping so that the gas distribution is known. Mapping the distribution of $CO_2$ gas is carried out using Surfer 13. Mapping the distribution of $CO_2$ gas at each

location is shown in the following figure. Figure 1 below shows the distribution of $CO_2$ concentrations in the Tugu Industrial Estate:

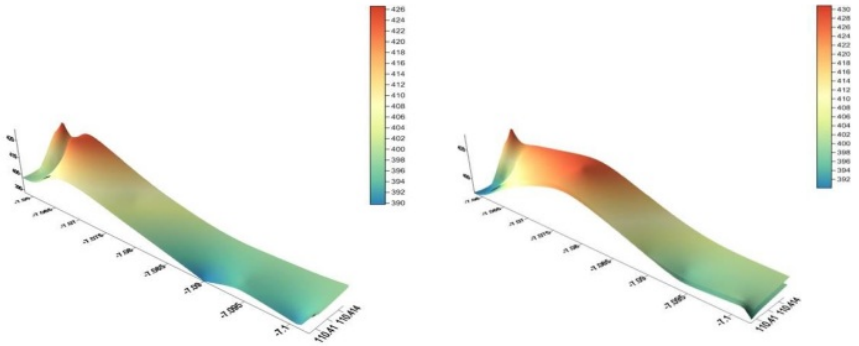


(a) Weekend Morning (b) Weekend Afternoon

**Figure 1.** Map of $CO_2$ concentration distribution in Tugu Industrial Estate.

Based on figure 1, the $CO_2$ concentration value in the Tugu Industrial Zone varied greatly on spatial location. However, the $CO_2$ concentration between morning and afternoon, there was no significant difference. The different concentration patterns in the morning and evening indicate that the source of the $CO_2$ emitter does not change in the morning and evening. And this can be caused by the transportation sector. The number of polluting sources in the Tugu Industrial Estate is high, particularly from vehicles. There are several times the accumulation of vehicle traffic due to the passage of trains at a particular time and the buildup of vehicles during work hours, and the presence of smoke resulting from the factory actuation process resulted in a significant source of emissions produced by the Tugu Industrial Zone.

Figure 2 below shows the distribution of $CO_2$ concentrations in the Commercial Area of the Supermarket



(a) Weekend morning (b) Weekend afternoon

**Figure 2.** Map of $CO_2$ distribution in commercial areas.

Based on the figure 2, the value of $CO_2$ concentrations between morning and afternoon in the commercial area of Supermarket is not entirely different. The $CO_2$ concentration in the commercial area in the supermarket is higher than in the industrial area due to a high building density in the supermarket so that air circulation in the area is low. It appears that the concentration plot for commercial areas is less steep than the industrial area of Tugu. This can happen because measurements in commercial areas are carried out along the road.

In general, the results of $CO_2$ measurements in the Tugu industrial area are higher than those in commercial areas. In the Tugu industrial estate, $CO_2$ values range from 409 - 470 ppm ppm. While commercial areas have ambient $CO_2$ of 388 - 460 ppm.

## 4. Conclusion

Based on the results of the study and discussion in this study, several conclusions were obtained, namely: the results of measurements of the concentration of carbon dioxide ($CO_2$) gas in industrial areas are higher than in the commercial area. It can be concluded that $CO_2$ concentrations between points or sites show significant differences.

## Acknowledgment

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