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ESTIMATION OF THE AIR POLLUTION IN ECO-TOURISM DURING COVID-19 PANDEMIC

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Abstract

The development of tourism sector in West Java in recent years has experienced a significant development, both in the eco-tourism and artificial tourism sector. In the middle of this COVID-19 pandemic, trend to visit eco-tourism has been increasing since artificial tourism in urban areas are being closed by the government. This is to prevent the vulnerability of West Java for the spreading of COVID-19, especially in tourism area. Therefore, this research was conducted to estimate the air pollution in tourism area during the pandemic of COVID-19. Further objective of this research may suggest recommendation for eco-tourism management to maintain the air quality. We conduct case study in Wana Wisata Kampoeng Ciherang, West Java, by monitoring air quality in two different times. A critical look at tourism, air quality, and COVID-19 research and literature was also conducted to achieve the research objectives. This study discusses about air quality in tourism sector during COVID-19. Based on this research, the results show that COVID-19 helps the improvement of air quality in the tourism sector, especially eco-tourism. This study concludes that the air quality result at the first is better than the last time. Moreover, eco-tourism management needs to pay attention to the time operational and make a regulation for the number of visitor.

Keywords: Air Quality, COVID-19, Tourism sector.

1. Introduction

Sustainable development has become a crucial concept of development studies and tourism in particular since 1980s [1]. Since then, the tourism sector has developed rapidly. With the development of tourism sector, it affected the air quality in the tourism as well as the residential area. Therefore, tourism area needs to have an air quality index to measure how polluted the air quality is in the region. The AQI (Air Quality Index) was developed by Environmental Protection Agency (EPA) [2, 3]. Air quality could be defined as good and poor depends on several things. A poor water quality usually contains pollutants that reduce the visibility. It also caused a damaged material and plants as well as caused several disease, such as a lung development deficiency. Moreover, a good quality air could be seen when the sky is clean and does not have a dangerous or serious effects on the environment [4, 5]. In addition to that, a growing tourism sector influenced the number of visitors that resulted to the air quality to become polluted. It is because the more visitors come at the tourism area, there will be more vehicles coming, which resulted to the air population whether in the residential or tourism area.

The air quality in each region has a different measurement. However, transportation also one of the thing that contributes the most to the air pollution in the tourism area. Currently, the air quality in Indonesia, especially in Bandung, has become better. This is due to the pandemic of COVID-19 that we are currently faced in. COVID-19 is a disease that targeting human's respiratory system [6]. The first case was found in Hubei, China. Since then, the disease spreads to all over the world and greatly affects many aspects, one of it is tourism area [7]. During the pandemic of COVID-19, government has declared that the artificial tourism sector should be close [8]. It is resulting people to choose an eco-tourism sector as a way to relieve their stress. In general, artificial tourism is a place for the tourists to visit a designed tourism area, such as Dufan. Meanwhile, eco-tourism is a natural tourism area that designed to protect and maintain the ecosystem integrity, which includes parks and sea [9].

Previous literature regarding air quality and pollution have been conducted by Saenz and Rossello in Mallorca indicates that the air quality is excellent at the rate PM_{10} [10]. Ahmad, et al. [11] and Becken et al. [12] also stated that tourism area development contributes to CO_2 emission in China. Xu, et al. [13] stated that COVID-19 pandemic helps to improve the air quality in China during the lockdown. Dantas et al. [14] explained further the lockdown in Rio de Janeiro during the pandemic of COVID-19 helps decreasing the CO_2 and NO_2 levels due to vehicles traffic reduction. Meanwhile, a study conducted at Kuala Lumpur by Suhaimi, Jalaludin, and Latif stated that carrying out Movement Control Order (MCO) in Malaysia helps to reduce the air pollution in the country by 1 to 68% [15]. Inclusion to the explanation above, the COVID-19 pandemic has a significant role in the air quality and pollution because people are forced to stay at home due to the social distancing regulation, which resulted to the decreased of air pollution [13]. However, there is only a few literature that discusses about the air quality in tourism sector, especially eco-tourism sector, during COVID-19 pandemic. Therefore, we combine these component as a research study to examine the effect of this pandemic towards the air quality of tourism sector, especially in eco-tourism.

This research was conducted to examine the air quality as well as the economic sector in tourism area during the pandemic of COVID-19 in Wana Wisata

Kampoeng Ciherang, West Java by monitoring and time interval using the air quality detector using air quality detector to monitor the air quality with time interval of two hours gap within each air quality test.

2. Methodology

This research used air quality monitor to detect the air quality using time interval with two hours gap within each air quality test. The data was collected in Wana Wisata Kampoeng Ciherang, Cijambu, Tanjungsari, Sumedang Regency, West Java on 16th July 2020 (see Fig. 1). The test was conducted at 10.00 AM and 12.00 AM in three different location to represent the entire location of Wana Wisata Kampoeng Ciherang within five minutes each during pandemic of COVID-19. We used several variables to measure the air quality such as $PM_{2.5}$, PM_{10}, HCHO, and TVOC in the research area.

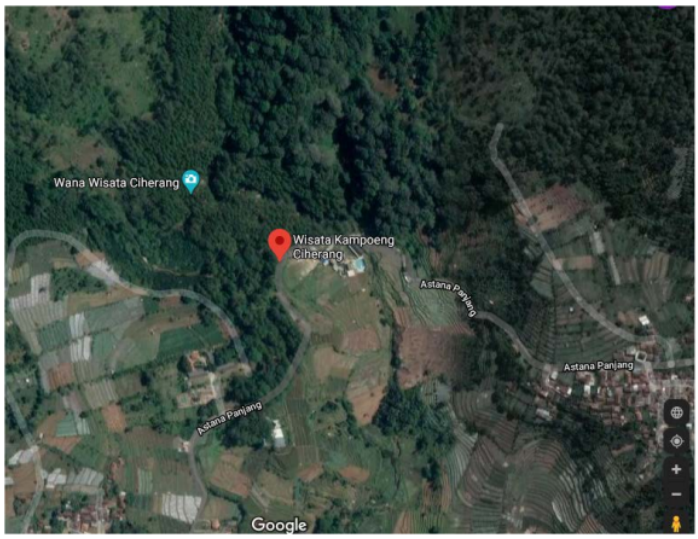

Fig. 1 Maps Wana Wisata Kampoeng Ciherang.

3. Results and Discussion

We used several particulate matters ($PM_{2.5}$ and PM_{10}), HCHO, and TVOC (Total Volatile Organic Compound) to estimate the air quality in the Wana Wisata Kampoeng Ciherang. $PM_{2.5}$ and PM_{10} are used because the particulate matter (PM) could affect the lung efficiency. That way, we could determine the pollutant in the region using this parameters. The differences between $PM_{2.5}$ and PM_{10}, are in the particle size [16]. Meanwhile, the parameters, HCHO, and TVOC are used to determine the air pollution in the area. In addition to that, HCHO or formaldehyde is a common organic chemical gas that exist in the environment, which has a strong smell but have no color. In addition to that, HCHO can also be found in household products and building materials [17]. Meanwhile, TVOC is the total of multiple

VOCs' concentration that present in the air simultaneously. VOC (Volatile Organic Compound) consist of a lot of substances, one of which is natural gas. TVOC is commonly used for measuring and controlling the air pollution as well as the treatment of exhaust air [18].

According to Designs, if the results of air quality measurement for $PM_{2.5}$ and PM_{10} are 0.0 to 12.0 and 0 to 54 respectively, it could be categorized as good. Meanwhile, 12.1 to 35.4 ($PM_{2.5}$) and 55 to 154 (PM_{10}) means moderate. However, for $PM_{2.5}$ and PM_{10}, if the results are 35.5 to 55.4 and 155 to 254 as well as 150.5 to 250.4 and 355 and 424 could be identified as unhealthy for sensitive groups and unhealthy, respectively. Meanwhile, if the $PM_{2.5}$ and PM_{10} shows 150.5 to 250.4 and 355 to 424 could be categorized as very unhealthy. However, if the $PM_{2.5}$ and PM_{10} are 250.5 to 350.4 and 425 to 5014 as well as 350.5 to 500.4 and 505 to 604 could be classified as hazardous and very hazardous, respectively [19] (See Table 1).

Table 1. Air quality measurement for particular mater (PM) [19].

$PM_{2.5}$ (µg/m^3)	PM_{10} (µg/m^3)	AQI	CATEGORY
0.0 to 12.0	0 to 54	0 to 50	Good
12.1 to 35.4	55 to 154	51 to 100	Moderate
35.5 to 55.4	155 to 254	100 to 150	Unhealthy for sensitive groups
55.5. to 150.4	255 to 354	151 to 200	Unhealthy
150.5 to 250.4	355 to 424	201 to 300	Very Unhealthy
250.5 to 350.4	425 to 504	301 to 400	Hazardous
350.5 to 500.4	505 to 604	401 to 500	Very Hazardous

Tecam Group stated that if the TVOC level is less than 0.3 mg/m^3, the level of concern would be low. Meanwhile if the level is 0.3 to 0.5 mg/m^3, it would be acceptable for humans. However, the level of concern would be marginal if the TVOC level reach 0.5 to 1 mg/m^3. Therefore, it would be risking people and can be categorized as high level of concern if the TVOC level each 1 to 3 mg/m^3 (See Table 2) [20].

Table 2. Acceptable TVOC levels [20].

TVOC Level mg/m^3	Level of Concern
Less than 0.3 mg/m^3	Low
0.3 to 0.5 mg/m^3	Acceptable
0.5 to 1 mg/m^3	Marginal
1 to 3 mg/m^3	High

Correspond with Zhai et al. [21] in their research, the air condition could be categorized as safe if concentration of HCHO is less than 0.080 mg/m^3. Meanwhile, if the concentration is between 0.080 to 0.300 mg/m^3 it indicates that the air condition is borderline or qualified not fresh but also cannot be qualified as hazardous. Moreover, the air condition is considered as polluted or hazardous if the HCHO concentration is more than 0.300 mg/m^3. In conducting this research, we used two different time in Wana Wisata Kampoeng Ciherang by monitoring the air

quality using the Air Quality Monitor in three different points to present the whole location of Wana Wisata Kampoeng Ciherang during COVID-19. We conduct this research to examine whether COVID-19 affects the air quality in eco-tourism area or not. The first test was done at 10.00 AM in three different point, namely near entrance area (first point), middle area or central area (second point), and near camping area (third point). The first sample of air quality in the Wana Wisata Kampoeng Ciherang could be seen in Fig. 2.

Figure 2 explains the first sample was taken in point 1 at 10.00 AM indicates that the $PM_{2.5}$ and PM_{10} are 7 and 9 ug/m^3, respectively. In the second point, $PM_{2.5}$ and PM_{10} are 8 and 10 4 ug/m^3. However, different from the first and second point, third point shows that the $PM_{2.5}$ and PM_{10} are 5, 6, and 2 ug/m^3, respectively. Meanwhile, the HCHO and TVOC can be seen in Table 3. Table 3 shows the HCHO and TVOC in the first point are 0.012 and 0.461 mg/m^3, respectively. Meanwhile the HCHO and TVOC are 0.014 and 0.035 mg/m^3, respectively. Different from the first and second point, the HCHO and TVOC in the third point are 0.075 and 0.131 mg/m^3, respectively.

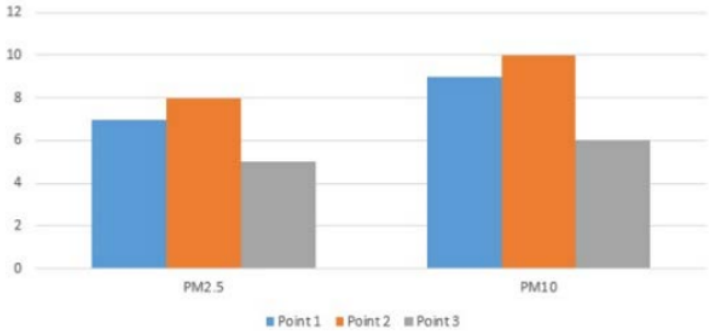

Fig. 2. Particulate Matter (PM) at 10.00 AM in Wana Wisata Kampoeng Ciherang.

Table 3. Variables at 10.00 AM in Wana Wisata Kampoeng Ciherang.

Point	HCHO (mg/m$^{3)}$	TVOC (mg/m^3)
1	0.012	0.461
2	0.014	0.035
3	0.075	0.131

The second test was done at 12.00 AM still in the same three points to present the whole location of Wana Wisata Kampoeng Ciherang could be seen in Fig. 3.

Figure 3 shows the $PM_{2.5}$, and PM_{10} in the first point, which indicates as 11 and 14ug/m^3. Meanwhile for the second point the $PM_{2.5}$, and PM_{10} are 15 and 18 ug/m3, respectively. The $PM_{2.5}$, and PM_{10} in the third point shows 12 and 14ug/m^3. Meanwhile, the HCHO and TVOC can be seen in Table 4. In the first point, the HCHO and TVOC are 0.022 and 0.301 mg/m^3, respectively. Meanwhile, HCHO and TVOC in the second point are 0.012 and 0.48 mg/m^3, respectively. In the third point, we could see that the HCHO and TVOC are 0.044 and 0.420 mg/m^3.

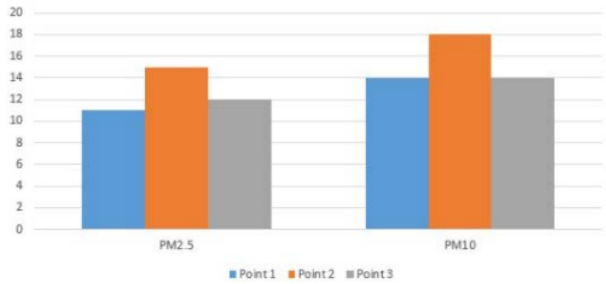

Fig. 3. Particulate Matter (PM) at 12.00 AM in Wana Wisata Kampoeng Ciherang.

Table 4. Variables at 12.00 AM in Wana Wisata Kampoeng Ciherang.

Point	HCHO (mg/m$^{3)}$	TVOC (mg/m^3)
1	0.022	0.301
2	0.012	0.48
3	0.044	0.420

According to the explanation above, the $PM_{2.5}$ and PM_{10} in the first point at 10 AM and 12 AM are 7 and 9 ug/m^3 as well as 11 and 14 ug/m^3, which indicate as good, respectively. Meanwhile for the second point in 10 AM, the PM2.5 and PM10 are 8 and 10 ug/m^3. As for the 12 AM are 15 and 18 ug/m^3 can be classified as good as well. On the other hand, different from first and second point, the $PM_{2.5}$ and PM_{10} in third point at 10 AM are 5 and 6 ug/m^3, which categorized as good. Moreover, as for the 12 AM, it shows 12 and 14 ug/m^3 are also qualified as good. In this research, we also analysed the HCHO and TVOC at Wana Wisata Kampoeng Ciherang. In the first point, the HCHO and TVOC at 10 AM and 12 AM are 0.012 and 0.461 as well as 0.22 and 0.301 mg/m^3, respectively. It means that HCHO in the first location could be categorized as safe [21].

However, for the TVOC level of concern, in the first location at 10 and 12 AM are acceptable. In the second point, the HCHO and TVOC at 10 and 12 AM are 0.014 and 0.035 as well as 0.012 and 0.482 mg/m^3, respectively. It indicates that both HCHO and TVOC are considered as acceptable and safe for humans. As the third point, the HCHO and TVOC at 10 and 12 AM are 0.075 and 0.131 as well as 0.044 and 0.420 mg/m^3. From this explanation, we could see that the HCHO levels are safe with 0.075 and 0.044 mg/m^3. However, the TVOC level in 10 AM is classified as low and for TVOC at 12 AM is qualified as acceptable for human.

4. Conclusion

From the explanation above, we could see that during this pandemic, people still visit an eco-tourism area, which affects the air quality in Wana Wisata Kampeong Ciherang. In addition to this, we could see that the air quality in 10 AM is way better than the one in 12 AM. This is due to the increasing number of visitors. However, to maintain the air quality, especially during COVID-19 pandemic, the eco-tourism management needs to pay attention to time management and make a regulation regarding the visitor limitation to maintain a good air quality.

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