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SMOKE FREE ROOM MODEL OF THE PALANGKA RAYA UNIVERSITY FOR MITIGATION PEATLAND FOREST FIRES IN CENTRAL KALIMANTAN

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ABSTRACT

The high risks and losses due to forest and land fires encourage the need for various serious efforts to take measures to prevent and overcome forest and land fires. This study aims to modify classrooms to mitigate the impact of forest and peatland fires. The research design with mem prepare 2 (two) single rooms, installed sliding doors from glass as a cover, windows in the filter / filter and plastic mica as protection. In the room, fans are installed 4 (four) pieces each and air conditioners 2 (two) pieces each . The tool used to measure the concentration of CO is EL-USB-CO and for the concentration of PM2.5 is the P-Sensor (Figure 4). In room 1 (one) without additional treatment, room 2 (two) in addition to the treatment of live plants. CO and PM2.5 recording devices were installed in both rooms from July-December 2021. Meanwhile, the experiment using the Smoke-Free Space Model was carried out in

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October 2021 for 3 days. Research findings show that the maximum concentration of CO after filtering / filtering treatment and turning on air conditioner (AC) to 50 µg / m3 in chambers 1 and 4 µg / m3 on space 2. Likewise, the maximum value of PM2.5 concentration in room 1 is 7.74 µg/m3 and chamber 2 is 2.77 µg/m3. This value shows that this UPR healthy space can be recommended for mitigating the impact of forest and land fires, so that schools do not need to be closed to in the event of forest and peatland fires, students continue to study safely.

Keywords: Risk, Mitigation, Fire, Forest, Peatland.

1. Introduction

Peatlands forest fires that often occur in Indonesia are a problem for the environment and the surrounding ecosystem and are always interesting to discuss, because their impacts greatly effect of human life. Peat fires are incomplete burning, that emit thick smoke when that occurs, starting with burning vegetation horizontally and then spreading vertically downwards to a certain point (depending on moisture and ground water conditions). Vertical burning of peat in open areas reaches 32 cm, regrowing forest reaches 44 cm and degradation forest reaches 54 cm (Kusin, et al., 2019). In addition, peat fires will cause changes in carbon content and bulk density (Sinclair et al., 2020; Volkova et al., 2021), as well as loss of biodiversity and inhibition of natural regeneration (Blackham, Webb & Corlett, 2014; Lampela et al., 2017).

The hotspots for peatland forest fires specifically for the city of Palangka Raya in 2019 were 246 points (Ditkrimsus Polda Kalteng, 2019), which caused smog as the largest source of gases (van der Werf et al., 2017) and was very dangerous if concentration is too large in the air, one of which is carbon monoxide (CO). Based on the Regulation of the Minister of Environment and Forestry Number: P.14/MENLHK/SETJEN/KUM.1/7/2020 concerning the Air Pollution Standard Index (ISPU) carbon monoxide (CO) for 24 hours is a *good category*; 4,000 µg/m^3, *category moderate;* 8,000 µg/m^3, *unhealthy category;* 15,000 µg/m^3, *very unhealthy category;* 30,000 µg/m^3 and *dangerous category*; 45,000 µg/m^3. The concentration of CO in the air greatly affects the concentration of carboxyhemoglobin (COHb) in human blood, the maximum concentration is only 2.5%. So that the concentration of COHb in the blood does not increase, it is necessary to pay attention to the quality standards for the concentration of CO in the air that can be absorbed, namely; 87.000 µg/m^3 for 15 minutes, 52,000 µg/m^3 for 30 minutes, 26,000 µg/m^3 for 1 hour, 9,000 µg/m^3 for 8 hours (WHO, 1999). An increase in COHb levels from 2-20% causes a decrease in vision, hearing and sensorimotor performance as well as brain and nerve performance (Townsend and Maynard, 2002). CO concentrations when peatland forest in August and September 2019 at Palangka Raya, increased to 14.000 µg/m^3 (Kawasaki, et al, 2019).

In addition, smog also contains particles that also affect the earth system and the environment for at least a short time (Kuwata et al., 2018; Jayarathne et al., 2018; Parker et al., 2016; Roulston et al., 2018; Wooster et al., 2018). Yulianti (2021) said that peatland forest fires in 2015 caused health problems; respiratory problems around 50%, sore eyes 46.7%, diarrhea and skin allergies (itching) 2.3%. Kawasaki, et al, (2019), concentrations *particulate matter* ($PM_{2.5}$) from peatland forest fires in August and September 2019 at Palangka Raya, increased to 800 µg/m^3 in one day. This figure is far above the normal threshold stipulated in the Regulation of the Minister of Environment and Forestry Number: P.14/MENLHK/SETJEN/KUM.1/7/2020 concerning the Air Pollution Standard Index (ISPU) for $PM_{2.5}$ for 24 hours is a *good category*; 15,5 µg/m^3, *moderate category*; 55,4 µg/m^3, *unhealthy category;* 150,4 µg/m^3, *very unhealthy category;* 250,4 µg/m^3 and

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dangerous category; 500 µg/m^3. The high concentration of $PM_{2.5}$ in 2019 is very unhealthy and very dangerous for health, especially for vulnerable groups such as infants, children, pregnant women and the elderly. $PM_{2.5}$ is quite small and can enter the lungs, enter the bloodstream and be transported to other tissues in the human body (McClellan, 2002), more dangerous than gaseous compounds (Kunii et al. 2002), affecting human health and life (Fujii et al, 2014; Crippa et al., 2016; Koplitz et al., 2016), a high risk of deposition in the alveoli of the lungs and is associated with a greater general health risk than coarse particles (Federal Register, 2006), inflammation of the respiratory tract that causes coughing, bronchitis, difficulty breathing, reduced lung function, and finally more severe obstructive respiratory disorders (Chretien and Nebut, 1996).

One of the vulnerable age groups is school-age children (elementary school), when peatland forest fires occur, schools are closed to protected that children are from the dangers of smog, but in reality, they continue to play even though the smog is getting thicker. In accordance with the mandate of the Constitution of the Republic of Indonesia 1945, article 28c paragraph (1) states that "Everyone has the right to develop themselves through the fulfillment of basic needs, has the right to receive education and benefit from science and technology, art and culture, in order to improve the quality of his life. and for the welfare of mankind", as well as Law of Republic of Indonesia Number 23 of 2002 article 9 paragraph (1) concerning Child Protection which states that "Every child has the right to receive education and teaching in the context of personal development and the level of intelligence according to his interests and talents". One of the efforts that can be a solution for the sustainability of education and protection for school-age children is to modify classrooms to mitigate the impact of forest and peatland fires. In this case the modification of the classroom must also be in accordance with the concept of engineering, in this case the concept of planning and building design, as well as the aesthetics of the building/room.

1. Methodology

2.1 Study area

The research was carried out at elementary school; Sekolah Dasar Negeri (SDN) 8 Bukit Tunggal Palangka Raya, Central Kalimantan, Indonesia (Figure 1) for 6 months, starting from July – December 2021, trial of Smoke Free Room Model was conducted in October 2021 for 3 days. Considerations why this school was chosen because it is very close to the location of peatland forest fires, which occur every dry season, students are affected so they are must be to protect.

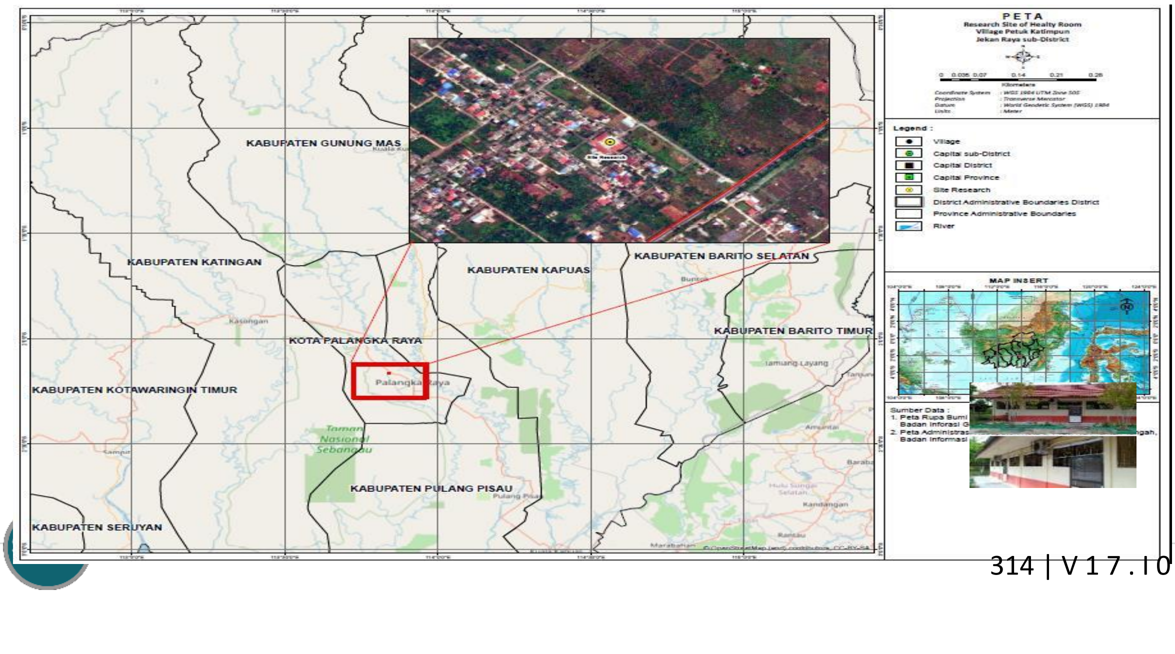

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Figure 1. Research site

2.2 Research Design

Prepared 2 rooms at Sekolah Dasar Negeri (SDN) 8 Bukit Tunggal, installed sliding glass doors as a cover, installed windows with filters and plastic mica as protection. In the room, 4 fans and 2 air conditioners are installed (Figure 2). The tool used to measure CO concentration is *EL-USB-CO* (Figure 3) and for $PM_{2.5}$ concentration is *P-Sensor* (Figure 4). In room 1 without additional treatment (Figure 5A), room 2 was added treatment of live plants (Figure 5B). CO and $PM_{2.5}$ recording devices were installed in the two rooms from July to December 2021. Meanwhile, the experiment using the Smoke Free Room Model was carried out in October 2021 for 3 days. The experimental stages, described below:

- Make sure the CO and $PM_{2.5}$ concentration recording device is installed in the room
- Close the door and install the provided door guard.
- Turn on one of the fans and/or air conditioner
- Leave the room empty for a while, then lower the filter installed in the window.
- Turn on the air conditioner and air purifier mode for 3 x 24 hours.
- Download data from CO and PM2.5 concentration recorders for further analysis.
- Clean the inner (plastic mica) and outer (flannel) window covers regularly so that dust and other debris do not accumulate for a long time.

To see an overview of CO and PM2.5 concentrations as a whole in Palangka Raya City, supporting data from the Laboratory of Dinas Lingkungan Hidup (DLH) of Palangka Raya City in 2019, 2020 and 2021 from July – December, as well as rainfall data from Station of *Center for International Cooperation in Sustainable Management of Tropical Peatland* (CIMTROP) at *Natural Laboratory of Peat Swamp Forest* (NLPSF) Sabangau in 2019, 2020 and 2021 (Figure 6).

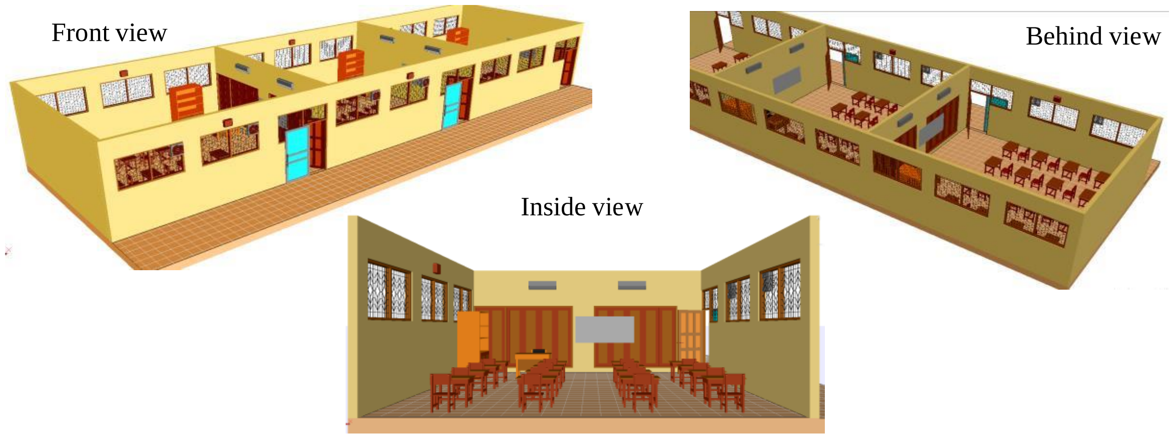

Figure 2. Smoke free room UPR model

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Figure 3. EL-USB-CO

Figure 4. P-Sensor

Figure 5. A Room 1 and B Room 2

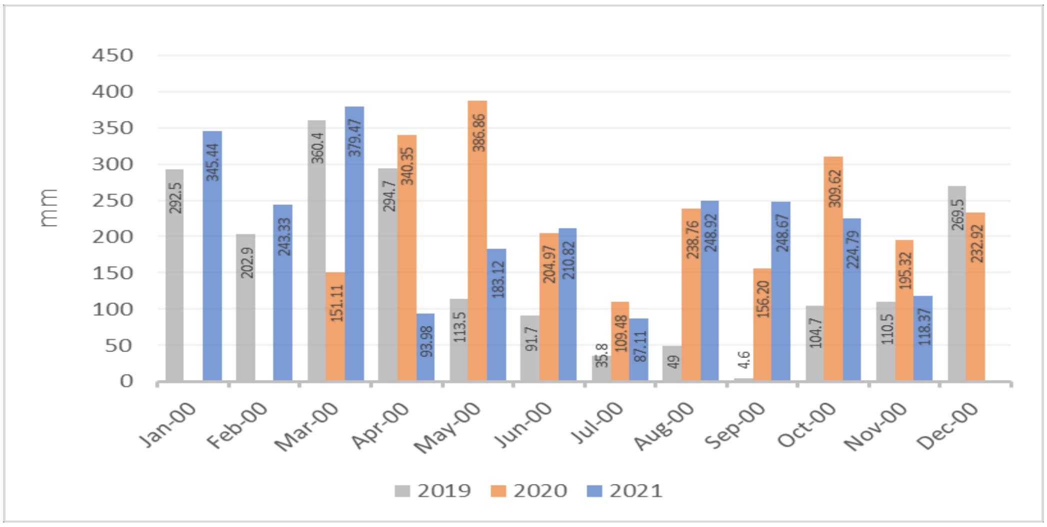

Figure 6. Precipitation

Source: Station CIMTROP at NLPSF Sabangau

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3 Result

3.1 CO Concentration

The CO concentration from the Laboratory of Dinas Lingkungan Hidup (DLH) of Palangka Raya City in 2019 was 801 µg/m^3, in 2020 it was 646 µg/m^3 and in 2021 it was 6345 µg/m^3 (Figure 7). The overall CO concentrations in the classrooms that will be studied from July – December 2021 are; in room 1 the maximum value is 251 µg/m^3 and in room 2 the maximum value is 43 µg/m^3 (Figure 8). Then in October 2021, experiments were carried out on 2 Smoke Free Room Models for 3 days, the results were that the maximum concentration of CO in room 1 was 52 µg/m^3 and in room 2 was 4.5 µg/m^3 (Figure 9).

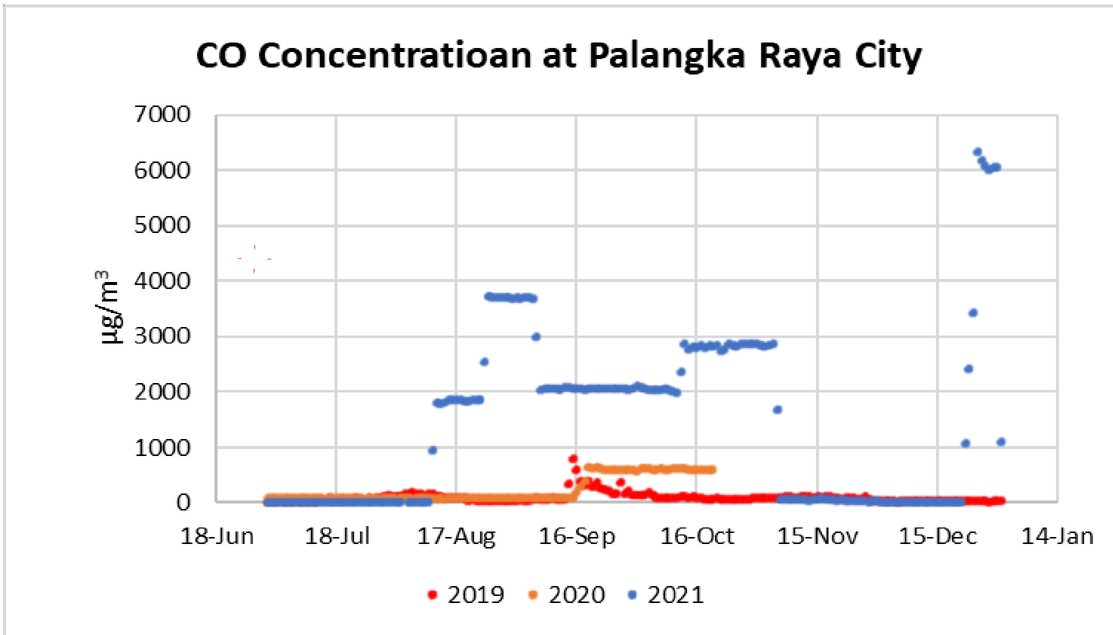

Figure 7. CO Concentration at Palangka Raya city
(Source: Lab. DLH Kota Palangka Raya)

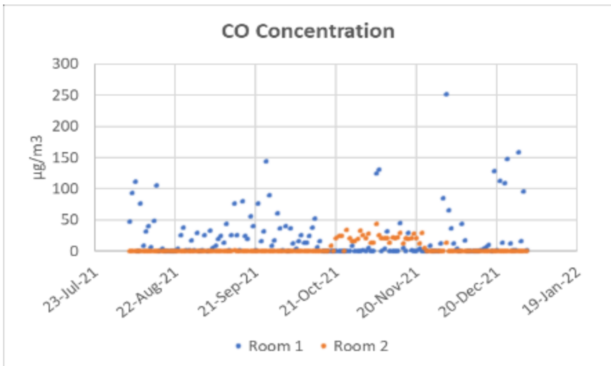

Figure 8. CO concentration

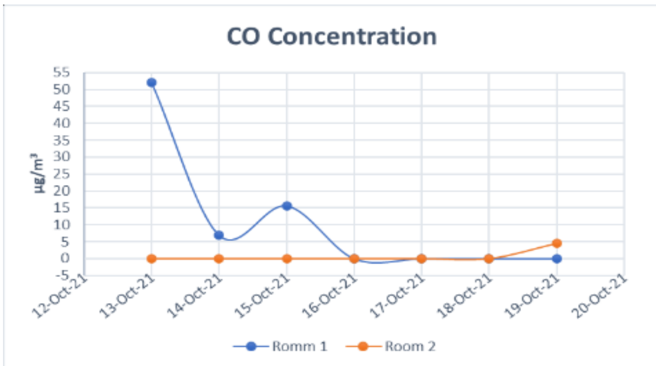

Figure 9. CO concentration when treatment

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The $PM_{2.5}$ concentration from the Laboratory of Dinas Lingkungan Hidup (DLH) of Palangka Raya City in 2019 was 1464 µg/m^3, in 2020 it was 50 µg/m^3 and in 2021 it was 46 µg/m^3 (Figure 10). The overall $PM_{2.5}$ concentration in the classroom to be studied from July – December 2021 in room 1 has a maximum value of 14.1 µg/m^3 and a maximum value of 12.5 µg/m^3 in room 2 (Figure 11). Then in October 2021 for 3 days, experiments were carried out on 2 Smoke Free Room Models, the results obtained that the maximum concentration of $PM_{2.5}$ in room 1 was 7.74 µg/m^3 and room 2 was 2.77 µg/m^3 (Figure 12).

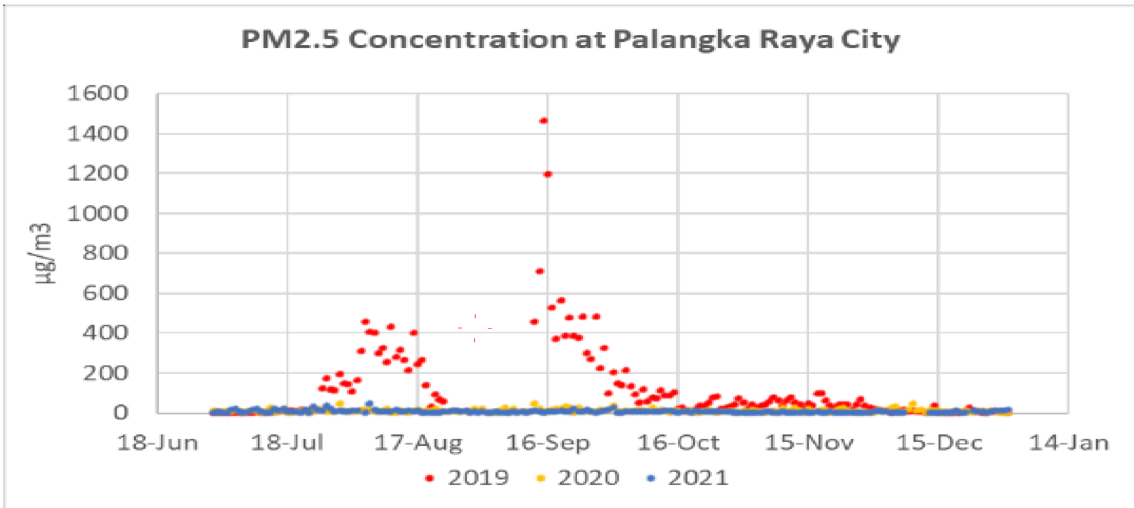

Figure 10. $PM_{2.5}$ Concentration at Palangka Raya city

(Source: Lab. DLH Kota Palangka Raya)

4. Discussion

The peatland forest fires that have occurred in recent years are very disturbing and have an impact on various development fields, one of which is education. The smoke from peatland forest fires is very dangerous because it contains gases and particles that are harmful to health. The concentration of these gases and particles varies from place to place, every day and every hour depending on the situation and conditions of the place, for example fire or rain. Based on rainfall data from the CIMTROP station at NLPSF Sabangau, during the peatland forest fires in 2019, it only rained 1929 mm, while in 2020 it was 2325 mm and in 2021 it was 2384 mm (Figure 6). High rainfall does not have much effect on CO concentrations, based on data from DLH Palangka Raya City in 2019 the CO concentration of 801 µg/m^3 and in 2020 of 646 µg/m^3 was in the *good category*, while in 2021 it was 6345 µg/m^3 in the *medium category* (Fig. 7). There are several factors that cause an increase in CO concentration, for example; heavy traffic, industry, domestic fuel burning and various agricultural activities (Kumar, et al., 2012). Kusminingrum (2008), added that the largest source of anthropogenic CO gas in the air was contributed from vehicle fuel by 65.1%. In contrast to the concentration of $PM_{2.5}$, when peatland forest fires occurred in 2019, the

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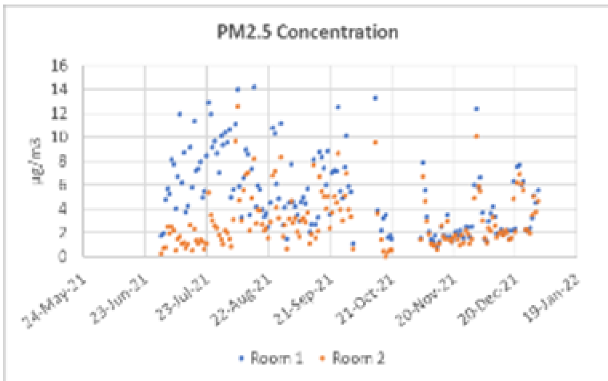

Figure 11. $PM_{2.5}$ concentration at room 1 and 2

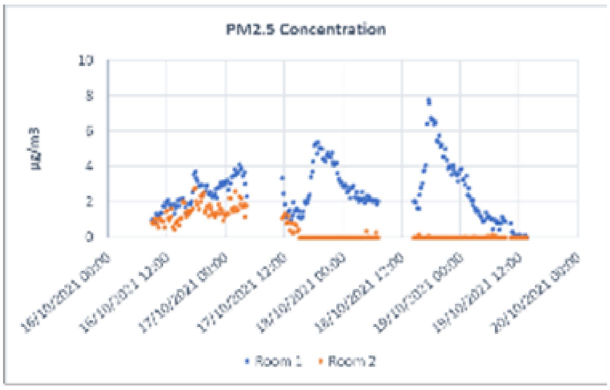

Figure 12. $PM_{2.5}$ concentration when treatment

concentration was in the *dangerous category*, namely 1464 µg/m^3, then in 2020 it was 50 µg/m^3 and in 2021 it was 46 µg/m^3 (Figure 12) was at *medium category*. Kumar, et.al., (2012) said that the highest particle concentration tends to be in the dry season, but in some places with strong winds and low temperatures, the particle concentration will decrease. Peat fires emit smog, contain fine and coarse particles (Stockwell, et al. 2016), are the dominant $PM_{2.5}$ emission source, accounting for 55% of all fire sources (Fujii, et al, 2014). Approximately 80 - 90% of smoke particles are in the $PM_{2.5}$ size range, these particles are derived from organic carbon, which is 50 - 60% of the total mass of particles (Phuleria et al., 2005; Reid et al., 2005).

The CO concentration in the smoke free room model of the UPR for 6 months (January – December 2021) in room 1 (Figure 6) was 251 µg/m^3 and room 2 (Figure 7) was 43 µg/m^3. Then an experiment was carried out with the treatment of installing a filter and turning on the air conditioner (AC) for 3 days in October 2021, the maximum concentration of CO decreased to 52 µg/m^3 in room 1 and 4 µg/m^3 in room 2. Likewise with a maximum value of $PM_{2.5}$ concentration before treatment, in room 1 (Figure 8) of 14.1 µg/m^3 and room 2 (Figure 9) of 12.5 µg/m^3, while after treatment the value decreased, in room 1 of 7.74 µg/m^3 and room 2 of 2.77 µg/m^3. The maximum value of CO and PM2.5 concentrations in the UPR healthy room after treatment was still at the quality standard value of the good category, which was 4000 µg/m^3 for CO and 15.5 µg/m^3 for $PM_{2.5}$. This value indicates that this healthy space can be recommended for mitigation of peatland forest fires, so that schools do not need to be closed, students continue to study safely to fulfil the mandate of the Constitution Republic of Indonesia on Education and child protection.

The concentration values of CO and $PM_{2.5}$ in room 1 were higher than in room 2, because in room 2 there was additional treatment, namely live plants (Figure 5B). Plants are air filters that are quite effective for cleaning the air, reducing pollution levels by absorbing, detoxifying, accumulating and or regulating metabolism in the air so that air quality increases through the release of oxygen by plants (Shannigrahi et al. 2003). Gray and Deneke (1978) added that plants can reduce air pollutants by the oxygenation process. Pollutants around

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plants undergo a process of mixing with oxygen, thereby making the air around the plants clean. Pollutants are absorbed by active plant tissues, especially on the leaf surface without showing any damaging effects (Harris et al, 1999).

5. Conclusion

The maximum concentration of CO after installing the filter and turning on the air conditioner (AC) was 50 µg/m^3 in room 1 and 4 µg/m^3 in room 2. Also, the maximum value of PM2.5 concentration in room 1 was 7.74 µg/m^3 and room 2 of 2.77 µg/m^3. This value shows that Smoke Free Room Model of the Palangka Raya University can be recommended for mitigating of peatland forest fires, during the fire schools do not need to be closed and students can continue to study.

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