Journal of Global Environmental Dynamics (JGED)

Contents list available at JGED website: *https://jurnal.uns.ac.id/jged*
ISSN: 2774-7727

Analysis of Environmental Services Regulating Function: Air Quality Maintenance in Lampar Village, Tamansari, Boyolali

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ABSTRACT. Lampar Village is one of the villages that can be said to have good environmental services for maintaining air quality because it is located in a highland far from factory activities. Good air quality is an important factor in environmental health. One of the environmental services that is global and is found on almost every surface of the earth is air. This research was conducted with the aim of knowing and analyzing the environmental services of the air quality maintenance function in Lampar Village, Tamansari, Boyolali. The research was conducted for approximately 3 months starting from May to July 2022. The research method used was descriptive-qualitative which represented the exposure of the observations verbally. Lampar Village is an area under the foot of Mount Merapi, so that the terrain includes a transition between flat and sloped so that it affects the pattern of utilization of existing environmental services. The types of utilization of environmental services in Lampar Village consist of air environmental services, water environmental services, and soil and vegetation environmental services. Judging from the measurement results of environmental parameters and the results of village community interviews, the air quality in Lampar Village is still quite good and cool because of the shady plant vegetation and surrounded by forest areas. The only problem lies in the carbon monoxide content resulting from the activity of passing heavy-duty vehicles. Efforts that can be made in maintaining air quality can be by reforesting at several points of the road that are passed by trucks. Optimizing green open spaces at polluted prone points as well as efforts to reduce methane emissions by making biogas and helping the release of oxygen.

Keywords: air, CO, environmental service, lampar village, regulating function.

Article History: Received: 18 August 2022; Revised: 28 September 2022; Accepted: 30 September 2022; Available online: 20 December 2022
How to Cite This Article: Fahrurozi, D. E., Noven, H. J. (2022). Analysis of Environmental Services Regulating Function: Air Quality Maintenance in Lampar Village, Tamansari, Boyolali. Journal of Global Environmental Dynamics, 3(3), 35-41.

1. Introduction

In the fundamental principle of the environment consisting of abiotic, biotic, and sociocultural aspects, there are even scientists who add divine aspects in it (Kristensen et al, 2021). Humans as the main actors in the modern environmental era are increasingly interacting with their environment, therefore humans apart from the biotic aspect are also included in the sociocultural aspect (Cairns, 2019). The purpose of the interaction is how humans seek to meet their needs. On the other hand, living things other than humans are still present in the net called ecosystem within the framework of biodiversity. The results of efforts that are cultivated or directly available in the habitat are called environmental services (Swallow et al, 2009). According to van Noordwijck et al (2012), what are called environmental services are all natural substances/materials provided by the environment for the sustainability of the existence of every living thing. Returning to the fundamental principles of the environment above, each aspect is considered as a classification that partitions between what and who provides and uses it. For example, the population of the Javan eagle that is accustomed to flying freely in the expanses of forest on the island of Java, in the last 2 centuries there has been a population decline that can be categorized as massive. The other reason is the reduced – and even lost – environmental services such as habitat and food. This fact is evidence of the importance of the role of environmental services in their function as custodians (Suryatmojo, 2006).

One of the environmental services that is global and is found on almost every surface of the earth is air. With its various compositions, properties, and conditions, air is needed by living things to take certain substances (Liu, 2016). Higher plants can represent that the need for air is very important, during the day when photosynthesis absorbs carbon dioxide it produces oxygen, but at night the opposite is to absorb oxygen (Rahayu, 2021). The existence of living things as biotic aspects, abiotic aspects, to organic and inorganic chemical reactions mostly interact with the air. These factors cause fluctuations in air conditions (Chen et al, 2017). If there is an imbalance or imbalance in the air condition, nature will perform auto recovery to restore the situation, such as a forest that supplies oxygen and is carried by the wind to spread to several territories. That is an example of environmental services that act as air quality maintainers (Boussetta et al, 2020; Hayati et al, 2022).

Good air quality is an important factor in environmental health. However, over time, various human activities cause a decrease in air quality and air pollution which has an impact on various diseases and other adverse impacts on environmental health. Lampar Village is a village located in Tamansari District,

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Boyolali Regency, Central Java. Lampar village is located in the highlands with a tropical climate. This village has boundaries covering the north with Tlogowatu Village, the south with Bandungan Village, east with Dragan Village, and in the west it borders on Tangkil Kemalang Village. Lampar village is dominated by plantation land, where almost every resident's house has garden land. The plantations that are managed have various types of plants, with the main product being durian trees. The location of Lampar Village is still beautiful, fertile, and cool so that the profession of the village community is dominated by farmers and ranchers who work on plantations (Rohmadi and Aulia, 2021). Although there are no factories or factory construction in the village of Lampar or far from industrial activities, this area is quite often traversed by motorized vehicles and large loads such as trucks carrying sand and other materials. This affects the conditions and air quality in Lampar Village. In addition, livestock activities, especially cattle farming, also contribute to releasing emission gasses.

Lampar Village is one of the villages that can be said to have good environmental services for maintaining air quality because it is located in a highland far from factory activities. Maintenance of environmental services is an effort to maintain air quality provided by sequestering, and storing carbon, the benefits of which are obtained from regulating (regulating) air quality. In natural resources there are visible and invisible economic values, where the economy does not appear to be contained in environmental services (Juita et al, 2016). For this reason, human resources are needed in the maintenance and utilization of natural resources which contain the principle of preserving nature and the environment in an effort to maintain natural resources. This makes it an effort to improve human welfare by maintaining and preserving sustainability for the needs of future generations. Therefore, this research was conducted with the aim of knowing and analyzing the environmental services of the air quality maintenance function in Lampar Village, Tamansari, Boyolali.

2. Materials and Methods

2.1 Research Time and Location

The following research was conducted over a period of approximately 3 months starting from May-July 2022. The research location is located in Lampar Village, Tamansari District, Boyolali, Central Java, which is a division of Musuk District. Given the large administrative area of Lampar Village, the research was carried out in several hamlets and communities in Lampar Village.

Fig. 1 Research Location in Lampar Village
(A. Lampar Village Entrance Hall, and B. Plantation near Dragan Lampar Elementary School)

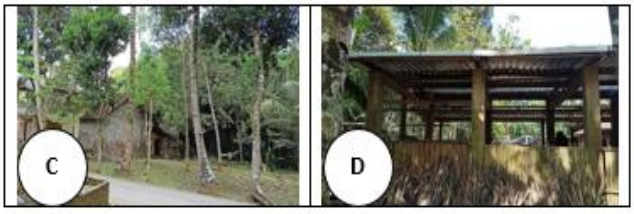

Fig. 2 Research Location in Lampar Village
(C. Residential Center and D. Cattle Farm)

The Lampar Village area, which is located in Tamansari District, has an average height of 700 m above sea level and has a maximum temperature of 33°C and a minimum temperature of 18°C (BPS, 2019). This research also gathered field data from 4 points in Lampar Village, which consist of Village Entrance Hall, Plantation near Dragan Lampar Elementary School, Residential Center, and Cattle Farm (shown in figure 1 and 2).

2.2 Procedures

The tools and materials needed in conducting the following research include writing instruments, cameras for documentation, handphones to record interviews, laptops to process the data that have been obtained, 4 in 1 Envirometer to measure environmental parameters (humidity, light intensity, wind speed), while CO-meter is needed to measure the levels of carbon dioxide gas. As for the materials needed in the form of paper or tally sheets, a list of questions, and internal documents supporting the village of Lampar. The following research method is a survey technique, field observations and interviews. The interview subjects selected were the people of Lampar Village who represented the hamlet. Interviews were conducted in-depth (in-depth interviews), which is a process to obtain information for research by means of face-to-face questions and answers between interviewers and informants with or without using guidelines or guides (Linarwati et al, 2016). The type of interview that was conducted was semi-structured using the guidelines that had been prepared previously, but the interviews were flexible and could be improvised which were not always the same as the guidelines.

The working procedure of the following research is shown by figure 3. It begins with a literature study from various references and continues with identifying problems and planning research. After the research design was prepared, field data were collected which included primary and secondary data. Pramiyati et al (2017) stated that primary data is data obtained directly from the main source. The primary data taken include the results of field observations and surveys, the results of CO gas measurements from the CO meter and the environmental parameters of Lampar Village from the 4 in 1 Envirometer, documentation, and interviews. While secondary data comes from indirect sources, such as books, journals, supporting internal documents in Lampar Village, and others. After all the data is collected, analysis is carried out, and the results are discussed. Then, formulate recommendations and conclusions at the end.

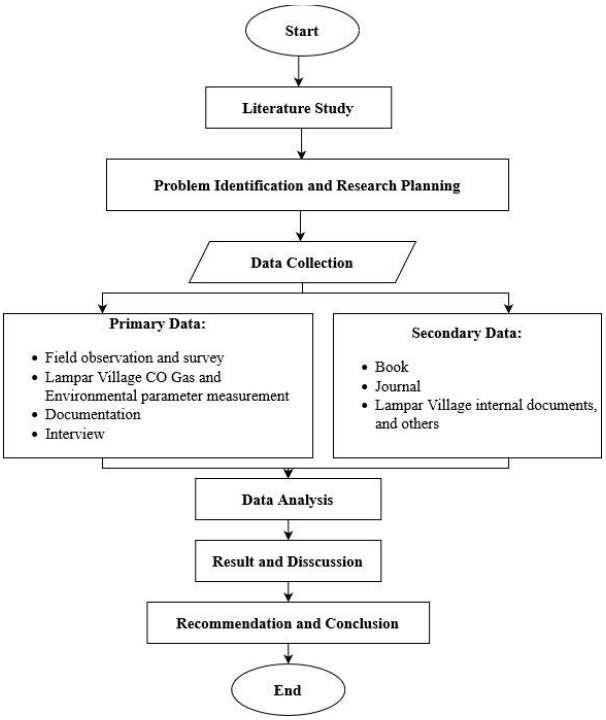

Fig. 3 Workflow Diagram

2.3 Data Analysis

Each data taken is tabulated in order to obtain factual and comprehensive information. Several variables were compared to find the point of data saturation. Writing articles through a descriptive-qualitative method which represents the exposure of the observations verbally. The selection of the method was based on the topics discussed, field conditions, and the outcomes written in order to bring up important information (Landres et al, 1999). With the description of the situation, it is hoped that interested parties can take advantage of the results of this study as a reference for recommendations for follow-up.

3. Result and Discussion

3.1 Utilization of Environmental Services in Lampar Village

Lampar village is an area under the foot of Mount Merapi so that the terrain is a transition between flat and sloping. This makes the condition of the vegetation very diverse and the climate cool, encouraging how the lifestyle of people there, including the use of environmental services. The following are the types of utilization of environmental services and the accompanying problems in Lampar Village:

1) Air Environmental Services

Looking at the natural conditions in Lampar Village and the results of interviews, it was concluded that this area was most likely a tropical rain forest in the mountains. It is proven by the number of perennials such as rubber (*Hevea brasiliensis*), Durian (*Durio zibethinus*), Coconut *(Cocos nucifera*), Trembesi (*Albizia saman*), Sengon (*Albizia chinensis*), including endemic flora of Boyolali, namely Rose *pager* (*Rosa kordesii*), and others. Until this research was published, every building erected in Lampar Village still preserves perennials in order to maintain the function of maintaining air quality. Coupled with the religious beliefs and beliefs of the Javanese community where excessive cutting of trees is prohibited, this supports the greenery in Lampar Village. From an ecological perspective, the role of trees – both in settlements and plantations – is very good because they are green open spaces.

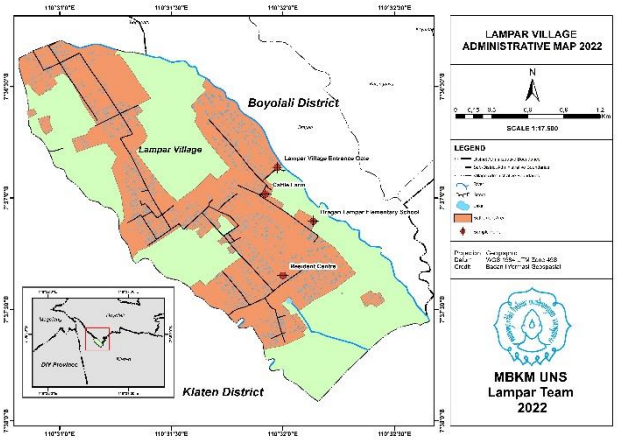

Fig. 4 State map of Lampar Village

According to Setyani et al (2017), ecologically green open space functions as a balancer of ecosystems, guards air quality, as well as habitat for other flora and fauna. Researchers also measure air quality for verification, as will be explained in sub-chapter 2. The problems that arise come from transportation and livestock business by some people. Lampar village is traversed by 2 connecting axis lines between Boyolali Regency and Klaten Regency via Tamansari District, where every day approximately 100 trucks transporting sand and stones pass there. As a result of these activities around the axis road there is ambient smoke and dust, the air quality is even worse than in areas that are not traversed by the axis road (Data Analysis, 2022). Then, cattle and goat farming which are spread in almost all areas of Lampar Village contribute to air pollution which contributes to CO2 and Methane.

2) Water Environment Services

Based on the results of field observations and interviews with village officials, most of the areas of Lampar Village have not yet obtained easy and proper access to clean water. This is because the plains are high enough to require deep well drilling. In areas with high topographic conditions, it is difficult to make dug wells or boreholes so that it can cause difficulty in getting clean water (Aswan et al, 2019). Similar to conditions in mountainous areas such as Lampar Village, it is better to use springs rather than boreholes because geographical conditions in slope areas are very difficult to extract water from bore wells. Spring is a condition in which groundwater flows out of the aquifer to the ground surface by itself (Purwitasari, 2007) and is dug or drilled (Directorate General of PPM and PLP, Ministry of Health, 1997). However, in Lampar Village there is no natural spring source, so the community depends on the supply of water utilization from springs from other villages that have springs. In addition to deep wells, some people use rainwater harvested independently to meet household-scale clean water needs. In fact, at the village level there is a rainwater storage system in the form of a "*embung*" (dam) that has been built in the village center. However, the utilization and maintenance of the infrastructure has not been optimal so that the results cannot be utilized by the local community. The dam in Lampar village is still standing and is left out to just collect raw rainwater without any management so the community is not being able to use it for daily needs. Recommendations that might be proposed regarding the availability of water are to optimize the work of the village dam facility as a rainwater

collection system. Research by Lestari (2020) which examines the availability of water in drought-prone villages in Musuk, Boyolali, recommends increasing the rainwater harvest or *Panen Air Hujan* (PAH) storage capacity and increasing the number of reservoirs built especially on the upper slopes so that rainwater falls, especially around the peak of Merapi. will not directly experience surface runoff, it should be done to minimize the occurrence of shortages in meeting domestic water needs. Even so, the rainwater collection system cannot run all the time because it is very dependent on rain. Furthermore, vegetation and soil conditions need to be maintained for the continuation of the hydrological cycle that supports water availability.

3) Soil and Vegetation Environmental Services

Lampar village is located on the slopes of Mount Merapi, thus affecting the environmental services of the soil and its vegetation. With the existence of talun plantations on dry land and residential land, this environmental service plays a major role for the people of Lampar Village. More than 60% of the plantations are planted with perennials such as coconut, durian, and sengon, as well as seasonal crops such as corn, chilies, and cassava. Soil conditions that are rich in humus and minimal lime make these plants tend to be easy to live and survive. The diversity of high perennials in the mountains cannot be separated from the climatic and soil conditions that are suitable for plant growth. Soil in mountainous areas or volcanic soils is characterized by a dark to slightly dark color due to the high content of organic matter, loose, light, and slippery to the touch. Soil formed from volcanic materials has distinctive morphological, chemical, physical and mineralogy characteristics and has a positive value on soil chemical-physical and biological fertility, thus supporting optimal plant growth (Sukarman et al, 2020). In addition, vegetation and soil properties are factors that play a role in the hydrological cycle, where different vegetation and soil properties have different absorption and water holding capacities (Wang et al. 2013). Therefore, the conservation of soil and vegetation needs to be maintained. On the other hand, there are still some problems found in the Lampar Village plantation, including rats and insect pests and their larvae, attacking the roots and fruit of plants so that crop yields are drastically reduced (Research Results, 2022).

3.2 Air and Environment Conditions in Lampar Village

According to Soviyanti (2017), environmental services are services provided by natural or artificial ecosystem functions, where the value and benefits can be felt directly (tangible) or indirectly (intangible) by stakeholders in improving the quality of the environment and people's lives and managing ecosystems in a sustainable manner, such as nature tourism services, water system protection services, soil fertility, erosion and flood control, beauty, uniqueness, and carbon sequestration and storage (carbon offset).

Table 1
Measurement of Environmental Parameters in the village of Lampar

No	Coordinate Point/ Parameters	Location			
		Lampar Village Entrance Gate	Plantations near Dragan Lampar Elementary School	Resident Centre	Cattle Farm
1	Coordinate Point	S-7.614380 – E110.532928	S-7.618173 – E110.053431	S-7.622458 – E110.533348	S-7.616367 – E110.532028
2	Wind Velocity (m/s)	0.5	1.0	0.4	0
3	Wind Direction	N-S	S-N	S-N	N-S
4	Temperatu-re (°C)	30.91	31.3	31.58	30.41
5	Sunlight Intensity (Lux)	7020	4510	11500	4640
6	Humidity (RH)	69.8	63.2	63.5	74.3

Source: Researcher (2022)

Table 2
Lampar Village CO Gas Measurement

No	Parameter Items	Location			
		Lampar Village Entrance Gate	Plantations near Dragan Lampar Elementary School	Resident Centre	Cattle Farm
1	CO gas (ppm)	361	363	382	345
2	CO gas (ppm)	428	359	377	399
3	CO gas (ppm)	437	366	377	391
4	CO gas (ppm)	355	374	385	398
5	CO gas (ppm)	355	377	394	398
6	CO gas (ppm)	352	373	402	397
7	Avg. (ppm)	381.3	368.6	386.1	388
8	mg/m^3	428.15	413.36	432.58	436.39
9	$\mu g/m^3$	428148.5	413357.7	432584.6	436389.7
10	ISPU Category	0-50 (good)	0-50 (good)	0-50 (good)	0-50 (good)

There are 4 classifications of environmental services, namely provisioning services, regulating services, cultural services, and supporting services. Types of environmental services in the form of regulatory services play an important role in the provision that regulates ecosystems including the function of maintaining air quality, climate regulation, water regulation, erosion control, water purification, waste management, human disease control, biological control, and risk reduction (Komarawidjaja, 2017). Environmental services, especially the function of regulating air maintenance, are closely related to environmental conditions. In relation to these environmental services, in the following study, measurements

of environmental parameters and levels of carbon monoxide (CO) gas were carried out in Lampar Village. Environmental parameters were measured using a 4 in 1 Environment Meter (Envirometer) which included humidity, light intensity, wind speed. Carbon monoxide is measured using a Carbon Monoxide Meter (CO meter) with results in parts per million (ppm). Measurements were carried out at 4 points selected based on the location of the plantation area representing the center of activities in Lampar Village, namely the Entrance Gate of Lampar Village, Plantation near Dragan Lampar Elementary School, Settlement Center, and Cattle Farm. The results of measuring environmental parameters in Lampar Village can be seen in table 1 and the results of measuring CO gas can be seen in table 2.

Based on the measurement results of environmental parameters in Lampar Village in table 1, it is known that the air temperature taken at 4 points ranges from 30.41°C - 31.58°C. This temperature is still in accordance with BPS (2019), where the maximum temperature in Tamansari District reaches 33°C and the minimum temperature is 18°C. The temperature tends to be high considering that the time of parameter measurement is carried out during the day, but still includes normal temperatures in tropical climates. In addition, from a geographical point of view, Lampar Village is located in a highland area with an average altitude of 700 meters above sea level (masl) making environmental conditions remain cool because of the wind that blows. In the plantation area near SD Dragan Lampar and cattle farms, the light intensity tends to be lower than the other observation locations, because at the two observation locations there are many trees and vegetation with a large canopy. The presence of large trees can reduce the intensity of light captured by the measuring instrument because the sunlight is covered by tree crowns. Meanwhile, the humidity in the village of Lampar is quite high, ranging from 63.2%RH - 74.3%RH.

Environmental parameters such as temperature, wind speed, and wind direction are also closely related to the concentration of CO gas in the air, the comparison of the results of several environmental factors with CO gas at the four location points in Lampar Village can be shown in diagram 1. Wind direction is a factor that influences direction of movement of pollutants. In addition, wind speed also affects the movement of pollutants, where the faster the wind movement, the process of mixing pollutant emissions will be faster so that the pollutants in the area will decrease. The wind speed from the measurement data is greatest at the plantation observation location near Dragan Lampar Elementary School, while the lowest wind speed is in the livestock area. This is consistent with the highest wind speed and lowest CO concentration in plantations near SD Lampar. Fitriana and Oginawati (2012) stated that wind speed can also be a factor affecting CO gas exposure in humans where because the measurements are carried out in open air or outdoors, the greater the wind speed will carry CO gas and the possibility of humans being exposed to it. getting bigger too. This can also lead to the possibility of accumulation of CO pollutants in certain locations, so that it affects humans who stay for a long time in that location.

One type of pollutant that is often encountered is carbon monoxide gas. According to Isnaini (2012), carbon monoxide is the main pollutant because almost 60% of the total air pollutant is produced from carbon monoxide. Saleh (2018) explained that carbon monoxide (CO) is a colorless, tasteless, and lighter gas than air. Carbon monoxide is a hidden killer (the silent killer), because even though it has no odor or color, it has toxic or toxic properties. Moreover, CO gas is very easy to mix with Hemoglobin (Hb) so that it can block the function of oxygen flow in the human body. CO gas has a crucial impact on health because it can cause disturbances ranging from mild with symptoms such as dizziness or headache, chest pain, shortness of breath, and nausea as well as severe conditions that affect cardiovascular system disorders, decreased mobility, heart attacks, and even death (Rambing et al, 2017). In addition, CO gas also has an impact on the quality of soil and water in an environment.

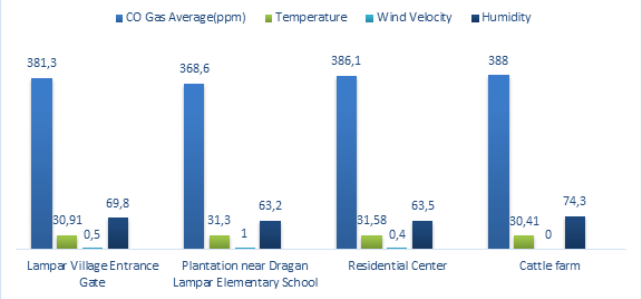

Fig. 5 CO (ppm) and Environmental Parameters Result Diagram

Based on the results of field measurements in table 2, it is known that the average value of CO gas in Lampar Village is in the range of 368.6 ppm – 388 ppm or equivalent to conversion of 413357.7 – 436389.7 g/m^3. The highest average value of CO gas is in the Plantation near the Cattle Farm, while the lowest average value of CO gas is in the Plantation near SD Dragan Lampar. This is because during the day, the yard around Dragan Lampar Elementary School is quiet from activities and motorized vehicles and is supported by shady trees that grow around the location. On the other hand, the highest average value of CO gas is in plantations near Cattle Farms. This is because the location tends to be frequented by trucks or motorized vehicles passing by with high mobility and activity. In addition, cattle activities also contribute to the production of emission gasses such as methane. The results of the measurement of carbon monoxide gas also show a range of 0-50 from the Air Pollutant Standard Index or *Indeks Standar Pencemaran Udara* (ISPU) and are in the good category which means that the air in Lampar Village is still in good condition and has a minimum of pollutant contamination, especially carbon monoxide gas.

Based on the results of interviews, according to the community, the air quality in Lampar Village is quite good and there are rarely complaints about health problems, especially in breathing. This is supported by environmental conditions that are still beautiful and cool because the trees are light. However, according to people who quite often move outside during rush hour trucks or cargo vehicles on the passing highway, they will often be exposed to and inhale carbon monoxide. Some people in Lampar Village feel disturbed and uncomfortable because of this, such as coughing or mild shortness of breath although overall it does not really affect their activities because it has become a daily habit. According to them, breathing problems are quite rare, but they are more disturbed by noise from transport vehicles. Although carbon monoxide gas is not too high, its effect on human health is quite real which can affect the work of the cardiovascular system or heart, the central nervous system, and all organs of the body that are quite sensitive in conditions of lack of oxygen (Kusuma, 2013). In addition, according to Wardoyo (2016) exposure to the most common CO gas can cause side effects to decrease

antibody-forming cells which are the main triggers for opening the process of abnormalities or body reactions such as allergies, respiratory tract infections, lungs, and other symptoms. Therefore, exposure to carbon monoxide in the community needs to be a concern, especially for people who are often exposed and people who are vulnerable to poisoning mitigation and avoiding short and long term effects of CO exposure.

3.3 Recommendations for Air Quality Maintenance and Conservation Strategies in Lampar Village

Based on the data obtained from interviews with the people of Lampar village, the air quality in the Lampar village area can be said to be quite good and there are no significant problems regarding air quality problems. Maintenance and conservation strategies that can be carried out in Lampar Village are by increasing human resources and public awareness of the importance of air quality. The people of Lampar Village who work as farmers or gardeners, sometimes waste or plant residues from plantations are burned by some residents, causing carbon gas that is harmful to health. Air quality maintenance strategies can be started by saving energy. From several studies that explain that many health problems are caused by combustion which results in the form of pollutants. Young steps that can be taken by reducing electricity consumption at home or at work (Zainuddin, 2010).

From the results of interviews, several residents complained about the activities of trucks or heavy-loaded vehicles passing on the main road. Efforts that can be made in maintaining air quality can be by doing reforestation or optimizing green open spaces at several road points traversed by trucks. Reforestation can be done by planting plants that can absorb more carbon and methane so that they can absorb more effectively and help release oxygen. With the many activities of the people of Lampar village who are gardening and almost all residents have private gardens, this is a very good thing in maintaining air quality in the village area. It is only a secondary necessary to plant crops or trees in more varied plantations for more efficient carbon sequestration (Rushayati et al, 2020). The next strategy is the use of sustainable products and recycled products. The selection of products or goods is very important that people's consumption patterns are needed for something that will affect the level of air quality. Society needs products that are environmentally friendly and do not use single-use products and avoid the use of plastics and products with chemicals. Walking and cycling can be one of the strategies and conservation efforts in maintaining air quality (Wahyuningsih, 2015). Due to the strategic location of Lampar Village and located in a highland area with shady forest areas, it is necessary to improve and provide understanding and input to improve natural resources and human resources to be able to maintain good and sustainable air quality.

In role of maintaining air quaity and making benefits for society, development of biogas plant is a strategic recommendation from researcher's analysis. According to Raha et al (2014), output of biogas plant can be used to household electricity or daily cooking. First step is planning out all of the systems of biogas plant which suitable to condition and charracteristics of loaction, and then making a mapping of raw material, system proccess, until utilization spread. By looking potentials on fields such as cattle manures and open grounds, the challenges of this program are fund sources and society partisipation ahead. Because of that, Lamapar Village Government can propose a systematic biogas program to district environmental office, educational institutions, or other organizations in order to help and support. In addition, the community can by mobilized to provide self-help in order to build and operate the biogas plant so that sustainability can be achieved. Here the role of academics and practitioners is essential to the supervision and promotion of society.

4. Conclusion

Environmental services in the form of forests and plantations in Lampar Village from an ecological point of view function in maintaining air quality. On the other hand, the community also uses it to meet their needs. There are several problems related to the use of environmental services, such as air pollution due to motor vehicles and livestock, and the clean water crisis. Departing from this, the researchers provide recommendations in the form of optimizing green open spaces at polluted prone points and efforts to reduce methane emissions by making biogas.

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