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ECONOMIC VALUATION WITH TRAVEL COST METHOD (TCM) SLANIK WATERPARK SOUTH LAMPUNG DISTRICT

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Abstract

This study aims to analyze: (1) the factors that affecting the number of tourist visits, (2) the economic value of the Slanik Waterpark in South Lampung District, (3) the visitor satisfaction with tourism cost attribute. This study uses survey method involving 70 respondents who came during the COVID 19 outbreak. The first objective uses multiple linear regression analysis, the second objective uses consumer surplus analysis, and the third uses the Customer Satisfaction Index (CSI) analysis. Data was collected in June until July 2020. The research shows that the factors that influence the number of tourist visits Slanik Waterpark are travel costs and days of visits, the economic value of the Slanik Waterpark tourist attraction is IDR 13,060,150,376 every year, the visitors are satisfied with the cost attributes incurred when traveled to Slanik Waterpark.

Keywords: *tourism, economic value, visitor satisfaction*

Introduction

Tourism developement is a scope of a broad developement, starting from society to the whole economic aspects in that society (Dwiatmojo, 2015). Through support and specific concern, tourism development process is focused on the progress tourism aspect in order to enable to run economic sector. According to tourism law about tourism 1990, tourism is support including facility and service provided by the government, entrepreneurs, and community for any kind of tourism activities (Nugroho, 2010).

Lampung province is one of provinces with a large number of tourism potentials. One of regencies in Lampung which has a good tourism potential is South Lampung.

South Lampung has the biggest waterpark as a tourism place in Lampung which is classified as a new tourism place named Slanik Waterpark. Slanik Waterpark is launched on 6th of February 2016 and it was well welcomed by Lampungnese people. A wide land is managed by the manager in order to provide supporting facilities which make visitors comfortable during their visit.

Slanik Waterpark contributes well to the economic aspect of people and traders nearby. One of the examples is the number of stores increasing around Slanik Waterpark. Now there are two souvenir shops opened, more than three stalls and repair shops. Another contribution can be seen from the good employment, the improvement of access road to Slanik Waterpark in order to enable visitors to visit Slanik Waterpark easily. This thing encourages the manager of Slanik Waterpark to develop the target number of visitors.

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The need of community towards water tourism place motivates the manager to provide attractive water park facilities switch enable to attract the visitors. This is important to increase the number of visitors so that Slanik Waterpark becomes more popular among the community.

Research Methodology

Factors affecting the number of visitors

Factors affecting the number of visitors can be seen through variable model of travel cost, distance, safety, accessibility, income, facility. Visiting days which are analyzed with multiple linear regression.With the indicator if significance probability > 0,1, H0 is accepted and H1 rejected. If significance probability < 0,1, H0 rejected and H1 accepted (Ghozali, 2011).

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_6D_1 + b_7D_2 + e \quad (1)$$

Note :
a = constant
b = regression coefficient
Y = The number of visit
X1 = Travel cost (Rp/Knj)
X2 = Distance (Km)
X3 = hygiene (Very clean/ Clean/ Clean enough/ Dirty/ Very dirty)
X4 = Safety (Very safe/Safe/ Safe enough/ Unsafe / Very unsafe)
X5 = Accessibility (Hour/Knj)
X6 = Revenue (Rp/Month)
D1 = Facility
1 = Good
0 = Insufficient
D2 = Visiting days
1 = *weekdays*
0 = *weekend*
e. = *Error*

Economic Value

After that, analyzing economic value travel cost method was by counting consumer surplus value per individual per year, according to Fauzi (2014).

$$SK = \frac{V^2}{2\beta 1} \quad (2)$$

Note:
SK = Consumer surplus (Rp/person)
V = The number of respondents' visit (times/year)
β_1 =Travel cost coefficient (TC)

The formulation of the total economic value is based on Marsinko *et al* (2002).

$$EV = SK \times TP \quad (3)$$

Note :
EV = Economic value of the tourism place area in a year (Rp/year)
SK = Surplus consumer visitor per person/visit (Rp/person)
TP = The average total of visit per year (person)

Visitors' satisfaction

Visitors' satisfaction was analyzed by using *costumer satisfaction index* (CSI) with likert scale on transportation cost attribute, consumption cost, entrance ticket cost, gazebo rent cost, swimming tire rent cost, cable car cost, parking fee etc. By seeing the level of importance and visitors reality. Scale and interpretation which are used to see consumers' satisfaction can be seen in the table 1 and 2.

Table 1. Determination of the level of satisfaction and Customer analysis interpretation Satisfaction Index (CSI) (Supranto, 2006)

Scale range	Interpretation
0.00 – 0.21	Very unsatisfied
0.21 – 0.40	Unsatisfied
0.41 – 0.60	Quite satisfied
0.61 – 0.80	Satisfied
0.81 – 100	Very satisfied

Table 2. The score of the level of importance and the level of reality (Supranto, 2006).

	Answer criteria	Score
Score of the level of importance	Very unimportant	1
	Unimportant	2
	Quite important	3
	Important	4
	Very important	5
	Answer criteria	Score
Score of the level of reality	Very expensive	1
	Expensive	2
	Quite expensive	3
	Cheap	4
	Very cheap	5

Result and Discussion

Travel Cost

Travel cost is the addition of each expenditure which is spent by visitors individually when they visit a tourism place in one trip. Those costs include transportation, consumption, entrance ticket, swimming tire rent, gazebo rent, and so on showed in table 3.

Table 3. Travel cost of Slanik Waterpark's visitor.

Clasification	**Maximum (Rp)**	**Minimum (Rp)**	**Average (Rp)**	**Average percentage (%)**
Transportation	181,000	11,500	62,512.93	35.88
Consumption	80,000	20,000	46,005.38	26.40
Enterance fee	50,000	35,000	42,571.43	24.43
Gazebo rent	75,000	0	14,642.86	8.40
Swimming tyre rent	35,000	0	3,500.00	2.01
Etc.	35,000	0	5,000.00	2.87
The total cost	456,000	66,500	174,232.59	100

Table 3 shows that the accumulation of each cost spent by visitors which can be seen from each cost spent by respondent per individual so that maximum cost, minimum cost, average cost, and average percentage are gained. Minimum cost in the classification of gazebo rent and swimming tire rent value Rp 0.00 because some of visitors uncommonly rent gazebo and swimming tire in their visit. Classification of other costs is Rp 35,000 since some of visitors spend this cost to pay locker rent or additional hygiene cost for bringing food or snack bought outside of Slanik Waterpark. To count the amount average cost of travel per individual in total trip cost is gained from the addition of costs spent by visitors which cost Rp12,196,21.086. With the number of average cost of Slanik Waterpark visitor per individual per visit which cost Rp174,232.59.

Factor Affecting visitors.

The rapid spread of corona virus affects all aspects in life. This pandemic causes new health protocols implemented in social activities. One of them is tourism activity. That issue affects the number of visit in many tourism places. It

triggers researchers to test each factor taken into consideration to see the effect of the number of visit which is analyzed by using multiple linear regressions.

Table 4. The Result of Multiple Linear Regression Coefficient Output

Model	Coefficient	t-Statistic	Prob
(Constant)	1.2901	0.9441	0.3488
Travel cost	-9.6E-06 ***	-3.3979	0.0012
Distance	0.0112	1.6522	0.1036
Hygiene	0.1650	0.8331	0.4080
Safety	-0.0372	-0.2445	0.8076
Accessibility	-0.2385	-0.7704	0.4440
Income	-1.06E-07	-1.0697	0.2889
Facility	0.2202	0.5807	0.5636
Visiting days	-0.7052 ***	-2.8609	0.0058
Variable		Total	
R- square		0.2389	
Adjusted R-square		0.1391	
F-Statistic		2.3938	
Prob (F-statistic) **		0.0257	
Durbin Watson		1.9192	

* The level of confidence 90%
** The level of confidence 95%
*** The level of confidence 99%

From the result of regression in the table 4 is gained the multiple linear regression equation below:

$$Y = 1{,}2901 - 9{,}6E\text{-}06X_1 + 0{,}0112X_2 + 0{,}1650X_3 - 0{,}0372X_4 - 0{,}2385X_5 - 1{,}06E\text{-}07X_6 + 0{,}2202D_1 - 0{,}7052D_2 + e \quad (4)$$

Data test had been done before regression of research data was conducted. It is found that there is no multicollinearity and heteroskadesticity in research data. The result of data test in table 4 shows that the factors affecting the number of visit are travel cost and visiting days which are in the level of confidence 99%. This is caused by the fact that the higher travel cost, the lesser visitors will visit. This result is in line with previous research conducted by Arifa (2019) which explains that the higher travel cost, the lesser visitors will visit the tourism place.

On the variable of visiting days, the number of visitors on weekdays is more than the number of visitors on weekends because the situation is not too crowded on weekdays so that it can minimize the spread of Covid 19.

While the variables of distance, safety, hygine, accessibility, income and facilities do not affect tourist visits to the Slanik Waterpark. This is because the majority of visitors are new visitors who first time come to Slanik Waterpark. Then, the perception that Slanik Waterpark is the largest water tourism object in Lampung Province with a strategic location on the Karang Anyar crossing, South Lampung Regency which is connected to Bandar Lampung City, Metro City, South Lampung Regency and East Lampung Regency and good road access plus

the presence of toll roads attract people to visit Slanik Waterpark.

Economic Value Based On Travel Cost

The travel cost approach can be used as an estimation step to determine the economic value of tourist attraction recreational services. This method was chosen based on the advantages of obtaining real data from the cost of visits made by a person on a tour. The calculation of the economic value of the Slanik Waterpark tourist attraction uses data on the number of visitors in 2017 of 118,116 people in one year.

Travel cost coefficients that have been analyzed by using multiple linear regression tests can be used as a calculation of the economic value of the Slanik Waterpark. Travel costs that have been analyzed using multiple linear regression can be used. The calculation of the economic value of the Slanik Waterpark tourist attraction can be seen in table.

Table 5. The economic value of Slanik Waterpark

Explanation	Value
The number of respondent (person) (a)	70
The number of visit per year (Times peryear) (b)	118,116
Coefficient travel cost (c)	0.00000969
Consumer surplus (Rp) (d)	22,291,022
Consumer surplus / individual/ visit (Rp) (e)	110,571
The total of economic value (Rp) (b x e)	13,060,150,376

Table 5 shows the consumer surplus of each individual per visit at Slanik Waterpark is IDR 22,291,022 so that the results of the economic value at the Slanik Waterpark tourist attraction are IDR 13,060,150,376 in a year. This value is quite high compared to the Dayu Park water tourism park in Sragen, Central Java Province with an economic value of IDR 260,841,380 (Ermayanti, 2012). This shows the attractiveness of the Slanik Waterpark has a fairly high economic value for existing resources. Thus, the tourism services provided by Slanik Waterpak can provide benefits and need to be maintained.

Visitor Satisfaction Based on Level of Importance with Reality

Customer or visitor satisfaction is a feeling or a form of someone's disappointment caused by having a desire to judge by comparing a performance that handles a product (or result) towards consumer expectations (Kotler and Keller, 2008). The costs spent by visitors when they travel to Slanik Waterpark have different levels of importance for each visitor. To determine this importance, the customer satisfaction index (CSI) is used on the cost attributes spent by each visitor by first knowing average importance score (RSP), average reality score (SSR), weighting factor (WF) and weighting score (WS).The Likert scale is used to see the level of importance and the reality that exists which is used as a measuring tool to see the value of importance for the costs spent by visitors when they travel (very important, important, quite important, not important and very unimportant) then to see the level of reality which is seen as very expensive , expensive, quite expensive, cheap and very cheap. It is used as a reference in measuring the satisfaction of visitors to the Slanik Waterpark in traveling.

Table 6. Interest level index calculation and reality

No	Attribute	Percentage	Importance Level Index	Percentage	Reality Index
1	The total of travel cost	68.86	Important	67.14	Cheap
2	Transportation cost	56.57	Quite important	68.86	Cheap
3	Consumption cost	74.00	Important	72.57	Cheap
4	Enterance ticket fee	67.14	Important	64.29	Cheap
5	Gzebo rent cost	64.57	Important	55.43	Quite cheap
6	Swimming tyre rent cost	59.71	Quite important	61.43	Cheap
7	Cable car cost	69.71	Important	68.86	Cheap
8	Parking fee	67.14	Important	72.57	Cheap
9	Others.	87.71	Very important	69.43	Cheap

Table 6 shows the calculation of importance level index of each cost model which is used as an attribute in determining the level of visitor satisfaction in Slanik Waterpark. The lowest percentage value in the importance level is transportation cost, but in the reality, transportation cost is valued cheap with the percentage 68.86%. This shows the importance level will not be always the same as what the visitors feel towards the costs spent when the visitors visit Slanik Waterpark.

Table 7. Calculation and interpretation of satisfaction level with CSI analysis

No	Attribute	RSP	WF	RSK	WS
1	The total of travel cost	3.44	0.11	3.36	0,38
2	Transportation cost	2.83	0.09	3.44	0,32
3	Consumption cost	3.70	0.12	3.63	0,44
4	Enterance ticket fee	3.36	0.11	3.21	0,35
5	Gazebo rent cost	3.23	0.10	2.77	0,29
6	Swimming tyre rent cost	2.99	0.10	3.07	0,30
7	Cable car cost	3.49	0.11	3.44	0,39
8	Parking fee	3.36	0.11	3.63	0,40
9	Others	4.39	0.14	3.47	0,49
The total number		30.77	1.00	30.03	3.35
CSI					66.97

Table 7 shows that Slanik Waterpark Visitor Satisfaction in the importance level and the reality of costs spent in visiting Slanik Waterpark is satisfied, because according to the resulting scale of the calculation of the CSI analysis resulted in the number 66.97. This satisfaction occurs because every visitor who comes to the Slanik Waterpark is quite loyal to consider the costs spent in traveling because most visitors coming from some regions think that every nominal money spent in visiting and seeing the condition of the existing Slanik Waterpark tourist attraction is very worth it. This result is in line with Amaliawati's research in (2015) that in her research on the satisfaction level of visitors to the Umbul Penging tourist attraction, one of the cost factors which spend in traveling such as ticket have a positive effect on consumer satisfaction.

Conclusion

The average travel cost spent by visitors per individual per visit is IDR 174,232.59 with higher expenditure allocation spent is transportation cost worth IDR 62,512.93 per individual. Factors affecting the number of visit in Slanik Waterpark are travel cost and visiting days on weekdays there are more than 45 people compared to visitors on weekends as many as 25 people. Economic value in Slanik Waterpark which is resulted by using travel cost method is IDR 13,060,150,376 per year. Most of visitors are satisfied with each attribute cost they spend when they visit Slanik Waterpark.

References

Amaliawati, S. 2015. Pengaruh Fasilitas dan Harga Tiket Terhadap Kepuasan Pengunjung Obyek Wisata Umbul Penging. *Skripsi*. Universitas Muhammadiyah Surakarta. Surakarta.

Arifa, E. 2019. Valuasi Ekonomi Kawasan Wisata Pulau Pisang Kabupaten Pesisir Barat. *Skripsi*. Fakultas Pertanian Universitas Lampung. Lampung.

Dwiatmojo, A. (2015). Valuasi Nilai Ekonomi Wisata Pantai Amal: Aplikasi TravelCost Method (TCM). Researchgate,https://www.researchgate.net /publicatio n/305778000, diakses Agustus 2019.

Ermayanti, F. 2012. *Valuasi Ekonomi Objek Wisata Ndayu Paark Dengan Metode Biaya Perjalanan dan Metode Valuasi Kontingensi*. Universitas Sebelas Maret. Solo. https://digilib.uns.ac.id. Diakses pada Tanggal 14 September 2020

Fauzi, A. 2006. *Ekonomi Sumber Daya Alam dan Lingkungan*. Gramedia Pustaka Utama. Jakarta

Fauzi, A. 2014. *Valuasi Ekonomi dan Penilaian Kerusakan Sumber Daya Alam dan Lingkungan*. PT Penerbit IPB Press. Jakarta

Ghozali I. 2011. *Aplikasi Analisis Multivariate dengan Program SPSS*. Edisi Ke-4. Universitas Diponegoro. Semarang.

Kotler, P. dan K. L. Keller. 2008. *Manajemen Pemasaran, Jilid 1*. Penerbit Erlangga. Jakarta.

Marsinko A, WT Zawacki., dan JM Bowker. 2002. Use travel cost model in planning: a case study. *Tourism analysis*. 6(1):203-211.https://www.researchgate.net/publication/233675295_Use_of_Travel_Cost_Models_in_Planning_A_Case_Study/download. Diakses pada tanggal 23 Juli 2019.

Nugroho, P. S. 2010. Valuasi Ekonomi Wisata Pantai Glagah Dengan Pendekatan

Biaya Perjalanan (*Travel Cost*) di Desa Glagah Kecamatan Temon Kabupaten Kulon Progo. *Skripsi*. Universitas Sebelas Maret.

Supranto, J. 2006. *Pengukuran Tingkat Kepuasan Pelanggan Untuk Menaikkan Pangsa Pasar, Cetakan keempat*. PT Rineka Cipta. Jakarta.

UU No. 9 Tahun 1990. *Kepariwisataan*.http:// www. kemenpar. go. id/userfiles /file/4636_1364UUTentangKepariwisataannet1.pdf. Diakses pada 10 November 2019

PUBLIC OPINION ON NOISE DISTURBANCE DUE TO THE ACTIVITIES OF HUSEIN SASTRANEGARA AIRPORT, BANDUNG, INDONESIA

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Abstract

Airport is a facility to accommodate arrivals and departures as well as aircraft movements that have the potential to cause noise impacts. This research was conducted to obtain opinions from the public regarding the noise that occurs around Husein Sastranegara Airport, Bandung, Indonesia. In addition, the determination of the airport noise area was also carried out using the Weighted Equivalent Continuous Perceived Noise Level (WECPNL) method. There are 12 measurement points, namely at distances of 100 m, 500 m, and 1500 m in each of the North, East, South, and West directions. Opinions regarding the noise that occurred were obtained from 150 respondents from the community around the airport. The results of the study can be concluded that the highest WECPNL index value is found on the 100 m runway, the WECPNL index value is 76.39, the 500 m distance the WECPNL index value is 62.71, and the 1500 m distance the WECPNL index value is 52.74. The results of the WECPNL index at Husein Sastranegara International Airport Bandung have a level 2 noise area where school buildings and settlements should not be allowed. The results of the interviews show that as many as 54% of respondents feel disturbed by the noise caused by the activities of Husein Sastranegara Airport.

Keywords: *airport activities, noise, WECPNL*

Introduction

At an active airport, there is usually a tendency to increase the frequency of aircraft flights every day and an increase in the type of aircraft used. At an active airport, accompanied by an increase in the frequency of aircraft flights, it can have positive and negative impacts on society. The presence of this industry can provide income for the region and the country and absorb a lot of workforce. However, this industry also has a negative impact on the communities around the airport if it is not controlled.

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Noise generated by aircraft passing through Bandung's Husein Sastranegara airport can cause disturbance to residents who live around the airport (Kusmiati et.al, 2006). Noise exposure received by the community around the airport can cause non-specific effects and sleep disturbances is a major problem that can lead to decreased quality of life (Siswati et.al, 2017). Disruption to noise can cause people to become irritable, communication problems, stress, and sleeplessness.

Noise is defined as unwanted sound which is a natural and man-made activity (Wahyuni et.al, 2019), (Mulyatna et.al, 2019). Based on the Minister of Environment Decree No. 48 of 1996 noise is unwanted noise from a business or activity in a certain level and time that can cause

disturbances to human health and environmental comfort. Meanwhile, according to the Minister of Health Regulation No. 718/ Menkes/ Per/ XI/ 1987 noise is the occurrence of unwanted noise, disturbing and or endangering health. The definition of noise according to the Decree of the Minister of Manpower No. 51 of 1999 concerning the Threshold Value of Physical Factors in the Workplace are all undesirable voices that come from production process tools and / or work tools which are at the level of hearing loss.

One of the studies that cover airport noise and the surrounding environment is research by Silalahi et al. (2016) who conducted research on the noise of Ahmad Yani Airport in Semarang City using the Weighted Equivalent Continuous Perceived Noise Level (WECPNL) method. This method measures the cumulative noise by weighting the time and frequency of flight activities. The results obtained using the WECPNL at Ahmad Yani Airport Semarang are 72.8 dBA. The results obtained indicate that around the airport has a high intensity for residential areas or areas that are inhabited for a long time.

This study aims to measure the noise that occurs and to analyze the influence of noise on the level of public disturbance to the activities of Husein Sastranegara Airport Bandung.

Research Methodology

Research sites

The measurement location is carried out in the north, east, south and west of the runway at Husein Sastranegara Airport, Bandung. The measurement recommended distances are 100 m, 500 m, and 1500 m in any direction north, east, south and west. The observation distance measured from the take-off and landing area is different for each cardinal point. This difference adapts to conditions in the field due to inaccessible area boundaries, the presence of buildings and residential areas.

Noise Measurement

The equipment used for measuring noise in this study is the Sound Level Meter (SLM). The unit of noise level is expressed in decibels weight A or dBA, namely the weight corresponding to the response of the normal human ear. Noise readings are carried out for a certain period of time using a stopwatch. The working mechanism of the Sound Level Meter is that if an object vibrates, it will cause a change in air pressure that can be captured by this tool which will then move the indicator meter.

Measurements are carried out for 7 consecutive days to get the operation of the aircraft for 7 (seven) days assuming that aircraft operations at Husein Sastranegara Airport are repeated every week. In this study, there are 12 observation points, there are three observation points in each direction of North, East, South and West of Husein Sastranegara Airport.

Figure 1. Sampling points.

The measurement procedure using a Sound Level Meter is as follows:

1. Before making a measurement, the Sound Level Meter is turned on early to heat the microphone so that it is free from moisture.
2. Sound Level Meter is placed at a height of 1.2 - 2 meters above the surface.

3. Readings of numbers on the Sound Level Meter are carried out every 5 seconds for 10 minutes for each measurement time.

The total mean dBA value in $(P/Po)^2$ is calculated by Eq. 1.

$$(P/Po)^2 = 10^{dBAmax/10} \quad (1)$$

Where P is sound pressure level (Pa), P0 is Reference sound pressure.

$$dBA = 10 \text{ Log } (P/Po)^2 \quad (2)$$

where dBA is the average noise level in dBA of the peak operation of the aircraft in 24 hours, $10Log(P/Po)^2$ is comparison between measurement sound intensity with human hearing threshold sound intensity.

The magnitude of the WECPNL noise criteria around certain airports is as follows:

$$WECPNL = \overline{dB(A)} + 10 \log N - 27 \quad (3)$$

$$N = N1 + 3N2 + 10N3 \quad (4)$$

where WECPNL is Weighted Equivalent Continuous Perceived Noise Level, dBA is Average noise level in dBA of the peak operation of the aircraft in 24 hours, N is number of arrivals and flight departure for 24 hours. N is number of arrivals and flight departure for 24 hours.

N1 = The number of aircraft operations in the period 07.00 - 19.00

N2 = Number of aircraft operations in the period 19.00 - 22.00

N3 = Number of aircraft operations in the period 22.00 - 07.00

The measured dBA is converted to WECPNL in accordance with the number of aircraft passing for 24 hours. The WECPNL calculation is taken from the average dBA maximum in a day and the number of aircraft passing during certain hours is entered into N. The formula shows that if there is an operation of one aircraft in the evening or at night it will change the correction price of 10 log N with evening flights = 3 day flights and night flights = 10 day flights.

Noise Contours

The contour map of the data from the noise measurement results is made by interpolation software. It is overlaid by earth image of the airport and vicinity in display.

Community Observation

People who are chosen to be respondents are residents who live or work in the airport area. Sampling was done using cluster random sampling. The number of respondents is 150 people.

Result and Discussion

Noise Intensity

Husein Sastranegara Airport operates every day with the operating volume of commercial aircraft that does not fluctuate, except for Indonesian Air Force aircraft which keep their operating schedules secret due to state secrets. The results of WECPNL measurements from 12 research points. Table 1 shows WECPL Measurement Results.

Table 1 WECPL Measurement Results

No	Measuring Points	dBA
1	Poin 1	75.51
2	Poin 2	62.71
3	Poin 3	52.11
4	Poin 4	62.65
5	Poin 5	48.03
6	Poin 6	41.13
7	Poin 7	68.74
8	Poin 8	53.11
9	Poin 9	50.11
10	Poin 10	67.29
11	Poin 11	54.33
12	Poin 12	42.04

This WECPNL value shows that settlements at point 1, point 4, point 7, and point 10 receive higher noise exposure than settlements at points 2, 3, 5, 6, 8, 9, 11, and 12. The WECPNL value

has an effect on determining the attitudes of the people in the aircraft noise exposure area.

There is a summary of the noise exposure that occurs in residential areas under the plane's trajectory and on the right and left side of the plane's trajectory. The WECPNL distribution pattern as a noise index shows that the area under the plane's trajectory has a greater danger zone for human health above 55 dBA.

Public Opinion on Noise Disturbance

From the results of the subjective assessment, there are residential areas around the airport, which are categorized as moderate, weak to hard. This area is prone to noise hazards from the activities of Husein Sastranegara Airport. The last one is the preparation of ideal noise contours with interpolated values (Figure 2) because measurements are made in the entire area by only looking at the acoustic physical quantities measured, which can be seen on the contour map of the noise distribution.

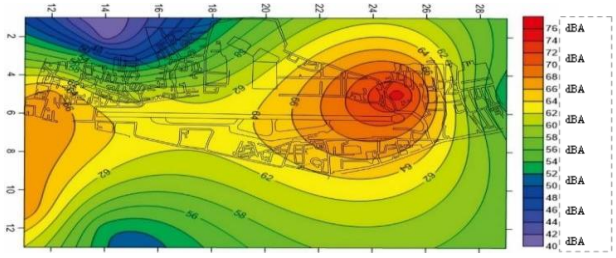

Figure 2. Noise Distribution Contour Map

From the results of interviews to 150 respondents, it was found that 68 people felt not noisy (45.32%). Meanwhile, respondents who felt noisy were 82 people (54.67%). Several noise control methods can be implemented to reduce airport noise levels (Liu, 2011).

Conclusion

Based on the above discussion, it can be concluded that the highest WECPNL index value is on the 100 m runway, the WECPNL index value is 75.51, the 500 m distance the WECPNL index value is 62.71, and the 1500 m distance the WECPNL index value is 52.74. In accordance with government regulation no. 20 of 2012 concerning the development of Airport Environmental preservation from the WECPNL index results at Husein Sastranegara International Airport Bandung, a solution is needed so that residential areas are not too noisy, it is necessary to install sound absorbers so that the noise from aircraft at the airport is not too noisy, and to reduce levels Noise in the area around the airport can be done by planting lush trees with spacing and height limits according to the airport environment which can function as a buffer zone. From the interview results, from 150 respondents, it was found that 68 people felt not noisy (45.32%). Meanwhile, 82 respondents felt noisy (54.67%).

References

Kusmiati, A., Yustiani, Y.M., Mubiarti, E. (2006), Valuasi ekonomi kebisingan pesawat udara di pemukiman sekitar Bandara Husein Sastranegara, *Jurnal Teknik Lingkungan*, edisi Khusus.

Liu, M. (2011). Kondisi Peredam Bising Akibat Lalu Lintas Pesawat Udara di Bandar Udara Sultan Hasanuddin Terhadap Aktivitas Masyarakat di Kawasan Permukiman Sudiang. *Jurnal Transportasi*. Vol. 11, No. 3 : 183-190.

Mulyatna, L., Yustiani, Y.M., Darmawan, A.R. (2019). Pemetaan Kebisingan di Ruang Departemen Spare Part dan Departemen Las Menggunakan Aplikasi Surfer. *Infomatek: Jurnal Informatika, Manajemen dan Teknologi*. Vol. 21, No. 2: 103-112.

Peraturan Pemerintah. 1987. Peraturan Menteri Kesehatan Republik Indonesia Nomor 718/ Menkes/ PER/ XI/ 1987 tentang Kebisingan yang Berhubungan dengan Kesehatan. Jakarta: Sekretariat Negara.

Peraturan Pemerintah. 1996. Keputusan Menteri Negara Lingkungan Hidup No. 48 Tahun 1996 tentang Baku Tingkat Kebisingan.

Jakarta: Sekretariat Negara.

Siswati, R. Adriyani. (2017). Hubungan Pajanan Kebisingan. *Jurnal Kesehatan Lingkungan Indonesia*. 16 (1): 29-36.

Silalahi, G.S., Andarani, P., Istirokhatun, T. (2016). Analisis Sebaran Kebisingan Akibat Aktivitas Landing dan Take-off Menggunakan Software Integrated Noise Model 7.0d di Sekitar Bandar Udara Ahmad Yani Semarang. *Jurnal Teknik Lingkungan*, Vol. 5, No. 4: 12p.

Wahyuni, S., Yustiani, Y.M., Juliandahri, A. (2019) Analisis Tingkat Kebisingan Lalu Lintas di Jalan Cihampelas dan Jalan Sukajadi Kota Bandung. Journal of Community Based Environmental Engineering and Managemet, Vol. 2, No.1: 9-12.

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COMMUNITY PARTICIPATION IN WASTE MANAGEMENT IN BATUNUNGGAL INDAH RESIDENSIAL AREA, BANDUNG, INDONESIA

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Abstract

Batununggal Indah housing still faces obstacles in waste management due to the low awareness of the community to separate and sort waste. Therefore, this area is the target of implementing waste management assistance carried out by the Bandung City Environment and Sanitation Service (DLHK) in collaboration with the City Government of Kawasaki, Japan. This study aims to evaluate the implementation of the waste management program in Permai and Jelita Clusters by identifying activities, changing community behavior and calculating changes in the amount of waste that is disposed of at the final disposal site. The evaluation results show that the main activity that has been carried out is a social approach in the form of workshops and counseling. Measurement of waste generation shows a decrease in the weight of generated waste that is disposed of at the final disposal site, indicating that waste separation has been practiced. This decrease is still insignificant because the community has not consistently carried out sorting behavior, so it needs sustainable encouragement.

Keywords: *waste management, 3R, waste separation*

Introduction

The waste problem is often stated as an urban issue in Indonesia (Yustiani et al, 2019). One of the southern parts of Bandung, to be precise in the Batununggal Indah Housing, is managed by a private company (IWABI) engaged in cleaning services established by the community in Batununggal Indah Housing. Community participation in managing the domestic waste is very important (Omran et.al, 2009) (Rusmaya et.al, 2019). Batununggal Indah still faces a major obstacle, namely the low awareness of the community to sort waste in an effort to reduce the waste that enters the temporary waste storage site (TPS) which will later be transported to the final disposal site. One solution to overcome this problem is through the development of sorting at the source, utilizing waste into organic fertilizer which is a social engineering activity that teaches people to sort waste and fosters public awareness in managing waste wisely and in turn reduces waste transported to the final disposal site. Efforts to increase public awareness in housing are carried out by promotion, socialization and counseling carried out by the Bandung City Environment and Sanitation Office (DLHK) in collaboration with the City Government of Kawasaki. Based on these conditions, this study aims to evaluate the waste management program in the Jelita Cluster and the Batununggal Indah Permai Cluster. In addition, this study seeks to determine the constraints of the community in sorting out

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waste sources that affect the reduction of waste to TPS.

Research Methodology

Research sites

The research location is Batununggal Indah Housing, focused on the Jelita Cluster and the Permai Cluster. This housing estate is located in Mengger Village, Bandung Kidul District, Bandung City, Indonesia. Evaluation of waste management is carried out with several activities, namely the measurement of waste generation that occurs, the implementation of programs carried out by the Bandung City Environment and Sanitation Service, and the community's reaction to the implemented program.

Measurement of waste generation is carried out in accordance with SNI M-36-1991-2003 concerning Methods for Taking and Measuring Samples of Generation and. Composition of Municipal Waste. This measurement is carried out before and after implementing the waste management program. Monitoring is carried out 3 times to see the sustainability of the program and the level of community participation.

Interviews were also conducted to obtain an overview of community opinions and the obstacles faced.

Result and Discussion

Implementation of Waste Management Program

There are several activities carried out by a team from the Bandung City Environment and Sanitation Service in waste management at Batununggal Indah Housing, including the socialization approach to the community. Table 1 shows the details of the activities carried out.

Table 1. Socialization Approach Activities to the Community (https://www.iges.or.jp/, accessed December 2020)

No	Activity	Description
1	First meeting	Before the workshop, an FGD was held in the target area. This FGD discusses the basics of waste management and the stages of compiling a waste management action plan
2	Field visit to Mentor Area	- Target Area visited the four mentor area locations to learn various 3R practices and share experiences - While in the field, representatives from the mentor area explain to the participants about waste management in their area and share knowledge, experiences and problems with the solutions that have been carried out. - All field visit participants are expected to be able to bring knowledge and teachings from KBS mentors as a reference for discussion of action plans to be carried out in their respective regions
3	Field Visit to Sukaluyu Area	KBS Sukaluyu is not KBS mentor in Kawasaki Bandung activities but the target area can learn about waste collection that has been carried out well in the Sukaluyu area.
4	Workshop	- Based on knowledge and sharing of experiences from field visits to KBS mentors, each target area is asked to discuss and determine the waste management system and method that is considered appropriate and can be done in their respective areas. - Develop a waste management system and a waste management action plan.
5	Workshop for High Economic Target Areas	- Sharing objectives, constraints, status in implementing waste sorting - Discussion of strategies to improve waste separation at source - Discussing the appropriate 3R facilities in Batununggal - Develop a waste management system and action plan

Another activity is the installation of banners with information stating that this community is one of the “Free Garbage Areas” guided and supported by the Kawasaki-DLHK Project. The banners can be seen in Figure 1 and Figure 2.

Figure 1.Vertical banner (IGES 2017)

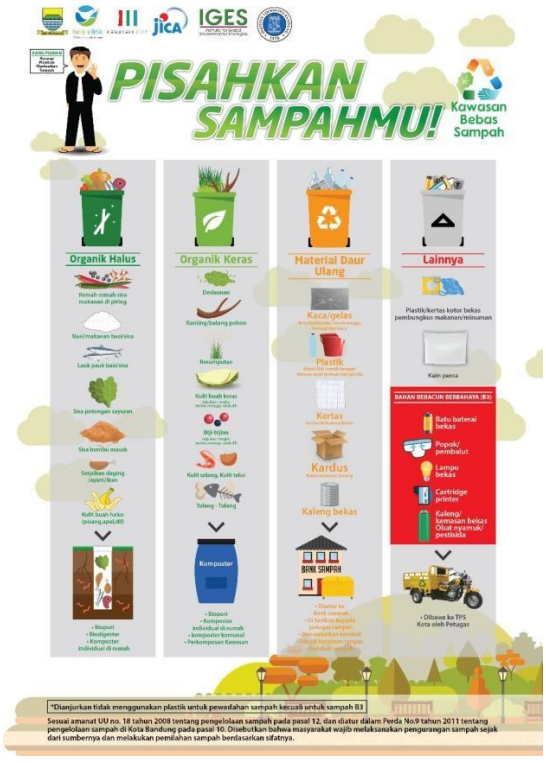

Figure 2. Poster of information of waste type to be sorted (https://www.iges.or.jp/, accessed December 2020).

The waste management system in Batununggal Indah Housing uses a collection and transport system, where the waste management system is not carried out in advance at the source so that the waste that is disposed of at the TPS does not reduce the volume of waste. However, after the existence of the KBS (Zero Waste Area) program from DLHK Bandung City in collaboration with the Japanese Kawasaki City Government, the existing waste management system at the Batununggal Indah household, especially in the Jelita Cluster and the Permai Cluster, became a disaggregated system where this system was separated in sources to reduce the volume of waste that enters the TPS.

Monitoring of Waste Reduction to TPS

The sorted waste (organic waste) and other waste from the Jelita Cluster and the Permai Cluster will be transported by the garbage officer (IWABI), then taken to the TPS Batununggal Indah. Organic waste will be processed at TPS in Batununggal Indah, other waste will be sorted by garbage collectors at TPS and the rest will be transported to the final disposal site. Figure 3 shows the waste generation from the Permai Cluster during 3 monitoring times.

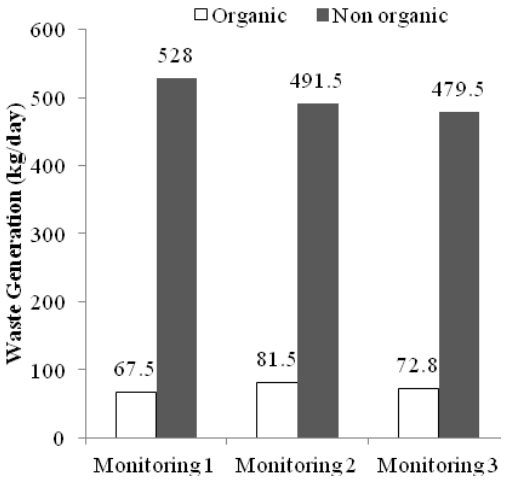

Figure 3. Data on the amount of waste (kg / day) in the Permai Cluster.

Analysis of the level of waste reduction to the TPS in the Permai Cluster:

1. Monitoring 1

In monitoring 1, the number of houses sorting out as many as 40 houses with organic waste which is separated 11.3% of the total waste of 595.5 kg/ day in the scenic cluster which will be transported to the TPS every day. The sorted organic waste will be processed by TPS Batununggal Indah.

2. Monitoring 2

In monitoring 2, the number of houses sorting out as many as 40 houses with organic waste which is separated by 14.2% of the total waste 573 kg/ day in the scenic cluster which will be transported to the TPS every day. The sorted organic waste will be processed by TPS Batununggal Indah

3. Monitoring 3

In monitoring 1, the number of houses sorting out 43 houses with organic waste which is separated by 13.2% of the total 552 kg/day waste in the scenic cluster which will be transported to the TPS every day. The sorted organic waste will be processed by TPS Batununggal Indah.

In the analysis of the level of waste reduction above, it can be seen that the progress of the level of waste reduction to TPS in monitoring 1 to monitoring 2 has experienced a quite high change from the initial 37.8 kg/day of organic waste from the total waste of 302.1 kg/day and the number of houses which sorted the waste are25 houses, making it 72.8 kg/day from the total waste of 552.3 kg/day and with 43 houses sorting out. This was caused by intensive mentoring. Consistent monitoring will increase public awareness (Yukalang et.al, 2018).

Figure 4 shows the waste generation from the Jelita Cluster during 3 monitoring times.

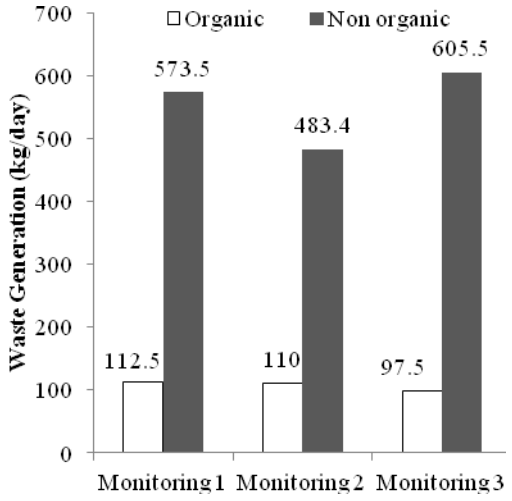

Figure 4. Data on the amount of waste (kg / day) in the Jelita Cluster

Analysis of the level of waste reduction to the TPS in the Jelita Cluster

1. Monitoring 1

In monitoring 1, the number of houses sorting out as many as 31 houses with organic waste which was separated 16.4% of the total waste 686 kg/day in beautiful clusters which would be transported to the TPS every day. The sorted organic waste will be processed by TPS Batununggal Indah.

2. Monitoring 2

In monitoring 2, the number of houses sorting out as many as 31 houses with organic waste which is separated by 18.5% of the total waste of 593.4 kg/day in the scenic cluster which will be transported to the TPS every day. The sorted organic waste will be processed by TPS3R Batununggal Indah.

3. Monitoring 3

In monitoring 1, the number of houses sorting out 34 houses with organic waste, which is separated by 13.9% of the total 703 kg/day waste in the scenic cluster which will be transported to the TPS every day. The sorted

organic waste will be processed by TPS Batununggal Indah

In the analysis of the level of waste reduction in the Jelita Cluster, there was a fairly high progress, from the initial 33.4 kg/day of organic waste that was separated from the total waste of 396.6 kg/day and with the number of houses sorting 15 houses to 97.5 kg/day organic waste is separated from the total waste of 605.5 kg/day with 34 houses sorting out.

However, the progress of reducing waste is not only seen from how much waste can be processed but also in terms of how many houses are sorting it out and also to foster a sense of community care for the environment.

From Figure 3 and Figure 4 it can be seen that the reduction of waste obtained by the two clusters is quite influential in reducing the volume of waste to the TPS, with the source separation system, the waste that should be wasted from one cluster is 595.5 kg/day to 528 kg/day. However, the waste that is processed by the garbage officer (IWABI) in this project is only organic waste.

Waste Separation at the Source by the Community

Sorting is the separation by classifying 2 types of waste, namely organic waste and other waste, the sorting process is very influential on reducing the volume of waste. This classification is a common separation and sorting of domestic waste in Indonesia (Hasbiah et.al, 2019).

Based on observations, the sorting operation did not go well because:

- Some people do not want to separate because the garbage collectors always mix sorted organic waste with other waste.
- Changes of household members in several houses because the people living in these houses have been submitted to the household member for their waste sorting, the household member does not know about the waste separation, so initially the house is sorting to not sorting it because there is no direction.
- Lack of education about sorting out the community.
- Lack of monitoring of the KBS program, so that people do not see the seriousness of the government in this program which results in people not wanting to separate.

For the sorting operation to run better, the IWABI party should reprimand the officers who collect organic waste and other waste so that they are not mixed, and from the DLHK project, they conduct education at least once a month to convey about the waste-free area program so that the public knows and wants to sort it out. The DLHK conducts monitoring so that the public will believe and assess that the government really aware of this program.

Waste Container

Waste containerization is the activity of temporarily collecting waste before it is collected, moved, transported, processed and carried out by final processing of the waste at the final disposal site.

Based on the results of observations during research in the field, the waste packaging does not go well, this is because.

- The community does not place garbage according to their criteria such as organic waste and other waste in one place, while the waste management (IWABI) has provided a special organic container or bin, which results in the waste being mixed with other waste and will be carried to the TPS.
- The community does not place the trash in its place or hang the garbage from the trees, which results in officers being unable to distinguish organic waste from other waste.

Waste Collection

Collection is the process of taking garbage from houses or the road to the TPS using a garbage truck.

Based on the results of observations during research in the field, garbage collection is not going well. This is because:

- Garbage collectors who mix organic waste and other waste into one so that they cannot be processed by officers who process organic waste, and in the end will be disposed of directly to the TPS without going through organic waste processing or composting.
- Officers do not bring special organic trash cans at the time of garbage collection so that the waste that has been sorted by the community is sometimes thrown away with other garbage.

For the collection operation to run more optimally, the officers should always be reminded by IWABI officers who have the authority so that garbage collectors always separate trash and carry special trash bins for organic waste.

Waste Treatment

The processing operation in Batunungal Indah is the processing of organic waste into compost. Based on the results of observations during research in the waste processing field it did not go well for some reasons:

- Batununggal Indah does not yet have an organic waste processing facility.
- The delay in processing disaggregated organic waste has resulted in an unpleasant odor in the TPS Batununggal environment
- The organic waste processing plant located in Babakan sari is far away, this has resulted in delays in processing organic waste

In order for processing to run smoothly, IWABI and DLHK work together to facilitate an organic waste processing facility so that the organic waste generated from the two clusters can be processed directly without having to take it to TPS Babakansari. It is hoped that with the existence of compost house in TPS Batununggal Indah, the community cares about the environment and is willing to do some sorting.

Conclusion

Garbage collection in the Operational Area of Bandung City, especially in the Batununggal Indah Housing Area, Bandung Kidul District, Mengger Village, is managed by a private company founded by the Batununggal Indah Housing community in Bandung.

Garbage collection in the Batunungal Indah Residential Area has problems such as when collecting organic waste at residents' houses, the garbage officer end ups mixes organic waste with other garbage that has been sorted by the residents so that it makes the community lazy to sort.

Measurement of waste generation shows a decrease in the weight of generated waste that is disposed of at the final disposal site, indicating that sorting has occurred. This decrease is still insignificant because the community has not consistently carried out sorting behavior, so it needs sustainable encouragement.

References

Hasbiah, A., Rusmaya, D., & Apriani, D. (2019). Sanitasi Berbasis Masyarakat di Pesantren Putri Al-Itihad, Kabupaten Cianjur. *Journal Of Community Based Environmental Engineering And Management, 3*(1), 1-8.

https://www.iges.or.jp/, accessed December 2020.

Omran, A., Mahmood A, Abdul A, Robinson GM. (2009). Investigating Household Attitude Toward Recycling of Solid Waste in Malaysia: *A Case Study. International*

Journal of Environment. 3 (2).

Rusmaya, D., Rochaeni, A., & Dewi, N. (2019). Penentuan Fasilitas Sanitasi Berdasarkan Persepsi Santri di Tahfidz Qur'an Madrasah Tsanawiyah (MTS) Assalam Kota Bandung. *Journal Of Community Based Environmental Engineering And Management, 3*(1), 15-24.

Yukalang, N., Clarke, B., Ross, K. (2018). Solid Waste Management Solutions for Rapidly Urbanizing Area in Thailand: Recommendation Based on Stakeholder Input. *Int. J. Environ. Res. Public Health*, 15, 1302.

Yustiani, Y.M., Rochaeni, A., Aulia, A. (2019). Konsep Pengelolaan Sampah di Desa Babakan Kabupaten Bandung. *EnviroScienteae*, 15(1): 121-126.

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STRATEGY OF ECOREGION PROTECTION AND MANAGEMENT, CASE STUDY OF TASIKMALAYA CITY

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Abstract

The Tasikmalaya City Ecoregion Protection and Management Strategy is a planning study aimed to support other developments, in accordance with the mandate of Law Number 32 of 2009 concerning Environmental Protection and Management. The purpose of this document is to provide an indication of the policy direction for environmental protection and management plans in the Tasikmalaya City based on the results of an analysis of the main challenges and strategic issues that refer to an environmental inventory at the ecoregion level in the Tasikmalaya City. The preparation of this document is intended to provide direction, reference and basis for development in the Tasikmalaya City based on the potential, availability, limitations of ecosystem services and natural resources in the Tasikmalaya City which are manifested in the threshold and status of the carrying capacity and the carrying capacity of the environment. Based on this status, policy interventions and program directions for environmental management and protection can be further formulated as a controller of development in Tasikmalaya City. The study is structured through the following stages: (1) data collection, thematic maps, and related literature, (2) Situational Analysis for the formulation of the main challenges and strategic environmental issues in Tasikmalaya City, using a spatial analysis framework, followed by DPSIR analysis (Driving Forces-Pressure-State-Impacts-Response) to identify the root causes of strategic issues of environmental protection and management, formulate their impact on community welfare and formulate policies and program directions as interventions in environmental protection and management.

Keywords: *ecoregion, sustainable development, Tasikmalaya City, DPSIR (Driving Forces-Pressure-State-Impacts-Response)*

Introduction

An ecoregion is a geographical area that has the same characteristics of climate, soil, water, native flora and fauna, as well as patterns of human-nature interaction that reflect the integrity of natural systems and the environment (Bailey, 2005). In accordance with Article 7 paragraph (2) of Law 32 of 2009 concerning Environmental Protection and Management, it is stated that the designation of ecoregion areas is carried out by taking into account the similarities:

a. Landscape characteristics;
b. Watershed;
c. Climate;
d. Flora and fauna;
e. Socio-cultural;
f. Economy;
g. Community institutions; and
h. Environmental inventory results.

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Ecoregion is understood as a land character that acts as a character trait and land potential constraints in accordance with its carrying capacity and carrying capacity. In the context of realizing sustainable development, Indonesia has established an ecoregion as a reference in the management and utilization of the environment. Ecoregion determination is the basis and has a very important role in seeing the linkages interactions, interdependencies and dynamics of the use of various natural resources between ecosystems in one ecoregion area (Ramadanta et.al, 2011). An ecoregion can be located within the volcanic mountain ecoregion of Mt. Halimun - G. Salak - G. Sawal stretching across the central part of West Java Province. One of the regions In addition, another goal of ecoregion designation is that functionally it can produce environmental protection-management planning, monitoring and evaluation together between interdependent regions, even though development operations are still carried out respectively by administrative regional offices, according to their respective authority (Subekti, 2016). Based on the Decree of the Minister of Environment and Forestry No.SK.8/ MENLHK/ SETJEN/ PLA.3/ 1/2018 concerning the Designation of Indonesian Ecoregions in Appendix I, the types of ecoregions in Tasikmalaya City include the ecoregion of the Mount Halimun-Mount Salak volcanic mountain complex. -Mount Sawal, the ecoregion of the Mount Ciremai volcanic mountain complex and the ecoregion of the Tasikmalaya karst hill complex. The area in Tasikmalaya City which is included in the ecoregion of the volcanic mountain complex G. Halimun - G. Salak - G. Sawal is Kawalu District, Tamansari District, Cibeureum District, Mangkubumi District, Cihideung District, Bungursari District, Indihiang District, and Cipedes District. Area of the ecoregion is 16,087 Ha.

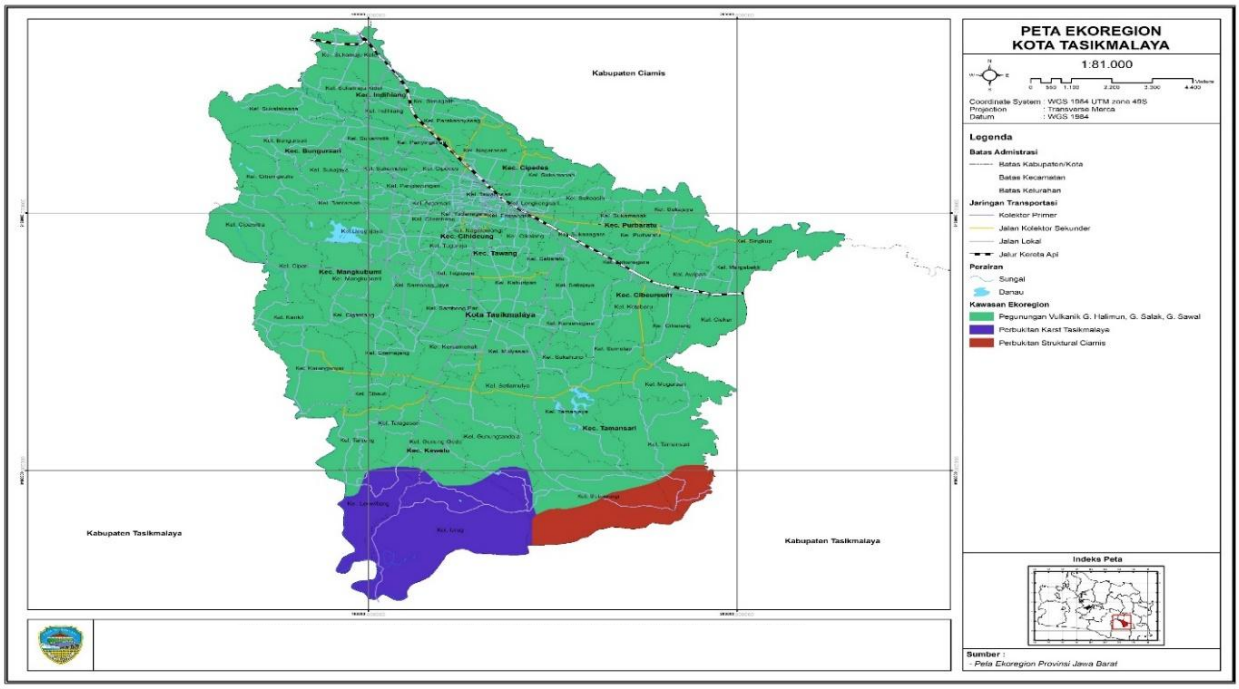

Figure 1. Ecoregion of Tasikmalaya City

Methodology

The methodology used is the DPSIR (Driving Forces - Pressure - State - Impacts - Response) analysis from the European Environment Agency (2016) to identify the root causes of strategic issues of environmental protection and management, to then formulate their impact on community welfare and formulate policies and directions. Programs act as an intervention in environmental protection and management. The use of the DPSIR method is based on the consideration that it provides a framework for understanding indicators and responses to the impact of human activities on the environment by referring to the causal chain of: driving force - pressure - state - impact - response. In addition, this method is based on a comprehensive system analysis so that it can be used as an analytical tool oriented towards determining strategic policies (Carr et.al, 2007) (Wang et.al, 2015).

The stages of preparing RPPLH using the DPSIR analysis framework are as follows:

1. Collecting data and related literature, which includes but is not limited to:

a. Ecoregion Map at 1: 500,000 scale and its description book.

b. The document on the results of an analysis of ecosystem services for each ecoregion in order to determine the potential of an ecosystem's "goods" and "services" and determine the important ecosystem services for the island ecoregion.

c. Natural resources utilization evaluation analysis document.

d. Environmental carrying capacity and carrying capacity analysis documents.

e. Land Cover Map.

f. Maps related to natural resource utilization permits.

g. Forest Area Map.

h. Disaster maps related to ecological damage.

i. Other thematic maps as needed.

2. Situational Analysis for the formulation of the main challenges and strategic environmental issues in the Tasikmalaya City. This stage is a comprehensive analysis of the characteristics of the area, environmental issues and problems and their respective locations. In detail, the stages include processing and analysis of data (spatial and non-spatial) to analyze the potential and facts of each ecoregion, as well as to consider development priority issues in Tasikmalaya City. Spatial data analysis at this stage includes:

a. Preparation of ecosystem service index map for each ecoregion of Tasikmalaya City.

b. Preparation of the threshold map and status of the Tasikmalaya DDLH, which consists of the preparation of:

- Map of availability of food stock and clean water.
- Map of the need for food stock and clean water
- Determination of the status of environmental carrying capacity based on food and water ecosystem services.
- Preparation of waste threshold and capacity maps.
- Compilation of emission distribution maps for air quality.

Result and Discussion

Projected Population Growth and Its Impact on Environmental Supporting Capacity

One of the causes of environmental pressure is population growth. In this plan, the pressure on the environment is analyzed based on the prediction of population growth, population density, and population distribution over the next 30 years starting from 2017 to 2028, 2038,

and 2048. The analysis was carried out descriptively by looking at growth patterns and changing trends. land cover, and what ecosystem services are affected by the stress.

An increase in the population in an area will be followed by a change in land use from a green area to a built-up area in order to meet housing needs and basic infrastructure for residents. This puts pressure on the ecoregion area because of the reduced land for ecosystem sustainability which results in damage to the ecosystem and disruption of the structure and function of the ecosystem to produce ecosystem services optimally. On the other hand, population growth also results in increased demand for ecosystem services that produce food and water, resulting in additional burdens in the utilization of ecosystem services, which can have an impact on decreasing the carrying capacity of the environment for food and water.

Based on the projection results of population growth in 2017-2048, it is known that the population in Tasikmalaya City has experienced significant population growth and can affect land availability, especially food land. Table 1 shows the population projection.

Table 1. Estimated Population Growth of the City of Tasikmalaya in 2017-2048

No	District	Year (People)				
		2017	2018	2028	2038	2048
1	Kawalu	88,531	88,804	91,581	94,445	97,399
2	Tamansari	66,084	66,310	68,614	70,998	73,465
3	Cibeureum	66,149	66,952	75,530	85,206	96,123
4	Purbaratu	39,458	39,589	40,930	42,317	43,750
5	Tawang	65,679	66,000	69,294	72,753	76,384
6	Cihideung	74,469	74,764	77,781	80,921	84,187
7	Mangkubumi	88,957	89,304	92,850	96,538	100,372
8	Indihiang	50,677	51,062	55,077	59,407	64,078
9	Bungursari	47,784	47,970	49,878	51,861	53,923
10	Cipedes	77,958	78,222	80,915	83,701	86,582
	Total	827,916	868,993	1,410,313	2,288,837	3,714,619

From the table of population growth projections in Tasikmalaya City in 2017-2048, it is known that the population growth is quite significant, where the projected growth is carried out per 10 years. The highest population growth is Mangkubumi District with a population in 2028 reaching 92,850 people and in 2048 is 100,372 people from the total population in 2048 is 3,714,619 people. While the lowest population growth is in Purbaratu District with a population in 2028 reaching 40,930 people and in 2048 is 43,750 people. An overview of the population growth projection can be seen on the population growth map and the attachment to the population projection in Tasikmalaya City.

The population density in Tasikmalaya City from the projection results is experiencing growth in line with the projected population growth. The total population density in 2017 is 4,503 people/km^2, while the total population density in 2048 is 20,205 people/km^2.

Table 2 shows the population density projections in Tasikmalaya City in 2017-2048, it is known that the highest population density is Cihideung District with the population density in 2018 reaching 13,618 people/km^2 and in 2048 it is 15,335 people/km^2. Meanwhile, the lowest population density is in Tamansari District with the total population density in 2018 reaching 1,842 people/km^2 and in 2048 it is 2,041 people/km^2.

Table 2. Estimated of Total Population Density of the City of Tasikmalaya in 2017-2048

No	District	Year (People/km^2)				
		2017	**2018**	**2028**	**2038**	**2048**
1	Kawalu	2,069	2,076	2,141	2,208	2,277
2	Tamansari	1,836	1,842	1,906	1,973	2,041
3	Cibeureum	3,474	3,516	3,967	4,475	5,048
4	Purbaratu	3,283	3,294	3,405	3,521	3,640
5	Tawang	9,277	9,322	9,787	10,276	10,789
6	Cihideung	13,564	13,618	14,168	14,740	15,335
7	Mangkubumi	3,626	3,641	3,785	3,936	4,092
8	Indihiang	4,590	4,625	4,989	5,381	5,804
9	Bungursari	2,826	2,837	2,950	3,067	3,189
10	Cipedes	8,691	8,720	9,021	9,331	9,652
	Total	**4,503**	**4,727**	**7,671**	**12,451**	**20,205**

Conflict on the Natural Resources Utilization

Land use conflicts are still one of the main problems in environmental management, especially in developing countries (Magsi et.al, 2017). An overlap in the location of utilization between natural resources can cause environmental damage, especially if the utilization is not taking into account the ecological functions or ecosystem services in an area. Table 3 is an indication of the overlapping use of natural resources in the agriculture, forestry, energy and water resources sectors in the Tasikmalaya City, among others.

Table 3. Overlapping or Conflict of Natural Resource Use in Ecoregion Areas

Agricultural Resources (Ha)	Kawasan Perhutanan				Geology Based Energy Resources (Ha)
	Production forest (Ha)	City Forest (Ha)	Community Forest (Ha)	Forest (Ha)	
2,422	1,428	250	1,089	409.06	542

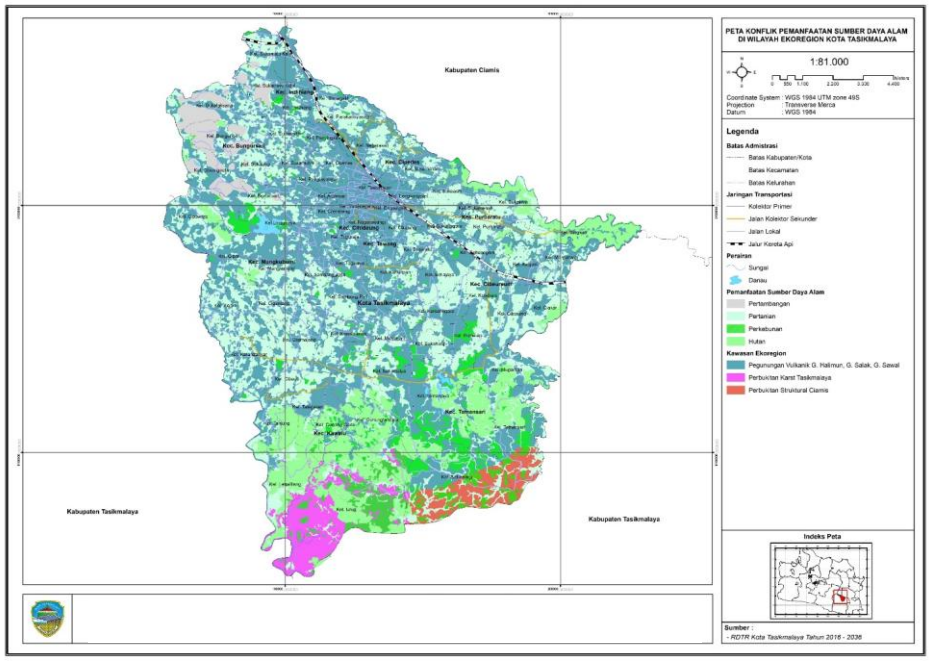

Figure 2. Map of Natural Resources Utilization Conflict

Based on the identification of spatial use conflicts between natural resources, several possible conflict resolution options are presented in the table below in order to maintain ecosystem services and functions in the ecoregion area. The options offered are so that in the future the use of forests and productive land, especially food and those with geological natural resources, can be utilized properly and maximally and there are trade-offs for forest reuse for the future. The options offered can be seen in the Table 4.

Table 4. Options for Revolution of Spatial Conflict between Natural Resources

Agricultural Resources	Forestry Area				Geology Based Energy Resources
	Production forest	City Forest	Community Forest	Forest	
Rice Fields	Permitted by an area exchange mechanism; Permitted for rain-fed rice fields by including it in the production forest rehabilitation process.	Not allowed	Permitted for rainfed lowland rice fields by participating in the process of production forest rehabilitation process	Permitted for rainfed lowland rice fields by participating in the process of production forest rehabilitation process	Not allowed
Allocation of Rice Paddy Land Provision	Permitted by an area exchange mechanism	Not allowed	Permitted by an area exchange mechanism	Permitted by an area exchange mechanism	Determination of Geology Based Energy Resources must first consider the status of the Allocation of Rice Paddy Land Provision
Geology Based Energy Resources	Permitted for non-forest land cover and unproductive land for forest exploitation	Not allowed	Permitted for non-forest land cover and unproductive land for forest exploitation	Permitted for non-forest land cover and unproductive land for forest exploitation	

Formulation of Tasikmalaya City Ecoregion Protection Strategy

1. Balancing the pace of development with the carrying capacity and carrying capacity of the environment, with the following objectives:
   a. Synchronization of RTRW with RPPLH for the City of Tasikmalaya
   b. Guaranteed availability of water for life and sustainable development.

c. Guaranteed environmental support for sustainable food production.

d. Guaranteed utilization and reserve of natural resources in a sustainable and socially just manner.

2. Improve the quality of the environment and protect the function of environmental sustainability with the following goals:

a. Reduced pressure on ecoregions and water-producing and regulating ecosystems.

b. Less pressure on ecoregions and food-producing ecosystems.

c. Reducing the level of soil and air environmental pollution.

d. Reduced levels of damage to forest and karst ecosystems.

e. The area and function of areas with genetic resources and habitat for high species are maintained.

3. Strengthen governance and government and community institutions for environmental control, monitoring and utilization and preservation. With the following objectives:

a. Availability of mechanisms for controlling the use of natural resources and the environment through various instruments.

b. Availability of systems and instruments for monitoring and preserving the environment with measurable indicators.

c. Guaranteed efficient use of natural resources and the environment for long-term use.

d. Increased cooperation between administrative areas in controlling, monitoring as well as utilizing and preserving natural resources and the environment.

e. Increased participation of the public and private parties in environmental protection and management.

4. Increase resilience and preparedness in the face of disasters and the impacts of climate change. With the following objectives:

a. The reduced level of vulnerability and risk due to the negative impacts of climate change.

b. Increased capacity and community preparedness in facing the negative impacts of climate change.

c. Availability of green infrastructure to minimize the impact of climate change.

d. Development of green cities and disaster resilient cities.

e. Development of a low emission public transportation system.

f. Development of new and renewable energy sources.

Indicators of Ecoregion Protection and Management in Tasikmalaya City based on 5K (Consistency, Consultation Coordination, Capacity and Sustainability)

Table 5 shows the protection and management of ecoregions in Tasikmalaya City based on consistency, coordination, consultation, capacity and sustainability.

Table 4. Protection and Management of Ecoregions in Tasikmalaya City based on 5K (Consistency, Coordination, Consultation, Capacity and Sustainability

No	Evaluation Aspects	Indicator
1	Consistency	• There is consistency of planning in Environmental Protection and Management Plan with the implementation carried out by government agencies. • Quantity of programs in Environmental Protection and Management Plan listed in government agency planning. • There is a match between the planning in Environmental Protection and Management Plan and planning in each Environmental Protection and Management Plan implementing institution.
2	Coordination	• The realization of a better and more directed level of planning coordination among various agencies implementing environmental protection and management involved in the Environmental Protection and Management Plan policies. • The realization of a better and more concrete level of budgeting coordination among various agencies implementing environmental protection and management. • The realization of a more synchronous and more harmonious level of implementation coordination among various implementing agencies for environmental protection and management.
3	Consultation	• There is community participation by submitting input, suggestions, criticism and complaints about the implementation of policies in the Environmental Protection and Management Plan carried out by various implementing agencies • The existence of communication and information media for the public to convey aspirations in an effort to oversee and improve the implementation of the Environmental Protection and Management Plan policy. • Availability and easy access to public information through electronic and print media, websites and internet, public complaint post boxes in order to encourage dissemination of the implementation of policies in the Environmental Protection and Management Plan.
4	Capacity	• The realization of adequate implementing institutional capacity in implementing Environmental Protection and Management Plan policies. • The realization of human resource capacity related to personnel involved in the process of implementing environmental protection and management programs. • Fulfilled sufficient funding capacity to be used in environmental

No	Evaluation Aspects	Indicator
		protection and management programs. • There are more diverse and mutually supportive sources of funding for each institution implementing Environmental Protection and Management Plan policies. • Fulfilled disaster risk reduction executive capacity in terms of control and supervision.
5	Sustainability	• Arrangement of various policies for maintenance and management in the medium and long term • The creation of an exit management program and activity strategy for the implementers of environmental protection and management policies. • Various policy inputs were formulated for the preparation of the Environmental Protection and Management Plan document for the next period.

Conclusion

Based on the description and explanation of the results of this study, it can be concluded as follows:

- The various program directives and milestones listed in this document need to be elaborated in more detail, particularly in preparing programs and activities for environmental protection and management to achieve predetermined targets.
- The implementation of protection and management of the Tasikmalaya City Ecoregion requires active involvement and participation of all stakeholders, not only the city government and its involved institutions, but also requires active involvement from the community. The active involvement of all stakeholders is very important starting from the planning process, conduct monitoring the implementation of policies.
- The projected population growth over the next 30 years will have an impact on increasing economic activity that has the potential to put pressure on the ecoregion.

References

Bailey, R.G. (2005). Identifiying Ecoregion Boundaries. *Environmental Management*. Vol. 34(Suppl.1), S14-S26.

Carr, E.R., Wingard, P.M., Yorty, S.C., Thompson, M.C., Jensen, N.K., Roberson, J. (2007) Applying DPSIR to Sustainable Development. *International Journal of Sustainable Development & World Ecology*. Vol 14, 543-555.

Magsi, H., Torre, A., Liu, H., Sheikh, M.J. (2017). Landuse Conflicts in the Developing Countries: Proximate Driving Force and Preventive Measure. *Pakistan Development Review*. Vol 56(1), 19-30.

Ramadanta, A., Basri, I.S. (2011). Pendekatan Ecoregion dalam Pengembangan Kawasan Wisata Studi Kasus Penataan Kawasan Wisata Danau Poso. *Jurnal "ruang"*. Vol. 3(1), 1-13.

Subekti, S. (2016). Rencana Perlindungan dan Pengelolaan Hidup Provinsi Kalimantan Selatan. *Jurnal Neo Tenika*. Vol. 2(1), 17-26.

Wang, Z., Zou, J., Loaiciga, H., Guo, H., Hong, S. (2015). A DPSIR Model for Ecological Security Assessment through Indicator Screening: A Case Study at Dainchi Lake in China. *Plos One*. DOI:10.1371/journal.pone.0131732

ANALYSIS AND MONITORING OF RIVER WATER QUALITY IN TASIKMALAYA CITY

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Abstract

The rivers passing through the City of Tasikmalaya include the Citanduy River, the Ciloseh River, the Ciwulan River and the Cibanjaran River. While the tributaries are the Cibanjaran River which include the Cihideung/ Dalem Suba River, the Cipedes River, the Ciromban River, the Cidukuh River, the Cicacaban River, the Cibadodon River, the Cikalang River, the Tonggong Londok River, the Cibeureum River and the Cimulu River. These rivers flow and empty into the Citanduy River. The aims and objectives of this study are environmental quality monitoring activities, especially the quality of river water in the Tasikmalaya City. To find out in more detail and carefully the level of pollution that occurs, this study aims to conduct water quality monitoring so that the resulting data can determine the source of pollutants that cause deterioration of river water quality. Monitoring was conducted during the rainy season and the dry season. Based on the monitoring, it appears that the river being monitored does not meet the quality standards as a class II water body with varying status ranging from lightly polluted to heavily polluted. Parameters that do not meet quality standards include TSS, BOD, COD, nitrite, $Cr6^{+}$, Zn, free chlorine, Total Phosphate, oil and fat, E. Coli and Total Coliform.

Keywords: *Tasikmalaya City, river water pollution, Water Pollution Index*

Introduction

One of the RPJN's sustainable development goals is the maintenance of environmental quality that can be used to measure the success of environmental management programs. It is an important task of a local government besides having a role in determining the formulation of policies and materials for public communication. The quality of the environment needs to be monitored to know changes from time to time (Yustiani et.al, 2016).

Part of environmental management which is the obligation of the Central, Provincial, Regency and City governments as well as companies is environmental monitoring activities. Environmental monitoring is the periodical environmental parameter tests at predetermined locations and sampling points for a certain period (Liu et.al, 2012). This means that when environmental samples taken can represent actual conditions for the same parameters in a certain period, the monitoring data can be compared. Environmental quality data can also be used as a basis for planning, evaluation, and supervision which is very useful for decision makers, planners, program compilers, both at the central and regional levels in determining environmental policies. This is in accordance with the philosophy which states that: "*No Measurement – No Data; No Data – No Information; No Information – No Management; No Management – No Policy".*

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Water is an environmental component that is important for human life and other living things. Water can be disastrous when it is not available in the right conditions, both in quality and quantity. One of the water bodies which is a wealth of water resources is a river. The river functions as a reservoir, storage for irrigation and raw material for drinking water for the community along its flow (Yustiani, et.al, 2017).

The river is also an easy and practical place for disposal of waste, both solid and liquid, as a result of household activities, home industry, garment, livestock, workshop, and other businesses (Roman et.al, 2016). With the disposal of various types of waste and rubbish containing various types of pollutants to water bodies, both biodegradable and non-biodegradable, it will cause heavier loads to be received by the river. If the load received by the river exceeds the threshold set based on quality standards in Government Regulation Number 82 of 2001 concerning Management of Water Quality and Control of Water Pollution, then the river is said to be polluted, physically, chemically and biologically.

Tasikmalaya City is one of the cities in the southeastern part of West Java Province, Indonesia. The rivers flowing through the Tasikmalaya City include the Citanduy River, the Ciloseh River, the Ciwulan River and the Cibanjaran River. While the tributaries are the Cibanjaran River which include the Cihideung/ Dalem Suba River, the Cipedes River, the Ciromban River, the Cidukuh River, the Cicacaban River, the Cibadodon River, the Cikalang River, the Tonggong Londok River, the Cibeureum River and the Cimulu River. These rivers flow and empty into the Citanduy River, except for the Ciwulan River.

The aims and objectives of this study are to investigate the river water quality by means of monitoring activities. Water quality monitoring serves to provide factual information about the condition (status) of water quality in the present, past trends and predictions of future environmental changes. The basic information generated from monitoring activities can be used as a reference for preparing environmental planning, evaluation, control and supervision, spatial planning, and location permits for businesses or activities. Monitoring data can be used as a basis for consideration, formulating policies or making decisions and evaluating environmental management policies, especially controlling water pollution.

Methodology

Water Sampling

There are several equipments used in the sampling activity:

1. Water sampler container/ bucket with a weight and equipped with a rope
2. Sample preparation tool: 6 bottles of Polyethylene Terephthalate (PET) 1.5 L.
3. Field testing equipment: pH meter, 2 pipette bottles, and a thermometer.

The chemical used in the sampling processes are HNO_3 p.a MERCK and H_2SO_4 p.a MERCK for sample preparation of chromium and COD parameters.

Sampling Points

There were 24 sampling points from rivers and tributaries passing through Tasikmalaya City. The sampling location were display in Table 1.

Table 1. River Water Monitoring Locations

No.	River / Monitored Surface Water	Sampling Location
1.	Ciwulan Hulu	Jl. Leuwi Budah Kp. Tanjung Loka (Sasak Gantung) RT 03/03 Kec. Kawalu
2.	Ciwulan Hilir	Jl. KH. Syeh Abdul Muhyi Jembatan Sukaraja (Perbatasan Kota Tasik dengan Kabupaten Tasik) Kel. Urug Kec. Kawalu
3.	Cibangbay	Kp. Peundeuy Kel. Urug

No.	River / Monitored Surface Water	Sampling Location
	Hulu	Kec. Kawalu
4.	Cibangbay Hilir	Kel. Leuwiliang-Kawalu
5.	Cimulu Hulu	Kp. Gn. Kokosan (Gd. Air PDAM) Kel. Cibunigeulis Kec. Bungur sari
6.	Cimulu Hilir	Jl. Anyar RT 02/03 Nyangga Hurip Kel. Marga Bakti, Kec. Cibeureum
7.	Cikalang Hulu	Bantarsari- Bungursari
8.	Cikalang Hilir	Kp. Tarikolot 06/02 Kel. Margabakti Kec. Cibeureum
9.	Cihideung Hulu	Jl. Bebedilan (Depan Cuci Mobil Pusaka Jaya Motor)
10.	Cihideung Hilir	Jembatan Singkup, Purbaratu
11.	Citanduy Hulu	Kp. Nangoh RT. 02/11 Kel. Sukamaju Kaler Kec. Indihiang
12.	Citanduy Hilir	Kp. Gobang Kel. Singkup Kec. Purbaratu
13.	Ciloseh Hulu	Bendung Bengkok Kp. Bengkok Bungursari
14.	Ciloseh Hilir	Kp. Ganoang Sukaasih (Sukamenak) Kec. Purbaratu
15.	Cilamajang Hulu	Bendung Cilamajang Kp. Gn. Lingga-Kel. Cibeuti Kec. Kawalu
16.	Cilamajang Hilir	Kp. Tanjung Loka Kec. Salawu
17.	Ciromban Hulu	Kp. Cibeureum Kel. Sukalaksana Kec. Purbaratu
18.	Ciromban Hilir	Jl. Bebedahan I No. 108 – Purbaratu
19.	Cibadodon Hulu	Jl. Paseh - Kel. Tuguraja Kec. Cihideung
20.	Cibadodon Hilir	Leuwi Munding (Belakang Perum Grand Laswi Residence)
21.	Cidukuh Hulu	Jl. Galunggung (Gg. Mesjid Baitul Mulya)
22.	Cidukuh Hilir	Jl. Golempang Kel. Sukaasih Kec.Purbaratu
23.	Cinutut Hulu	Jl. Lukmanul Hakim (depan ruko A9) Kel. Tugu Jaya Kec. Cihideung
24.	Cinutut Hilir	Jl. Taman Harapan (Jembatan Cibadodon)

Referring to the Decree of the State Minister for the Environment Number 115 of 2003 concerning Guidelines for Determining the Status of Water Quality, one of the methods used to determine the quality status of river water is the pollution indexing method. The pollution index is an index related to pollution compounds used to determine the level of pollution relative to the permissible water quality parameters (Nemerow 1974 in Kepmen-LH Number 115 of 2003). Management of water quality on the basis of the Pollution Index (IP) can provide input in decision making in order to assess the quality of the waters for a designation and take action to improve the quality if there is a decrease in quality due to the presence of pollutants. Water quality designation (j) (Appendix 3) and Ci states the concentration of water quality parameters (i) obtained from the analysis results, then Pij is the Pollution Index for the allocation (j) which is a function of Ci / Lij. Pij is determined by:

1. Choosing parameters if the parameter price is low, the water quality will improve.
2. Select a quality standard parameter concentration that does not have a range.
3. Calculating the Ci / Lij price for each parameter at each sampling location.
4. If a decreasing concentration value indicates an increased level of pollution (for example DO), then the maximum value of Cim is determined (for example for DO, then Cim is the saturated DO value). In this case the measured Ci / Lij value is replaced by the calculated Ci / Lij value, namely:

$$(Ci/Lij)\ new = \frac{Cim - Ci\ (measurement)}{Cim - Lij} \quad (1)$$

If the Lij quality standard value has a range,

- for $C_i \leq L_{ij}$ average

$$(Ci/Lij)\ baru = \frac{[Ci - (Lij)average]}{[(Lij)min - (Lij)average]} \quad (2)$$

- for $C_i > L_{ij}$ average

$$(Ci/Lij)\ baru = \frac{[Ci - (Lij)average]}{[(Lij)max - (Lij)average]} \quad (3)$$

If two values (Ci/Lij) are adjacent to the reference value 1.0. Suppose (C1 / L1j) = 0.9 and (C2/L2j) = 1.1 or a very large difference, for example (C3/L3j) = 5.0 and (C4/L4j) = 10.0.

In this example the extent of damage to water bodies is difficult to determine. The way to overcome this is:

- Use of the value (Ci/Lij) of the results measurement if this value <1.0, then the value

$$(C_i/L_{ij})_{new} = (C_i/L_{ij})_{measurement} \quad (4)$$

- If the result of (Ci/Lij) measurement> 1.0 then the new (Ci/Lij) value can be obtained from:

$$(Ci/Lij)new = 1{,}0 + P.\log(Ci/Lij)measurement$$

P is a constant and its value is determined independently and adjusted to the results of environmental observations and or the desired requirements for a designation (usually the value 5).

Determine the average and maximum values of the overall Ci/Lij ((C /Lij) R and (Ci/Lij) M). So that the value of the Pollution Index can be known from the equation:

$$Pij = \sqrt{\frac{(Ci/Lij)M^2 + (Ci/Lij)R^2}{2}} \quad (5)$$

From the results of the calculation of the Pollution Index value, the value or score describes the condition of the water quality according to the criteria in the following table.

Table 2. Determination of water quality status based on the Pollution Index

Score	Criteria
$0.0 \leq P_{Ij} \leq 1.0$	Good
$1.0 < P_{Ij} \leq 5.0$	Lightly polluted
$5.0 < P_{Ij} \leq 10$	Moderately polluted
$P_{Ij} > 10$	Heavily polluted

The result of sampling and laboratory analysis of river water quality in Tasikmalaya City is as in Table 3. Based on the results of monitoring conducted at several monitoring locations during two monitoring periods, assuming the rainy season and dry season, it appears that the river being monitored does not meet the quality standards as a class II water body with varying status starting from lightly polluted, moderately polluted to heavily polluted (Table 4). Parameters that do not meet quality standards include TSS, BOD, COD, nitrite, $Cr6^+$ metal, Zn metal, free chloride, Total Phosphate, oil and grease, E. Coli and Total Coliform.

The river in Tasikmalaya City is generally used by residents for agricultural irrigation. On the other hand, water resources are also used as water bodies that receive waste from industrial or domestic activities that have the potential to reduce the quality of these water bodies. Water body pollution can occur due to industrial waste, household/ domestic waste and agricultural waste.

Based on the source, pollution can be grouped into 3 (three) namely pollution that comes from households (domestic), industrial waste from companies, and agricultural / plantation waste. Various kinds of pollutant sources indicate that the concentration of pollutants varies widely; this is because the sources of wastewater also vary so that the time factor and the sampling method greatly affect the concentration.

Table 3 Results of River Monitoring in the City of Tasikmalaya

No	River Name	Monitoring Point	Date (mm/dd/yyyy)	Temp (°C)	pH	TDS (mg/L)	TSS (mg/L)	BOD (mg/L)	COD (mg/L)	NO_2 (mg/L)	NO_3 (mg/L)	Free Chloride (mg/L)	TP (mg/L)	Oil & Grease (mg/L)	Fecal Coliform (/100 ml)	Total Coliform (/100 ml)
1	Ciwulan Hulu	Jl. Leuwi Budah Kec. Kawalu	2/24/2019	27.0	7.9	112	38	3	22	0.01	0.4	0.12	0.3	6	3,200	14,000
			8/14/2019	26.5	7.5	102	24	3	20	0.01	0.3	0.1	0.2	4	2,400	10,000
2	Ciwulan Hilir	Jl Syekh Abdul Muhyi (Jembatan Sukaraja	2/24/2019	27.1	8.3	102	38	3	22	0.01	0.1	0.1	0.25	8	1,600	12,100
			8/14/2019	27.0	8.1	96	26	3	18	0.01	0.1	0.1	0.2	6	1,200	10,000
3	Cibangbay Hulu	Kp. Peundeuy Kel. Urug Kec. Kawalu	2/20/2019	25.1	8.5	169	14	1	9	0.02	0.7	0.08	0.11	48	300	1,900
			8/22/2019	25.0	8.1	148	12	1	8	0.002	0.5	0.05	0.11	24	200	1,400
4	Cibangbay Hilir	Kel. Leuwiliang Kec. Kawalu	2/20/2019	25.5	8.2	236	4	1	9	0.012	0.3	0.06	0.42	4	1,700	10,800
			8/22/2019	25.6	8.1	212	4	1	5	0.012	0.2	0.06	0.42	3	1,200	9,600
5	Cimulu Hulu	Kp. Gn. Kokosan Kec. Bungursari	5/8/2019	28.3	8.3	773	8	1.6	4	0.011	0.8	0.01	1.4	11	2,300	18,800
			10/30/2019	28.3	8.1	680	6	2	4	0.011	0.8	0.01	1.2	9	2,000	16,000
6	Cimulu Hilir	Nyangga Hurip Kel. Margabakti Kec. Cibeureum	5/8/2019	37.9	7.4	111	10	2	5	0.016	0.6	0.16	0.19	76	55,100	60,500
			10/30/2019	27.0	7.5	96	8	2	4	0.014	0.4	0.1	0.1	56	35,100	55,100
7	Cikalang Hulu	Kel. Bantarsari - Kec. Bungursari	2/10/2019	26.5	8.3	28	4	4	15	0.001	0.3	0.05	1.07	42	1000	5000
			9/8/2019	27.0	8.1	24	4	4	12	0.001	0.2	0.05	0.6	32	600	$1{,}25x10^4$
8	Cikalang Hilir	Kel. Margabakti Kec. Cibeureum	2/10/2019	27.6	8.1	32	2	10	16.5	0.008	0.7	0.08	0.19	20	1000	5000
			9/8/2019	28.0	7.9	32	28	8	15	0.008	0.6	0.05	0.8	16	4,200	8000
9	Cihideung Hulu	Jl. Bebedilan	5/10/2019	26.8	7.6	196	20	9	23	0.001	0.1	0.01	1.54	103	62,100	430,000
			11/1/2019	27.0	7.8	182	14	7	18	0.001	0.1	0.01	1.24	84	46,200	240,000
10	Cihideung Hilir	Jembatan Singkup Kec. Purbaratu	5/10/2019	28.2	7.4	117	48	2.18	4	0.24	1.2	0.05	0.78	31	7,100	38,500
			11/1/2019	28.4	7.5	102	34	2	4	0.12	0.8	0.05	0.56	22	4,600	24,500
11	Citanduy Hulu	Jl. Letjen Ibrahim Adjie Kec. Indihiang	2/28/2019	25.0	8.5	92	14	3.5	26	0.013	0.4	0.05	0.22	7	1,100	7,700
			8/18/2019	26	8.1	76	8	3	20	0.013	0.5	0.03	0.18	5	900	6,200
12	Citanduy Hilir	Kp. Gobang Kel. Singkup Kec. Purbaratu	2/28/2019	27.4	8.2	101	42	2	6	0.007	0.2	0.04	0.33	12	200	1,100
			8/18/2019	28.0	7.9	98	36	2	5	0.006	0.2	0.03	0.2	8	100	900
13	Ciloseh Hulu	Bendung Bengkok Kp. Bengkok Kec.	2/27/2019	27.7	8.6	102	2	17	7	0.005	0.6	0.09	0.48	6	700	32,000
			9/7/2019	28.1	7.8	96	2	6	15	0.003	0.5	0.07	0.32	4	600	28,000

No	River Name	Monitoring Point	Date (mm/dd/yyyy)	Temp (°C)	pH	TDS (mg/L)	TSS (mg/L)	BOD (mg/L)	COD (mg/L)	NO_2 (mg/L)	NO_3 (mg/L)	Free Chloride (mg/L)	TP (mg/L)	Oil & Grease (mg/L)	Fecal Coliform (/100 ml)	Total Coliform (/100 ml)
		Bungursari														
14	Ciloseh Hilir	Kp. Ganoang Sukaasih (Sukamenak) Kec. Purbaratu	2/27/2019	28.1	8.2	56	6	18.5	22	0.026	0.8	0.01	1.07	14	1,300	21,800
			9/7/2019	28.5	7.6	48	4	14	20	0.001	0.6	0.01	0.8	12	1,100	18,000
15	Cilamajang Hulu	Kp. Gn. Lingga Kel. Cibeuti Kec. Kawalu	2/6/2019	24.0	8.0	146	76	5	7	0.034	0.2	0.04	1.25	6	1,200	5,600
			8/15/2019	25.0	7.6	128	62	4	6	0.03	0.2	0.03	0.8	5	1,100	4,800
16	Cilamajang Hilir	Kp. Tanjung Loka Kec. Kawalu	2/6/2019	25.2	6.8	138	76	4	23	0.038	0.7	0.09	1.49	10	900	3,600
			8/15/2019	25.0	6.5	124	56	3	22	0.04	0.6	0.06	1.2	8	700	2,800
17	Ciromban Hulu	Kp. Cibeureum Kel. Sukalaksana Kec. Purbaratu	5/15/2019	27.1	7.7	144	202	15	38	0.005	0.9	0.03	0.39	31	500	2,900
			11/3/2019	28.0	7.4	124	186	12	28	0.005	0.8	0.03	0.33	24	400	2,400
18	Ciromban Hilir	Jl. Bebedahan I No. 108 Kec. Purbaratu	5/15/2019	27.6	7.3	180	4	6	15	0.018	0.3	0.02	1.73	10	1000	12,700
			11/3/2019	27.0	7.5	140	4	4	10	0.016	0.3	0.01	1.56	8	600	10,000
19	Cibadodon Hulu	Jl. Paseh - Kel. Tuguraja Kec. Cihideung	2/3/2019	29.1	8.1	452	66	77.5	122	0.021	1.2	0.07	3.75	120	30,000	330,000
			9/14/2019	28	7.7	348	56	64.2	112	0.01	0.8	0.06	2.76	82	10,000	220,000
20	Cibadodon Hilir	Leuwi Munding (Belakang Perum Grand Laswi Residence)	2/3/2019	28.8	7.8	160	30	12	30	0.012	0.7	0.1	12	83	10,000	90,000
			9/14/2019	28	7.6	140	24	10	26	0.01	0.5	0.05	8	64	7,000	60,000
21	Cidukuh Hulu	Jl. Galungggung (Gg. Mesjid Baitul Mulya)	5/9/2019	26.4	7.4	103	92	29	73	0.025	0.3	0.02	0.91	8	8,400	9,000
			10/31/2019	26.0	7.5	84	64	18	36	0.01	0.2	0.02	0.4	6	5,400	7,000
22	Cidukuh Hilir	Jl. Gelompang Kel. Sukaasih Kec. Purbaratu	5/9/2019	28.0	7.7	106	202	5.6	14	0.038	0.7	0.02	0.41	25	6,400	43,500
			10/31/2019	27.5	7.4	92	124	5	12	0.02	0.6	0.02	0.3	18	1,800	38,100
23	Cinutut Hulu	Jl. Lukmanul Hakim Kel. Tugujaya Kec. Cihideung	5/15/2019	26.8	8.4	140	38	2.8	7	0.08	0.08	0.02	0.88	0.88	2,600	20,400
			11/2/2019	26.5	8.1	128	26	2.4	6	0.06	0.6	0.02	0.6	0.6	2,000	18,200
24	Cinutut Hilir	Jl. Taman Harapan (Jembatan Cibadodon)	5/15/2019	28.4	7.5	149	36	6	16	0.051	0.4	0.02	1.53	1.53	31,700	54,700
			11/2/2019	27.5	7.6	132	28	6	16	0.051	0.4	0.02	1.24	1.24	29,100	48,200

Table 4 Status of River Water Quality in Tasik Malaya City

No	River Name	Period I Water Quality Status	Period II Water Quality Status	Parameters that Exceed Quality Standards
1	Ciwulan Hulu	Heavily polluted	Heavily polluted	Free Chlorine, Fecal Coliform, Total Coliform
2	Ciwulan Hilir	Moderately polluted	Moderately polluted	Free Chlorine, Total Coliform
3	Cibangbay Hulu	Lightly polluted	Lightly polluted	Free Chlorine
4	Cibangbay Hilir	Moderately polluted	Moderately polluted	Free Chlorine, Total Coliform
5	Cimulu Hulu	Heavily polluted	Heavily polluted	Total Phospat, Fecal Coliform, Total Coliform
6	Cimulu Hilir	Heavily polluted	Heavily polluted	Free Chlorine, Fecal Coliform, Total Coliform
7	Cikalang Hulu	Moderately polluted	Moderately polluted	Free Chlorine, Total Phosphate
8	Cikalang Hilir	Moderately polluted	Moderately polluted	BOD, Free Chlorine, Fecal Coliform
9	Cihideung Hulu	Heavily polluted	Heavily polluted	BOD, Total Phosphate, Fecal Coliform, Total Coliform
10	Cihideung Hilir	Heavily polluted	Heavily polluted	Free Chlorine, Fecal Coliform, Total Coliform
11	Citanduy Hulu	Lightly polluted	Lightly polluted	Free Chlorine
12	Citanduy Hilir	Lightly polluted	Lightly polluted	Free Chlorine
13	Ciloseh Hulu	Heavily polluted	Heavily polluted	BOD, Free Chlorine, Total Coliform
14	Ciloseh Hilir	Moderately polluted	Moderately polluted	BOD, Total Phosphate, Total Coliform
15	Cilamajang Hulu	Moderately polluted	Moderately polluted	Free Chlorine, Total Phosphate
16	Cilamajang Hilir	Moderately polluted	Moderately polluted	Free Chlorine, Total Phosphate
17	Ciromban Hulu	Lightly polluted	Lightly polluted	BOD
18	Ciromban Hilir	Moderately polluted	Moderately polluted	Total Phosphate, Total Coliform
19	Cibadodon Hulu	Heavily polluted	Heavily polluted	BOD, COD, Free Chlorine, Total Phosphate, Fecal Coliform, Total Coliform
20	Cibadodon Hilir	Heavily polluted	Heavily polluted	BOD, Free Chlorine, Total Phosphate, Fecal Coliform, Total Coliform
21	Cidukuh Hulu	Heavily polluted	Heavily polluted	BOD, COD, Fecal Coliform
22	Cidukuh Hilir	Moderately polluted	Moderately polluted	Fecal Coliform, Total Coliform
23	Cinutut Hulu	Moderately polluted	Moderately polluted	Fecal Coliform, Total Coliform
24	Cinutut Hilir	Heavily polluted	Heavily polluted	Total Phosphate, Fecal Coliform, Total Coliform

Visually the condition several water samples were seen turbid. Based on the results of the calculation of the water quality status of several rivers, there are rivers that have TSS values above the required Class II water quality standards. This is because the condition of the river water has begun to change its function due to the many activities that occur along the river so that it will affect the physical condition of the water which is formerly clearly visible from the total amount of suspended solids in the river.

Other river water parameters that exceed Class II Water Quality standards are COD levels at several monitoring points. This COD parameter is a very important parameter because this parameter is also an indicator of water pollution. COD is the amount of oxygen needed to oxidize organic substances in rivers by utilizing potassium dichromate oxidizer as a source of oxygen. The COD figure is a measure of water pollution by organic substances which can naturally be oxidized through biological processes and can reduce dissolved oxygen in rivers. The high COD parameter can be caused by industrial waste or domestic waste (Ramawati et.al, 2013). On the other hand, water that is not polluted has a low COD value.

Another river water parameter that also exceeds Class II Water Quality standards is free chloride found in several rivers. The presence of free chloride can be caused by natural conditions. Naturally, the presence of chloride in rivers is very large. Excessive concentrations of free chloride will certainly be harmful to health if the water is used as a source of drinking water.

Conclusion

Based on the monitoring, laboratory analysis and data processing, it can be concluded as follows:

- River status are varied from lightly polluted, moderately polluted to heavily polluted
- The index shows that river water status was similar between two periods of monitoring.
- Parameters that do not meet quality standards include TSS, BOD, COD, nitrite, $Cr6^{+}$, Zn, free chlorine, Total Phosphate, oil and fat, E. Coli and Total Coliform.

References

Liu, Y., Zheng, B.H., Fu, Q., Wang, L.J., Wang, M. (2012). The Selection of Monitoring Indicators for River Water Quality Assessment. *Procedia Environmental Sciences*, Vol. 13: 129-139.

Ministry of Environmental of Republic of Indonesian Kepmen-LH Number 115 of 2003.

Rahmawati, Chadijah, St., Ilyas, A. Analisa Penurunan Kadar COD dan BOD Limbah Cair Laboratorium Biokimia UIN Makasar menggunakan Fly Ash Batubara. Al-Kimia, Vol 1(1): 64-75.

Roman, M., Duan, F.K., Suwari. (2016). Kontribusi Limbah Domestik Penduduk di Sekitar Sungai Biknoi terhadap Kualitas Air Bendungan Biknoi sebagai Sumber Baku Air Minum Serta Upaya Penanganannya. *Jurnal Bumi Lestari*, Vol. 16(2): 155-162.

Yustiani, Y.M., Lidya, L. (2016). Towards an Information System of Modeling and Monitoring of Cikapundung River, Bandung, Indonesia. *Procedia Engineering*, 154: 353-360.

Yustiani, Y.M., Lidya, L., Matsumoto, T., Rachman, I., Komariah, I. Formulation of the Integrated Information System of River Water Quality in the Cikapundung River Bandung, Indonesia. *International Journal of Engineering and Technology*, Vol. 9(1): 137-142

IMPROVING COMMUNITY AWARENESS FOR A CLEAN AND HEALTHY LIFE TO PREVENT THE SPREAD OF COVID 19 IN TANAH KALI KEDINDING, KENJERAN, SURABAYA

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Abstract

High population density in urban areas is a challenge in preventing the spread of Covid 19. High population density encourages the occurrence of crowds in public facilities, which has a great potential for the spread of the Covid 19 virus. People's awareness to live clean and healthy is an individual's role in realizing personal health, family and the environment. One of the healthy behaviors is the habit of washing hands with soap, which is an effort to prevent the spread of Covid 19. However, everyone's awareness is different, influenced by their socio-economic background. Education on clean and healthy living needs to be carried out continuously, therefore, ITATS Environmental Engineering Department, conducts community service activities in the form of education on clean and healthy living in Tanah Kali Kedinding Village, Kenjeran, Surabaya. Activities of this community service include assisstanship and facilities donation. The result shows that Covid 19 spreading was lowering after the event. The community awareness on cleaner and healthier living is improved.

Keywords: *Covid 19, hand washing, Kenjeran,*

Introduction

In early 2021, the Indonesian government began to carry out vaccinations gradually to prevent an increase in new cases of Covid 19. New cases of Covid-19 are still increasing in various parts of Indonesia. The Indonesian population who live in urban areas is 52.9%, this causes a high level of population density in urban areas. High population density makes it difficult to maintain social distancing, facilitates crowds, thereby facilitating the spread of the Covid 19 virus.The habit of washing hands with soap using running water is an effort to prevent the addition of new cases of Covid 19. Education on the habit of washing hands with soap needs to be carried out continuously (Purnama & Susanna, 2020) (Proverbs, 2020).

PHBS (Clean and Healthy Living Behavior) is behavior that is carried out consciously as a result of learning to be healthy independently and to take an active role in realizing public health is the core of. PHBS can be implemented in household environments, health facilities, educational institutions, workplaces and public places. Using clean water and washing hands with soap are two out of ten PHBS behaviors that can be carried out in the household environment by every family member. These two behaviors are closely related to the government's appeal to prevent the spread of Covid 19 in society, namely wearing masks, maintaining distance and washing hands using clean water and soap (Indonesian Ministry of Health, 2011).

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Data on Covid 19 cases from April 2020 to July 2020 there was an increase in the number of Covid 19 cases in Kenjeran District, Surabaya City and the highest was in the Tanah Kali Kedinding Village area. Kenjeran District is located in the northern part of Surabaya City, consisting of 4 villages, namely Tanah Kali Kedinding Village, Sidotopo Wetan Village, Bulak Banteng Village and Tambak Wedi Village.

Students as the younger generation who will become agents of change in the future, apart from learning, they must also have concern for the surrounding community. As a student of the ITATS Environmental Engineering Department, who already has knowledge related to the provision of clean water and public health, and then conducts community service activities in the form of education on clean and healthy living related to an effort to prevent the spread of Covid 19 in Tanah Kali Kedinding Village, Kenjeran, Surabaya (Iriani et al., 2020).

The activity includes assisstanship on behavior changing of the community in dealing with the Covid 19 pandemi. This community service was also conducted to investigate its effect to Covid 19 spread.

Methodology

Method

This study was conducted using a qualitative method approach, case studies. The Covid 19 case was recorded in the Tanah Kali Kedinding Village having the highest score compared to the other three villages in Kenjeran District, Surabaya City. To explain the phenomenon of the high number of Covid 19 cases in Kali Kedinding Village compared to the other three urban villages, secondary data collected from related agencies is used.

Location

This activity was carried out in Tanah Kali Kedinding Village, Kenjeran District, Surabaya City in June-July 2020, carried out by the ITATS (Institute of Technology Adhitama Surabaya) Environmental Engineering Deparment team consisting of students and accompanying lecturers.

Figure 1. Kenjeran District is located in the northern part of Surabaya City

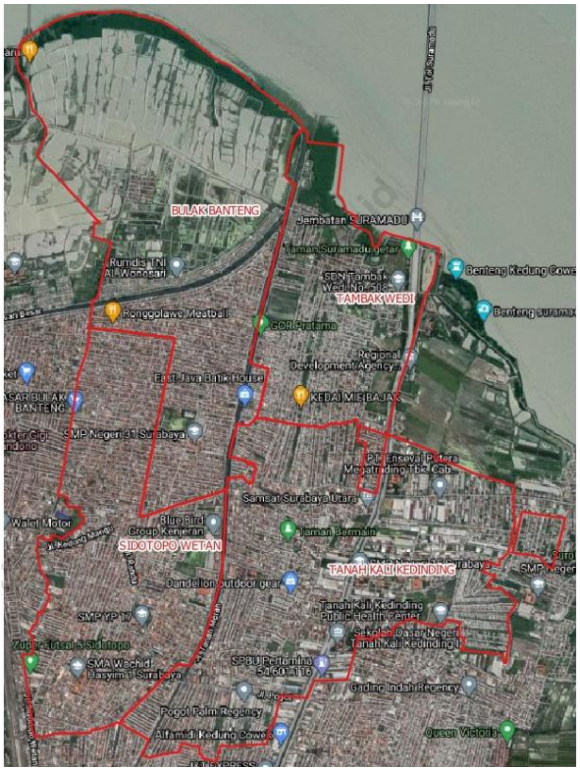


Figure 2. Kenjeran District, Surabaya City

Result and Discussion

The general description of the population of Kenjeran District including density, educational background and employment, is presented in the following graph (Kenjeran District in Figures of the year 2020, 2020).

Table 1 Population Density

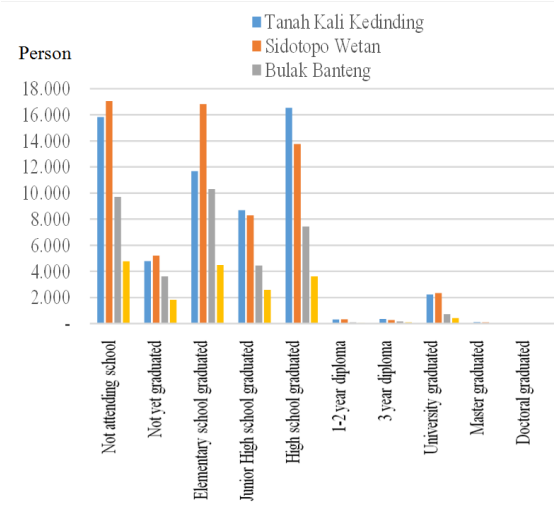
Sub-District	Area (km^2)	Total population (people)	Density (people/km^2)
Tanah Kali Kedinding	2.41	60,566	25,131
Sidotopo Wetan	1.66	64,200	38,675
Bulak Banteng	2.67	36,517	13,677
Tambak Wedi	0.98	17,915	18,281
Total	7.72	179,198	

Table 2 Average number of household

Sub-District	Total population (people)	Household number	Average population/ house
Tanah Kali Kedinding	60,566	17,629	3.4
Sidotopo Wetan	64,200	18,373	3.5
Bulak Banteng	36,517	9,887	3.7
Tambak Wedi	17,915	5,050	3.5
Total	179,198	50,939	

The population density of Kenjeran District is high (Table 1) with an average family member of 3-4 people per family (table 2). High population density causes crowds to easily occur in households and public facilities, such as means of transportation, markets, etc., making it difficult to maintain distance, thus facilitating the spread of the Covid 19 virus (Purnama & Susanna, 2020)

Figure 3 shows that the majority of the population in Kenjeran District has a high school education background and below. The high number of people who do not / have not gone to school shows that the population is young, the age of children is quite large; this is also supported by Figure 4, which shows the high number of people who are not / not working. Therefore, clean and healthy living habits need to be carried out continuously by observing methods that are in accordance with the characteristics of the local community.



Figur 3 Educational background of residents of Kenjeran District

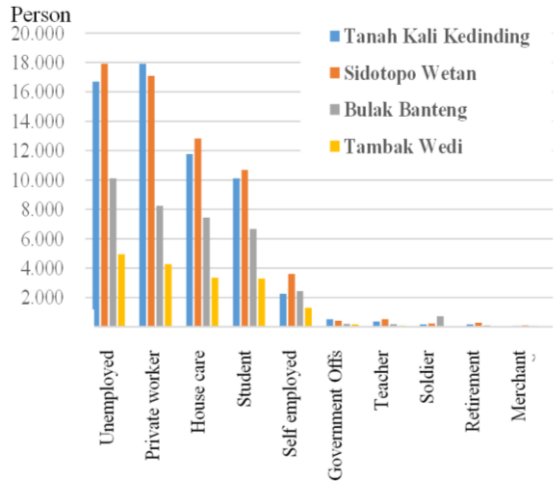


Figure 4 Type of occupation for residents of Kenjeran District

In June - July 2020 by paying attention to health protocols, the ITATS Environmental Engineering team collaborated with youth organizations accompanied by local community leaders to conduct education about clean and healthy living for themselves and the

surrounding environment, as well as handing over assistance in the form of hand washing facilities, hand washing soap, as well as hand sanitizers to prevent the spread of Covid 19 in the region. The activity was carried out at Balai RW 01 of Tanah Kali Kedinding Village, Gang Arbei RT 06, and residents of RT 14 of Tanah Kali Kedinding Village.

(a) Education on clean and healthy living

(b) Donation of soap hand washing tools

Figure 5 Activities in the Kelurahan Tanah Kali Kedinding

The decrease in the rate of confirmation of Covid 19 in Kenjeran District has occurred since September 2020, this means that the community has adapted to new habits during the pandemic by increasing awareness of maintaining cleanliness and health (Figure 6).

Figure 7 shows the highest addition of new cases occurred in Kelurahan Tanah Kali Kedinding from July to September 2020, after which new cases decreased in all sub-districts in Kenjeran District. In April - May 2020, the public still does not understand about the Covid 19 disease, while in June-September 2020 the community has gradually begun to adapt and apply the habit of wearing masks, washing hands and maintaining distance with more and more education through the media. This has an impact on the cumulative confirmation of Covid 19 cases (Figure 6) (Proverbs, 2020) (Bakhtiar et al., 2020).

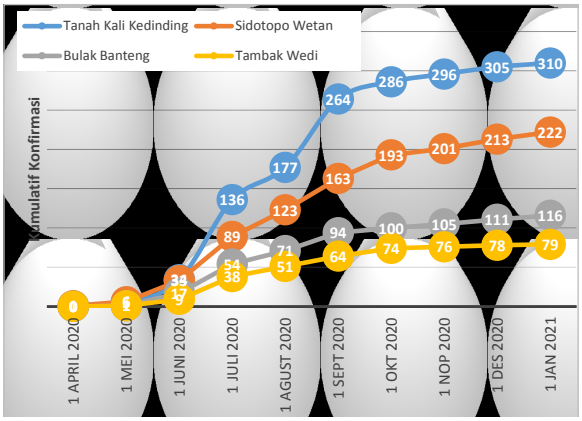


Figure 6. Cumulative confirmation of the Covid 19 case in Kenjeran District (https://lawancovid-19.surabaya.go.id/visualisasi/graph)

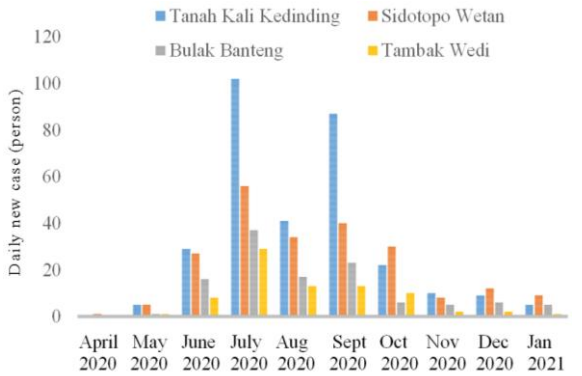


Figure 7. Addition of new Covid 19 cases in Kenjeran District (https://lawancovid-19.surabaya.go.id/visualisasi/graph)

Usually, it takes a long time to form a habit in society to adopt a new behavior. This happens especially if behavior change is required to be part of the adult community (Alfiah et.al., 2018). The formation of new habits is usually provided through youth education and into the primary school curriculum. One of the subjects related to this includes Environmental Education (Rachman et.al, 2015). However, in this community service activity, the rapid improvement of people awareness was obtained. It played an important role in slowering Covid 19 spreading in this area.

Conclusion

Everyone can play a role in preventing the spread of Covid 19 by adopting clean and healthy living habits. Education on clean and healthy living needs to be carried out. The awareness of the Kenjeran District community to live clean and healthy has helped reduce the rate of increase in confirmed cases of Covid 19.

The community service activities which are including assissanship and facilities donations show significant role in improving the awareness of the community to life cleaner and healthier.

Acknowledgement

Our gratitude goes to the ITATS Environmental Engineering students and lecturers who have jointly carried out this community service activity.

References

Alfiah, T., & Yuliawati, E. (2018). Analisis Resiko Kesehatan Lingkungan Udara Ambien terhadap Pengguna Jalan dan Masyarakat sekita pada Ruas Ir. Sukarno Surabaya. *INFOMATEK: Jurnal Informatika, Manajemen Dan Teknologi*, *20*(1), 27-34.

Amsal, A. (2020). The Water, Soap, Sanitation, and Handwashing Facilities are Associated with COVID-19 Transmission in 44 Countries. *Poltekita : Jurnal Ilmu Kesehatan*, *14*(1), 50–57. https://doi.org/10.33860/jik.v14i1.86

Bakhtiar, R., Hilda, H., Duma, K., & Yudia, R. C. P. (2020). Relationship between understanding of COVID-19's infographics and the efforts to prevent COVID-19 transmission. *Journal of Community Empowerment for Health*, *3*(2), 67. https://doi.org/10.22146/jcoemph.56749

Iriani, S. S., Manoy, J. T., Dinata, V. C., & Ronaboyd, I. (2020). The Role of University in Empowerment of Clean Living for Anticipating the Spread of Covid-19 at East Java: *Proceedings of the International Joint Conference on Arts and Humanities (IJCAH 2020)*. International Joint Conference on Arts and Humanities (IJCAH 2020), Surabaya, East Java, Indonesia. https://doi.org/10.2991/assehr.k.201201.232

Kecamatan Kenjeran Dalam Angka 2020. (2020). Badan Pusat Statistik Kota Surabaya. https://surabayakota.bps.go.id/publication/download.html?nrbvfeve=ZDE1NGE4OWRmYTc3ODg5YmRjOTA2NWMy&xzmn=aHR0cHM6Ly9zdXJhYmF5YWtvdGEuYnBzLmdvLmlkL3B1YmxpY2F0aW9uLzIwMjAvMDkvMjgvZDE1NGE4OWRmYTc3ODg5YmRjOTA2NWMyL2tlY2FtYXRhbi1rZW5qZXJhbi1kYWxhbS1hbmdrYS0yMDIwLmh0bWw%3D&twoadfnoarfeauf=MjAyMS0wMi0yMCAyMTozMjozMg%3D%3D

Kementerian Kesehatan RI. (2011). *Pedoman Pembinaan Perilaku Hidup Bersih dan Sehat (PHBS)*. https://promkes.kemkes.go.id/download/jsg/files13583Pedoman_umum_PHBS.pdf

Peraturan Menteri Kesehatan Republik Indonesia nomor: 2269/MENKES/PER/XI/2011 Pedoman pembinaan perilaku hidup bersih dan sehat (PHBS). (n.d.).

Purnama, S. G., & Susanna, D. (2020). Hygiene and Sanitation Challenge for COVID-19

Prevention in Indonesia. *Kesmas: National Public Health Journal*, *15*(2). https://doi.org/10.21109/kesmas.v15i2.3932

Rachman, I., Toru, M., & Yustiani, Y. (2015). Influence of Parent's Behavior to the Children Awareness on the Environmental Preservation. *Journal Sampurasun : Interdisciplinary Studies For Cultural Heritage*, *1*(1). doi:10.23969/sampurasun.v1i1.22

[Surabaya lawan covid-19]. (n.d.). https://lawancovid-19.surabaya.go.id/visualisasi/graph.

ANALYSIS OF REDUCING CO_2 EMISSIONS USING SPIRULINA MICROALGAE

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Abstract

Greenhouse Gases (GHG) consists of various types of gases that are produced either naturally from the environment or from the activities of living things, some examples of the dominant GHGs are water vapor, carbon dioxide (CO_2), methane (CH_4), nitrogen oxides (NOx) and Sulfur Oxide (SOx), the largest contributors to GHG emissions are in the Energy sector, amounting to 175.62 million tons of CO_2. Microalgae are the most primitive plants, can grow in low water quality with the availability of adequate nutrients and sunlight. The amount of CO_2 that can be absorbed by 1 kg of dry spirulina is 1.83 kg of CO_2. In addition, Spirulina Platensis can tolerate gas content of SOx, NOx and CO_2 whose concentrations are <12%. This study aims to determine the process of utilizing CO_2 gas emissions from power plant for the cultivation of Spirulina Platensis microalgae at PT. Indonesia Power UPJP Perak Grati. Based on the research results, the average emission load value generated from power plant, especially HRSG 1.1, is 10,403.31 tons CO_2/ month on average. The temperature factor has a significant correlation with the growth of microalgae cells with an inverse correlation. Based on the tests carried out to determine the relationship between changes in the flow rate of CO_2 in microalgae cultivation ponds to the growth of microalgae cells, it was found that the addition of CO_2 in the cultivation pond with a flow rate of 1 L/ minute had a greater effect than other treatments. The amount of CO_2 absorption by microalgae installations with a flow rate variation of 1 liter CO_2/ minute is able to absorb 0.2766 tons of CO_2/ month, or is only capable of <1% of the average emission load of HRSG 1.1 per month.

Keywords: *CO_2, Microalgae Spirulina Platensis, Power plant emissions, Emission Loads*

Introduction

Currently the issue of Global Warming has become an issue around the world, which is one of the causes of global warming is the occurrence of the greenhouse effect on the earth's atmosphere, which results in the effect of heat reflected on the earth's surface trapped by the gases in the atmosphere layer, as a result the heat will be reflected back to the earth's surface so that the earth's surface temperature increases (Hairiah, 2007). Greenhouse Gases (GHG) consists of Carbon Dioxide (CO_2), Methane (CH_4), Nitrogen Oxide (NOx) and Sulfur Oxide (SOx). Based on GHG emissions inventory data in the Energy Sector from the Ministry of Energy and Mineral Resources, the total GHG emissions produced in Indonesia in 2015 amounted to 261.89 million tons of CO_2 with an average increase of 2.43% per year. The biggest contributor to GHG emissions is in the Energy sector, amounting to 175.62 million tons of CO_2.

PT. Indonesia Power Generation Unit and Pembangkitan Perak Grati are committed to becoming a Trusted Energy company that is friendly to the environment. One of its applications is by making efforts to reduce CO_2

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emissions from power plant activities, namely utilizing CO_2 from exhaust gas emissions from the generation process, especially power plan. CO_2 gas is a gas produced from the combustion process of fossil fuels. In this case the emissions are generated from the Gas and Steam Power Plant (GSPP), which in the process uses gas as the fuel. The amount of CO_2 gas produced from gas fuel is 12% (Pusdatin ESDM, 2016).

Therefore it is necessary to reduce CO_2 gas emissions, one of which is by mitigating CO_2. CO_2 in nature is the main source in the process of plant photosynthesis, one of which is the Microalgae Spirulina Platensis (Istiyanie, 2011).

Microalgae are the most primitive plants, with cellular size and commonly known as phytoplankton. The habitat for microalgae lives in almost all waters in the world. Microalgae can carry out photosynthesis like other plants; therefore microalgae need sunlight and CO_2 gas to carry out the photosynthesis process. One type of microalgae is Spirulina Platensis (Bunowo & et al, 2018). Spirulina Platensis is a microalga that can grow well in low quality water such as wastewater in alkaline conditions with sufficient availability of nutrients and sunlight. Spirulina Platensis contains protein, amino acids, vitamins, minerals and pigments that can be used as additional food ingredients (supplements) for humans, animals, and aquaculture (Setiawan & et al, 2014).

One type of microalgae is Spirulina Platensis. Spirulina requires CO_2 gas to carry out photosynthesis; one kilogram of dry microalgae uses about 1.83 kg of CO_2 while the amount of use of CO_2/ biomass of Spirulina Platensis ranges from 0.36-1.78 g CO_2/ g biomass with an average of 0.78 g CO_2/ g of biomass at a rate of 750 ml/ min. (Setiawan & et al, 2014).

Growth of Spirulina Platensis is influenced by environmental conditions including temperature (temperature), nutrients (nutrients), light intensity, degree of acidity (pH), aeration (CO_2 source), and salinity. The following is the environmental quality standard for microalgae growth based on several literatures (Kawaroe, 2010). Spirulina is the type of microalgae that is most widely cultivated; this is due to its fast growth process, relatively low maintenance costs, and high nutrient content. The pigment content of Phycocyanin in spirulina is useful as an antioxidant, a natural colorant for food, cosmetics, and medicine, especially as a substitute for synthetic colors and can reduce obesity (Muhammad, 2010).

At PT. Indonesia Power UPJP Perak Grati microalgae spirulina platensis is used as an effort to reduce CO_2 gas emissions generated from the GSPP chimney. According to Yusuf Setiawan (Setiawan & et al, 2014), the amount of CO_2 that can be absorbed or used by Spirulina Platensis biomass is in the range of 0.36-1.78 g CO_2/ g biomass with an average CO_2 absorbed of 0.78 g CO_2/ g biomass. In addition, the dry biomass produced from the cultivation process is processed to become a fish feed mixture in collaboration with the community around the company as a Corporeate Social Responsibility (CSR) program.

In this study, we will discuss the use of Microalgae Spirulina Platensis to reduce CO_2 gas emissions generated from emissions from the power generation process of PT. Indonesia Power Unit for Generation and Generation of Grati Silver (UPJP PGT), especially in the Heat Recovery Steam Generator (HRSG) chimney. This research was conducted at the Microalgae Cultivation Unit which utilizes emissions from Heat Recovery Steam Generator (HRSG) number 1.1.

Methodology

Type and Conceptual of the Research

This study uses a quantitative approach. The research method used is an experimental method (Min, 2016). The scope of this research activity includes field activities. Field activities include

experimental activities for microalgae cultivation by utilizing emissions from GSPP, especially in HRSG 1.1. This research is part of the activities carried out by the K3L Division of PT. Indonesia Power Unit for Generation and Service Generation (UPJP) Perak Grati. From this research, data will be obtained regarding light intensity, pH, and the amount of microalgae biomass obtained at harvest. Examination of pH and light parameters was carried out at the cultivation location using the available equipment.

The conceptual framework is a relationship between concepts or variables to be observed or measured through the research conducted (Soekidjo, 2005). The conceptual framework in this study can be described as seen in Fig. 1.

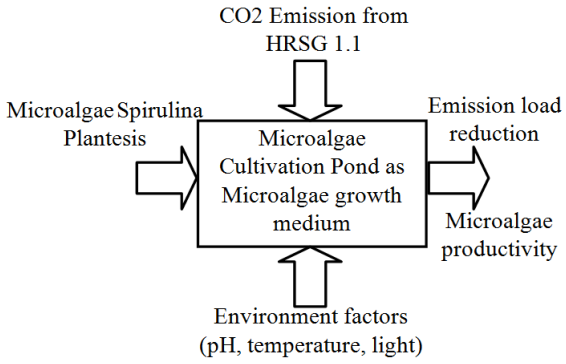

Figure 1. Research Concept Framework

Variables are measures or characteristics possessed by members of a group that are different from those of other groups (Soekidjo, 2005). The independent variable is a variable which if at any time changes will result in changes to other variables. The dependent variable is a variable that changes due to changes in the independent variable. The variables in this study are as seen in Fig.2.

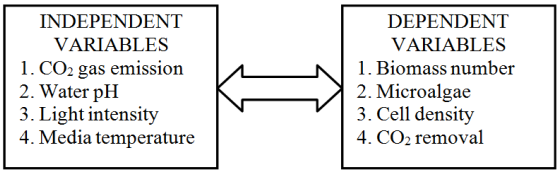

Figure 2. Variables in Research

Research Location and Sampling

The research was conducted at PT. Indonesia Power UPJP Perak Grati, which is located on Jl. Raya Surabaya Probolinggo KM 73. Wates Village, Lekok District. Regency. Pasuruan - East Java.

The population in this study was the Spirulina Platensis Microalgae that were cultivated in the Microalgae Installation of PT. Indonesia Power UPJP Perak Grati, by utilizing CO_2 gas emissions from HRSG 1.1.

The sample is part of the overall object under study and is considered to represent the entire population at the research site. The sampling technique used in this study was purposive sampling using inclusion criteria. The inclusion criteria were the characteristics of the sample that could be included or were eligible to be studied, while the inclusion criteria used were microalgae Spirulina Platensis. The microalgae are obtained from Indonesian waters and have been cultured by the Brackish Water Cultivation Fishery Center (BPAP) Situbondo, East Java. The microalgae seeds used have been reproduced in the company's environmental laboratory which will then be used as a starter for the cultivation process in the event of a failure in the cultivation process.

Data Sources

The primary data of this research are noise data. The primary data obtained in this study are data of light intensity, pH, pool temperature, the amount of biomass from microalgae yields. Data of lighting intensity, pH and pool temperature every day during the observation period by direct measurement. Secondary data in this study were obtained from existing data in the company and literature studies or related literature. Secondary data in this study include fuel consumption data in determining CO_2 emission load, microalgae installation design, etc. The Emission Load data used is data for the 1st Quarter (January-March) 2018, this is because

the CO_2 emission load data for the 2nd and 3rd Quarter (April-September) periods are still in the process of being compiled by the company.

Study literature by conducting theoretical studies through books and other sources of information relating to the learning media that will be developed.

Research Design

This research includes 2 stages, namely: the Observational research stage and the Experimental research stage. The observational research stage includes secondary data analysis to determine the CO_2 emission load generated from HRSG 1.1. The data period to be analyzed is data in January-March 2018. While the experimental research stage is to cultivate microalgae spirulina platensis with the variations that have been determined during July 16 2018-July 29 2018. In the experimental stage the observations will be divided into 4 pools, namely Control Pool, Variation Pool 1, Variation Pool 2, and Variation Pool 3. Each pool will get different treatments. This treatment includes adjusting the flow rate of CO_2 that is flowed into the pool, there are 3 variations of the flow rate of CO_2, namely as follows:

1) Control Pool: Raw Water + Microalgae + Ordinary Aerator (Control)
2) Variation Pool 1: Raw Water + Microalgae + CO2 Aerator with V1 = 1 Liter/ minute.
3) Variation Pool 2: Raw Water + Microalgae + CO2 Aerator with V2 = 2 Liter/ minute.
4) Variation Pool 3: Raw Water + Microalgae + CO2 Aerator with V3 = 3 Liter/ minute

Data Analysis

In calculating the GSPP Emission Load, the calculation method in this study includes the calculation of CO_2 Emission Load and the calculation of CO_2 absorption by microalgae. The method for calculating the CO_2 load generated from HRSG 1.1 refers to the Minister of Environment Regulation No. 21 of 2008 concerning Fixed Emission Quality Standards for Thermal Power Plants Appendix VII (F) with the Equation (1).

$$E\ CO2 = \sum F \times Ac\ CC \times OF \times \left(\frac{MW\ CO_2}{AN\ C}\right) \quad (1)$$

Where OF is Oxidation Factor (0.95), MW CO2 is Molecular Weight CO_2 (44), AN C is Atomic Number C (12), E CO_2 is Emission Load CO_2 (ton), ∑F is Actual Carbon Content → 154 ton/ month.

Environmental factors are one of the factors that influence the growth of a living being. Environmental factors that will be observed in this study include:

1) light intensity,
2) pH of water
3) water temperature

Observation of environmental factors was carried out in all observation ponds (control pool, variation 1, variation 2 and variation 3). The data that has been collected will then be analyzed using the SPSS application to determine the correlation between environmental factors and microalgae growth using the correlation test method using the Pearson Correlation. Person correlation is a statistical method used to measure the strength and direction of the linear relationship of two variables. The correlation between these variables is connotated with a value of 1 to -1. The higher the correlation value is indicated by the closer the value to 1 or -1.

In this study, the influence of CO_2 gas will be calculated on the growth of the Spirulina Platensis Microalgae. The calculations are carried out still using the SPSS application using the one-way ANOVA (Analysis of Variance) test, because only one factor of concern is the growth of microalgae. In this experiment, several different treatments will be given to each microalgae sample.

The principle of the Anova test is to analyze the variability of data into two sources of variation, namely variations within groups and between

groups. The results of this method are in the form of a comparison of the values of the two variants, where if the results get closer to the number one, there is no difference in the effect of the intervention carried out, in other words the mean value being compared is no difference and vice versa (Anisa, 2010).

The analysis of the amount of CO_2 that can be absorbed by this microalgae installation is calculated based on the amount of CO_2 emissions (tonnes) that are produced, reduced by the assumption that the amount of CO_2 gas that can be absorbed by microalgae. The amount of CO_2 that can be absorbed or used by biomass. The strength of the CO_2 absorption capacity of Spirulina Platensis is in the range of 0.36 - 1.78 g CO_2/ g of biomass with an average CO_2 absorbed of 0.78 g CO_2/ g of biomass (Setiawan & et al., 2014). The formula for calculating the absorption of CO_2 by microalgae is as Eq. (2).

$$absorbed\ CO_2\ (Ton) = \frac{harvest\,(kg) \times 0.78}{1000} \quad (2)$$

Result and Discussion

Production Activities of PT.Indonesia Power UPJP Perak Grati

The main business activities of PT. Indonesia Power is a provider of electricity through electricity generation and as a provider of operation and maintenance services for power plants that operate power plants spread across Indonesia.

The production process of GSPP Grati includes 3 blocks, namely, Block 1, Block 2 and Block 3. Block 1 (Combine Cycle) has been operated since October 1997 with a 3: 3: 1 system which itself 3 x 100 MW Gas Turbine, 3 HRSG (Heat Recovery Steam Generator) with 1 x 150 MW Steam Turbine. Block 2 (Open Cycle) which consists of 3 x 100 MW Gas Turbines. Since 2017 to date, an Add On or additional capacity is being carried out by installing 3 HRSG units and 1 Steam Turbine with a capacity of 1 x 150 MW. Since 2015, Block 3 (Combine Cycle) has been built consisting of 2 x 150 MW Gas Turbines and 1 x 150 MW Steam Turbines and is expected to be COD (Commmercial On Date) in November 2019.

Characteristic of Power Plant Emission

Monitoring exhaust emissions at GSPP Grati, using external laboratory analysis services and direct measurement using the Continous Emission Monitoring System (CEMS) tool. The data obtained from the last examination in March 2018 are as seen in Table 1.

Table 1. Emission Characteristics Data

No	Parameter	Unit	Standard***	Lab.	CEMS	Tolerance of Microalgae*
1	Particulate	mg/Nm3	30	1	2.2	200,000*
2	SO2	mg/Nm3	150	<1	0.06	400,000**
3	NO2	mg/Nm3	320	302	8.62	240,000*
4	Opacity	%	-	<20	-	-
5	Oxygen (O2)	%	-	15.8	15.8	-
6	Air flow	m/s	-	2.1	13.7	-

*)Brown (1996); **)Matsumoto (1997);
***) PermenLH no. 21 Tahun 2008

Research Result

Emission Load Calculation Results

Based on the calculation results, the CO_2 emission load of GSPP Grati in the January - March 2018 period is as displayed in Table 2.

Table 2. CO2 Emission Load of Grati Power Plant

	JAN	FEB	MAR
Emission Load CO_2	9.086	10.610	11.514

Based on the data above, the average emission load value generated from HRSG 1.1 is 10,403.31 ton CO_2/ month on average.

Environmental Factor Correlation Test Results Against Microalgae Growth

Changes in environmental factors that occur are observed and compared with changes in growth that occur. The following data were obtained during the 14 days of observation.

Lighting is an environmental factor that can affect the photosynthesis process of microalgae, and can affect the increase in surface temperature of microalgae cultivation pond water. The Figure 3 is the result of the average change in lighting intensity around the aquaculture pond.

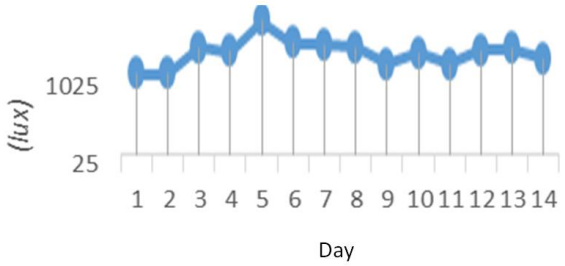

Figure 3. Graph of Light Intensity in Cultivation Pond

Lighting intensity measurements were carried out every day at 09.00, 12.00, 15.00 and 18.00. Based on the data above, the highest lighting intensity was on July 22, 2018, with an average value of 1,372 lux and the highest average lighting intensity was on July 20, 2019, which was 894 Lux.

Changes in water surface temperature are one of the factors that can affect the growth of microalgae spirulina platensis. The observed data for each variation are as seen in Fig. 4.

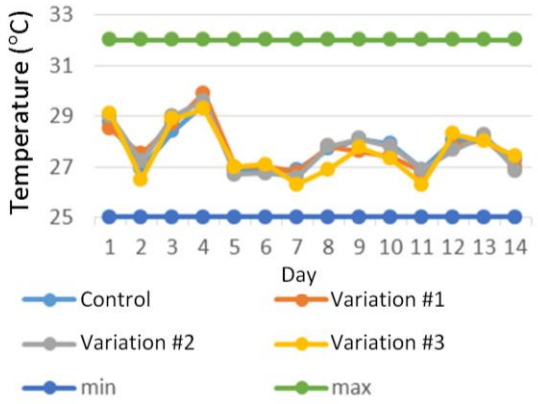

Figure 4. Graph of Changes in Surface Water Temperature in Cultivation Ponds.

The temperature changes that occurred in the cultivation pond were very fluctuating but tended to decrease, and the pond temperature in all treatments was still at the optimal temperature for microalgae growth, which was between 25-33°C.

Another environmental factor is the pH of water, where the ideal pH for microalgae growth is in the range of 5.5-9.5. The following is data from monitoring results and trending changes in the experimental pond pH during the observation period.

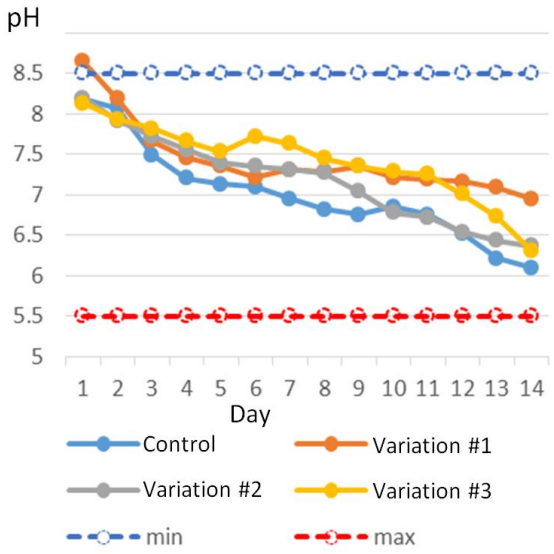

Figure 5. Graph of changes in the pH of the cultivation pond

The graph above shows a decrease in pH value in each pond even though the decrease is still within the optimal limit of microalgae growth. However, from the 4 observation pools, Variation Pool 1 showed a decrease that was not too significant so that on the 14th day the pH of the water was still at a value of 7.

Before conducting a correlation analysis, the data obtained will be tested using the Kolmogorov Smirnov test. The application of the Kolmogorov Smirnov test is that if the significance is below 0.05, it means that the data to be tested has a significant difference with standard normal data, meaning that the data is

not normal. Furthermore, if the significance is above 0.05, it means that there is no significant difference between the data to be tested and the standard normal data. Based on the results of the Kolmogorov Smirnov distribution test data in this study, a significance value was obtained above 0.05, which indicates that the data was normally distributed. So that the correlation test can be done. Based on the results of the Pearson Correlation Test with the SPSS application, a summary of the correlation values is obtained as seen Table 3.

Table 3. Correlation Test Results between environmental factors and microalgae growth

	Statistic test	Light intensity	Temperature	pH
Microalgae Growth	Korelasi	0.009	**-0.329**	-0.487
	Signifikansi	0.946	**0.013**	0.000

Analysis of the Effect of CO2 on Microalgae Growth

Microalgae cultivation ponds that are given a regulation of the amount of CO2 flow will then be observed for cell growth by weighing the dry weight every day from the beginning of cultivation to the harvest period. Based on the results of observations, data were obtained as seen in the Fig. 6.

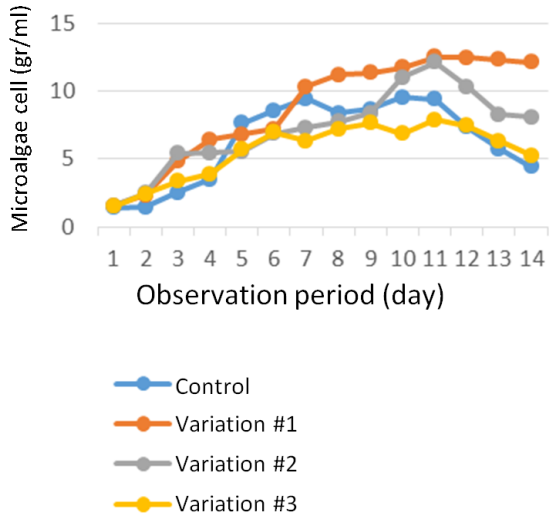

Figure 6. Graph of Microalgae Growth in each cultivation pond

Based on the data, it can be seen that the growth of microalgae with variation 1 or with a CO2 flow rate setting of 1 liter/ minute shows a more stable growth, when compared to other variations.

Furthermore, based on the data that has been obtained, an ANOVA test will be carried out to determine the effect of adding CO2 gas to the growth of microalgae. Before the ANOVA test is carried out, the variance homogeneity test and normalized test will first be carried out to ensure that the data obtained is homogeneous and normally distributed.

Based on the results of calculations using the SPSS application, the ANOVA test results were obtained as follows:

Table 4. ANOVA Test Results on Microalgae Growth

ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	113.243	3	37.748	5.262	**.003**
Within Groups	372.996	52	7.173		
Total	486.238	55			

Based on the data above, it shows a significance value of 0.003 or less than the probability value (p-value) <0.05, this indicates that Ho is rejected. As well as the value of F = 5.262 if we compare it with the data in Table F (See Appendix) the F value in the table with Df1 = 3 and Df2 = 51 obtained an F value of 2.78 so that from the results above it is known that F count> F table, so Ho was rejected and a further test would be carried out (Post Hoc Test). So that the provisional result of this test is that the addition of CO_2 affects the growth of microalgae. So to find out which treatment has the most effect, a Benferoni Post Hoc Test is carried out. Table 4.5 below is the data from the follow-up test results.

Table 5. Post Hoc Test Results (Benferoni)

Multiple Comparisons

Dependent Variable: Microalgae Growth

Bonferroni

(I) Flow rate	(J) Flow rate	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Control	CO_2 1 L / min	-3.08071*	1.01228	.022	-5.8574	-.3041
	CO_2 2 L / min	-1.17214	1.01228	1.000	-3.9488	1.6045
	CO_2 3 L / min	.66500	1.01228	1.000	-2.1116	3.4416
CO_2 1 L / min	Control	3.08071*	1.01228	.022	.3041	5.8574
	CO_2 2 L / min	1.90857	1.01228	.390	-.8681	4.6852
	CO_2 3 L / min	3.74571*	1.01228	.003	.9691	6.5224
CO_2 2 L / min	Kontrol	1.17214	1.01228	1.000	-1.6045	3.9488
	CO_2 1 L / min	-1.90857	1.01228	.390	-4.6852	.8681
	CO_2 3 L / min	1.83714	1.01228	.452	-.9395	4.6138
CO_2 3 L / min	Kontrol	-.66500	1.01228	1.000	-3.4416	2.1116
	CO_2 1 L / min	-3.74571*	1.01228	.003	-6.5224	-.9691
	CO_2 2 L / min	-1.83714	1.01228	.452	-4.6138	.9395

*. The mean difference is significant at the 0.05 level.

Based on the data above, the treatment results that have a significant impact on the growth of microalgae are the addition of CO_2 of 1 liter/ minute.

Calculation of CO_2 absorption by microalgae

The following is a comparison of the yields of microalgae in each experimental pond shown in Table 4.6.

Table 6. Experimental Pond Harvest Data

No	Pond	Harvest (kg)
1	Control	8.37
2	V1 (1 L.CO_2 /Min)	23.05
3	V2 (2 L.CO_2 /min)	15.36
4	V3 (3 L.CO_2 /min)	9.97

The yield of the V1 pool with the addition of 1 liter of CO_2/ minute yielded greater microalgae bioass than other ponds, then the V1 yield data will be calculated to determine the amount of CO_2 that can be absorbed by the microalgae.

Harvest result V1 = 23.05 Kg

Microalgae CO2 absorption = 0.78

Based on the calculation results, the amount of CO_2 that can be absorbed by the microalgae biomass in the V1 cultivation pond is 17.2875 Kg. If it is assumed that each cultivation cycle produces the same biomass as in pond V1, here is the amount of CO_2 that can be absorbed by the GSPP Grati microalgae installation for 1 month (2 cultivation cycles):

CO_2 Emission Load Average HRSG 1.1: 10,403.31 Ton CO_2/ Month

CO_2 Absorption/ Pool: 0.00173 Ton CO_2/ Cycle

Number of Microalgae Ponds: 8 Ponds.

Microalgae Installation CO_2 Absorption:

$= 8 \times 0.00173$

$= 0.1383$ Ton CO_2 /cycle

$= 2 \times 0.1383 =$ 0.2766 Ton CO_2/ month

Based on the results of these calculations, the amount of CO_2 that can be absorbed by the GSPP Grati microalgae installation every month is 0.2766 tons of CO_2/ month or <1% CO_2 emission load/ month.

Conclusion

Based on the results of the research that has been done, several conclusions can be drawn and at the same time answer the objectives of this study. The following are some of the conclusions that can be drawn from this study:

1. Based on the calculation results of CO_2 Emission Load refers to the Regulation of the Minister of Environment No. 21 of 2008 concerning Stationary Emission Quality Standards for Thermal Power Plants Appendix VII (F), the total monthly average CO_2 emission load produced is 10,403.31 tonnes.
2. Based on the research results, the growth of microalgae cells has a correlation with 2 of the 3 environmental factors observed. There is a correlation between the growth of microalgae cells with light intensity, where

changes in light intensity are directly proportional to the growth of microalgae cells. In addition, there is also a correlation between changes in pH and the growth of microalgae cells, where the growth of microalgae cells is inversely proportional to changes in the pH of culture water.

3. Based on the analysis, it is concluded that the addition of CO_2 gas emissions from HRSG 1.1 affects the growth of microalgae cells. Of the 4 (four) variations in the flow rate of CO_2 emissions given, the pond with a flow rate of 1 Liter CO_2/ minute showed a significant change in growth.

4. The amount of CO_2 absorption by microalgae installations with a flow rate variation of 1 liter CO_2/ minute can absorb 0.2766 tons of CO_2/ month, or only <1% per month of the average emission load of HRSG 1.1. So it is necessary to do further studies to increase the productivity of the microalgae spirulina platensis in order to reduce the burden of greater CO_2 emissions.

References

Anisa, W. (2010, Oktober 31). METODE PENELITIAN KORELASIONAL. (Wordpress.com) Retrieved Agustus 05, 2018, from BINTANGKECILUNGU'S BLOG: https://bintangkecilungu.wordpress.com/2010/10/31/metode-penelitian-korelasional-2/

Brown, L.M. 1996. *Biodiesel from microalgae: Commplementary in a fuel development strategy*. National Reneawable Energy Laboratory.

Bunowo, N.R., Nurhasanah, Q.R. (2018). Studi Pertumbuhan Populasi *Spirulina* sp. pada Skala Kultur yang Berbeda. *Jurnal Ilmiah Perikanan dan Kelautan*. Vol. 10(1): 26-33.

Hairiah, K. (2007). *Perubahan Iklim Global : Penyebab Terjadinya GRK*. Malang: Universitas Brawijaya, Fakultas Pertanian.

Istiyanie, D. (2011). *Pemanfaatan Emisi CO_2 dari PLTU Batu Bara dalam Pengolahan Limbah Cair Domestik Berbasis Mikroalga*. Jakarta: Universitas Indonesia.

Kawaroe, D. (2010). *Mikroalga Potensi dan pemanfaatannya untuk Produksi Bio Bahan Bakar*. Bandung: ITB.

Matsumoto, H.A., N.Hamasaki, Y. Sioji, Ikuta. 1997. Influence of CO_2, SO_2, and NO in flue gas on microalgae productivity. *Jurnal Chemical Engineering*. Japan.

Ministry of Environmental of the Republic of Indonesia, PermenLH no. 21 Tahun 2008.

Min, M. (2016). *Jenis Jenis Metode dalam Penelitian Kuantitatif dan Pengertian Terlengkap*. (Team Pelajaran.co.id) Retrieved Agustus 04, 2018, from Pelajaran.co.id: http://www.pelajaran.co.id/2016/21/jenis-jenis-metode-dalam-penelitian-kuantitatif-dan-pengertian-terlengkap.html

Muhammad. (2010). Pengembangan Spirulina Sebagai Super Food. Retrieved Agustus 18, 2018, from http://repository.ipb.ac.id: http://repository.ipb.ac.id/jspui/bitstream/123456789/44442/4/INTI-PKMGT-2010-IPB-Muhammad-Pengembangan%20Spirulina%20Sebagai.pdf

Pusdatin ESDM. (2016). *Data Inventory Emisi GRK Sektor Energi*. JAKARTA: Kementerian Energi dan Sumber Daya Mineral Republik Indonesia.

Setiawan, Y., & dkk. (2014). Pemanfaatan Emisi Gas CO2 untuk BUdidaya Spirulina Plantensis dalam Upaya Penurunan Gas Rumah Kaca (GRK). *Jurnal Riset Industri* Vol. 8 No.2, 83 - 89.

Soekidjo. 2005. Metodelogi Penilitian Kesehatan. PT Rineka Cipta. Jakarta.