Relationship between water quality, sanitation and hygiene on environmental health of community settled on Kahayan River Bank, Palangka Raya

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Abstract. People in Central Kalimantan province have long depended on the rivers around their villages. Yet, reports from the local health service show that the five diseases with the most patients are related to environmental factors, such as sanitation of water reservoirs and sanitation of home yards. This study aims to analyze the relationship between water quality, sanitation, and hygiene on environmental health in settlements on the banks of the Kahayan River. Data on sanitation, hygiene, and public health status were collected through observation and interviews, while river water quality was tested in the laboratory. The water to be analyzed was taken from three spots, namely upstream and downstream of the river, which are located out of the city, and the middle of river stream in the city centre. The results showed that the quality of water, sanitation, and hygiene in the city centre did not have a significant effect on environmental health even though the Environmental Heat Risk Assessment (EHRA) in the area showed poor scores. The study concludes that waste, as well as clean and healthy living behaviour is the biggest sanitation risks for environmental health. Synchronization of programs by related agencies could facilitate the arrangement of settlements on the riverbanks.

1. Introduction

The settlement and living environment is a basic human need and a critical determinant of public health [1,2]. Almost half of human life is spent at home, so the quality of the home has a great impact on the health of the occupants [3]. Homes should be places that are free from disturbances and protect the people who live in them from extreme heat and cold, rain and scorching sun, wind, pests, and disasters such as floods and earthquakes, as well as pollution and diseases [4,5]. A healthy environment is a human right and an investment for the success of national construction [6,7].

As a country that seeks to meet the basic needs of its people, including healthy housing and a healthy environment, the Indonesian government has launched the program Healthy Indonesia, a state where everyone lives in a healthy environment, is clean and healthy, has access to health services, and has a high level of the highest health [3]. This program includes a clean and healthy environment as part of creating a quality Indonesian people. In this context, environmental health means the physical environment and the social environment. Environmental health is realized when the supporting elements are met, namely the availability of clean water, beautiful nature that is free from disease and supported by a healthy and intelligent social environment [8,9].
Environmental health problems that are common in Indonesia and other developing countries can generally be identified by poor water quality, low public understanding of sanitation, and poor hygiene conditions [10,11]. This situation is caused by uncontrolled natural exploitation and inadequately treated waste from households and factories. Poor water and sanitation quality leads to the spread of various diseases and makes the population vulnerable [12]. The quality of water used for consumption (drinking water) should be maintained from the source of water to the consumer's house. Rapid assessment of water quality using various techniques and appropriate data can provide information on water quality and safety and prediction for the future. Parameters commonly used for rapid water quality assessment are microbiological quality, parameters that cause consumer rejection of water, and chemical health risks [13–15].

The province of Central Kalimantan is geographically unique in that it has 11 major rivers, tributaries, and thousands of small river arms associated with oxbow lakes and other floodplains. The Dayak community generally relies heavily on the river for their daily needs, but also as a residential area in the form of lanting (floating houses) as a form of local wisdom. About 860,426 people live on the banks of the river, of which 37,816 live in the city Palangka Raya [16]. According to a report by the College Palangka Raya (2015), there are 452 types of houses on stilts with 245 sanitation facilities (MCK) on the banks of the Kahayan River, Palangka Raya City.

It is believed that the poor quality of sanitation and water consumed by people along the Kahayan River is closely related to the number of people suffering from diseases caused by environmental conditions. Local Public Health Centre reports that in 2018 and 2019, five diseases were prevalent with the most patients, namely diarrhea (1,958 patients), typhoid and paratyphoid (1,329 patients), intestinal infections caused by other bacteria (939 patients), viral pneumonia (205 patients), and pneumonia TB (148 patients) (Palangka Raya City Health Office, 2019). Based on this description, it is important to analyze the relationship between water quality, sanitation, and hygiene on environmental health in the settlements on the banks of the Kahayan River. It is expected that the results of this study will form the basis for the formulation of a more integrated policy on riverbank management in the city of Palangka Raya.

2. Methodology
2.1. Time and location
The study was carried out from September to December 2020. The location of water sampling was determined by dividing the study area into segments expected to represent the study population. The location of water sampling was determined in three steps, namely geometric correction, digitization, overlay, and site analysis. Geometric correction is done by rectification using a geographic coordinate system with reference to World Geodetic System 1984.

Data on sanitation and hygiene were collected through interviews, questionnaires, and observations. The study site consists of three points: Station 1 is located upstream in the village Tumbang Rungan, Station 2 in the middle of the Kahayan River in the village Pahandut Seberang and Station 3 on the downstream side of the river in the village Bereng Bengkel (Figure 1). The samples for water quality analysis were collected three times and the sampling points were located near the settlements.
2.2. Population and sample of respondents
The social data are collected from the residents of the settlements on the banks of the Kahayan River. The population resides in 3 villages namely Tumbang Rungan, Pahandut Seberang and Bereng Bengkel. The number of samples is drawn proportionally to the number of families in each village. The sample size is determined by the following formula:

\[ n = \frac{N}{N_d^2 + 1} \]  

Where:
- \( n \) = number of samples
- \( N \) = population
- \( d \) = degree of confidence

With a total number of 2098 households and a confidence level of 90%, the sample size was 95 respondents. The selection of respondents was based on pre-determined criteria, namely housing conditions, completeness of sanitation, environment according to the parameters and variables used.

2.3. Research variables and operational definitions
The research variables consist of independent and dependent variables. The independent variables include water quality, sanitation and hygiene in 3 villages. The dependent variable is the environmental health status of the residents in these villages. The operational definitions of the research variables are given in Table 1.

| Variable      | Definition                                                                 | Instrument                          | Data Collection                  | Parameter      |
|---------------|-----------------------------------------------------------------------------|-------------------------------------|----------------------------------|----------------|
| Independent variable | Water quality Water conditions for consumption that meet physical, chemical and biological requirements | • water quality checklist • laboratory test | • interviews and observations • fieldwork | 1. Good 2. Moderate 3. Bad |
| Sanitation     | Supervision of the human environment can have adverse effects on human | questionnaire and checklist          | interviews and observations      | 1. Good 2. Moderate 3. Bad |
The following is a brief description of the research variables.

1) The water aspect studied is the number of people living in settlements on the riverbank against diseases that may occur in the surrounding community. In terms of water quantity: the amount of water available per person per day; the amount of clean water from water sources; and reliable water supply. In terms of quality: the amount of water available per person per day; the amount of clean water from water sources; and the reliable supply. In terms of accessibility: how far away is the source of clean water; are there problems with disabled, elderly, and vulnerable populations; other sources of water; and the possibility of making it easier for residents.

2) The sanitation aspect includes the facilities available and the number and distribution of facilities. In terms of facilities: all facilities; how vulnerable group: disabled seniors; whether open defecation is a health hazard; hand washing facilities; and whether toilets meet health requirements. Practical: the tradition of defecation and use of toilets, water for rectal cleansing, community toilets, and pregnant and menstruating women. Technical: local materials for sanitation construction and existing appropriate technology

3) Hygiene aspects relate to community behavior, i.e. healthy living behaviors, hand washing after defecation, waste disposal, water storage and handling, and food storage and handling. Solid waste management, breastfeeding (hygienic), cooking utensils, health services (Puskesmas), community participation in education and appropriate health promotion.

2.4. Data analysis

Data analysis was carried out using the non-metric multidimensional scaling (NMDS) method in two stages as follows:

1. Determination and preparation of attributes that can describe the state of each aspect analyzed.
2. Evaluation of each attribute on an ordinal scale. Each attribute is assigned a score according to the state of that attribute on an ordinal scale.
The ranking (score) is in order from least to greatest, quantitatively and qualitatively, rather than in order from worst to best. For example, scores of 0, 1, 2, and 3 mean that there is a decrease of less than 10%, 10-25%, 25-50%, and more than 50%, respectively. For this attribute, a score of (0) is the best and a score of (3) is the worst. The data analysis was carried out in 2 stages. Firstly, determining the attributes of economic, environmental and social dimensions and determining the critical attributes using multidimensional scaling (MDS) and leverage analysis. Second, identification of key variables using prospective analysis.

Environmental health status analysis includes public health status assessment, environmental health risk assessment, and public health status evaluation (NRC, 1983; WHO, 2004). Assessment of health status can be indicated by the morbidity rate, namely the number of people who are sick or feeling of illness about their body condition. Public health status has a reciprocal relationship with socio-economic and environmental development [17].

3. Results and discussion

3.1. Respondents characteristics

The respondents of this study were communities on the banks of the Kahayan River in the villages of Tumbang Rungan, Pahandut Seberang and Bereng Bengkel. The characteristics of the respondents, including education level, age, and occupation, are shown in Table 2.

Table 2. Characteristics of respondents by education level, age and occupation

| Atribut                  | Tumbang Rungan | Pahandut Seberang | Bereng Bengkel | Total |
|--------------------------|----------------|-------------------|----------------|-------|
| Education Level          |                |                   |                |       |
| Bachelor                 | 2              | 2                 | 2              | 6     | 6.25 |
| Senior High School       | 16             | 12.50             | 10             | 10    | 10.42 |
| Junior High School       | 9              | 50.00             | 37.50          | 37.50 | 37.50 |
| Elementary School        | 1              | 3.13              | 0              | 0     | 0.00 |
| Not going to school      | 1              | 15.63             | 4              | 1     | 15.63 |
| Age                      |                |                   |                |       |
| 30-35 years              | 7              | 21.88             | 6              | 18.75 | 28 | 21.88 |
| 36-40 years              | 11             | 34.38             | 8              | 25.00 | 12 | 34.38 |
| 41-45 years              | 3              | 9.38              | 6              | 18.75 | 6 | 10.42 |
| 46-50 years              | 5              | 15.63             | 4              | 12.50 | 2 | 15.63 |
| >50 years                | 6              | 18.75             | 8              | 25.00 | 2 | 18.75 |
| Occupation               |                |                   |                |       |
| Fisherman                | 5              | 15.63             | 2              | 6.25  | 11 | 15.63 |
| Laborer                  | 13             | 40.63             | 15             | 46.88 | 16 | 45.83 |
| Trader                   | 6              | 18.75             | 6              | 18.75 | 5  | 18.75 |
| Housewife                | 6              | 18.75             | 7              | 21.88 | 6 | 18.75 |
| Public servant           | 2              | 6.25              | 2              | 6.25  | 1 | 6.25  |

Table 2 shows that the highest level of education in the study villages is junior high school or its equivalent (41.67%), while the lowest is not going to school (1.04%). This may affect the type of job and the level of income. As for age, the largest number is in the productive group (36-40 years old) with 32.29% and the smallest is in the 41-45 years old group with 10.42%. It is considered that people of productive age are physically and biologically matured and at the peak of their activities. As far as their
occupation is concerned, most of the respondents (45.83%) work as laborers followed by fishermen, housewives, traders and civil servants.

3.2. Water quality
The results of laboratory tests on chemical and biological parameters of water on the banks of the Kahayan River are presented in Table 3.

| Parameter | Unit | Quality Standard Grade | Tumbang Rungan | Pahandut Seberang | Bereng Bengkel |
|-----------|------|-------------------------|----------------|------------------|---------------|
| Temperature | °C | Deviasi 3 | 27.63 | 27.77 | 28.33 |
| pH | | IV (5-9) | 4.46 | 4.90 | 5.27 |
| BOD | mg/L | II (3) | 1.24 | 1.98 | 1.08 |
| COD | mg/L | II (25) | 28.8 | 46.63 | 33.90 |
| Iron (Fe) | mg/L | I (0.3) | 0.69 | 0.47 | 0.55 |
| E.Coli | number/100ml | | 800 | 1000 | 767 |

Table 3 shows the average temperature in the three study sites namely Tumbang Rungan (27.63°C), Pahandut Seberang (27.77°C) and Bereng Bengkel (28.33°C). These average values are not very different and still meet the standard of water temperature as per the government regulation 82/2001. Meanwhile, the average pH of water at the stations Tumbang Rungan, Pahandut Seberang and Bereng Bengkel are 4.46, 4.9 and 5.27 respectively.

The results of laboratory analysis showed that the average BOD values in the villages of Tumbang Rungan, Pahandut Seberang and Bengkel were 1.24 mg/L, 1.98 mg/L, and 1.08 mg/L, respectively. The highest BOD value was in the Pahandut Seberang station while the lowest one was in Bereng Bengkel. This value falls under government regulation 82/2001. The addition of organic matter in the form of waste that can be degraded by microorganisms will increase the BOD value. The high BOD value in Pahandut Seberang is understandable because this area is denser than the other two regions. This BOD value decreases downstream (Bereng Bengkel), so it can be understood that the organic waste disposed of in Pahandut Seberang decomposes before reaching downstream. Water testing in laboratory showed that the average COD values at Tumbang Rungan, Pahandut Seberang and Bereng Bengkel stations were 28.80 mg/L, 46.63 mg/L, 33.90 mg/L, respectively. These values fall in Class II in the government regulation number 82/2001 with a score of 25.

3.3. Sanitation and Hygiene
Public health status can be determined based on data on sanitation and hygiene. The results of the assessment of public health status are presented in Table 4.

| Field Data | Water Source | Waste (%) | Rubish (%) | PHBS (%) | Puddle (%) | Strata Score |
|------------|--------------|-----------|------------|----------|------------|--------------|
| Health status assessment | 25.31 | 40.47 | 27.14 | 59.64 | 45.25 | 197.81 |

Note: PHBS (Perilaku Hidup Bersih dan Sehat) or Clean and Healthy Life Behavior
3.4. Statistical Tests
3.4.1 NMDS (Non Metric Multi-Dimensional Scaling). NMDS (non-metric multidimensional scaling) analysis was carried out with the objective of analyzing the relationship between water quality from laboratory tests, sanitation, hygiene, and physical water quality at 3 (three) study sites, namely Tumbang Rungang (upstream), Pahandut Seberang (intermediate) and Bereng Bengkel (downstream). The results of the detailed NMDS analysis are presented in Figure 2.

Figure 2. Biplot graph of non-metric multidimensional scaling

Remarks: 1) NMDS scores for all variables (red font): water quality parameters (pH, COD, BOD, Fe and E.Coli), sanitation (SN1, SN2, up to SN51), hygiene (HY1, HY2, up to H11) and water quality perception, K (K1, K2, up to K6).  
2) Object code: R = Rungan, PS = Pahandut Seberang, BB = Bereng Bengkel 
3) Up to 96 respondents participated in the workshops in each village.  
4) NMDS1 = First NMDS result axis, NMDS2 = Second NMDS result axis.

The NMDS biplot in Figure 2 is a spatial (multidimensional) description of the object data and parameter variables of water quality, sanitation, hygiene and respondents' perception of water quality. The NMDS plot generates a configuration of objects located in specific dimensions such that the distance between objects is as close as possible to the input value of dissimilarity or similarity. Figure 3 shows that the components of the sanitation variable (SN): SN17, SN18, SN22, SN24, SN25, SN26, SN27, SN37, SN46, SN51 and hygiene (HY): HY1, HY2, HY4, and HY 10, as well as the perception of physical quality (K): K6 each has a positive correlation with water quality parameters pH, Fe, COD and E.Coli, and is in quadrant IV of the NMDS graph, with positive (+) NMDS 1 and NMDS 2 values. Components SN2, SN3, SN4, SN6, SN28, SN32, SN42, SN37, SN40, SN42, SN43, SN45, and H11 as well as K2, K4 are positively correlated with BOD and are in quadrant I of the NMDS graph with positive NMDS 1 and NMDS 2 values (+). Judging from the distance visually, the coordinates of BOD in quadrant I are close to the coordinates of the COD, pH, Fe and E.Coli parameters, which are in quadrant IV, which means these parameters are closely related. In addition, a positive NMDS value
indicates that if one parameter increases, the other parameters will also increase. This can be explained by considering the sample point variables in the NMDS chart.

Figure 8 shows that the majority of the sample in Pahandut Seberang (PS) and Bereng Bengkel (BB) are located in quadrants I and IV, while the sample variables for Tumbang Rungan (R) are in quadrants II and III. Because quadrants II and III have a negative correlation with quadrants I and IV, it is indicated there is a decrease in public knowledge about sanitation and hygiene in the Tumbang Rungan area. This will have an impact on increasing the value of water quality parameters in the Pahandut Seberang and Bereng Bengkel areas. If the pollution in Tumbang Rungan increases, the downstream areas of the river, namely Pahandut Seberang and Bereng Bengkel, will be affected. This is in line with the results by Asmawi et al. (2020), where a decrease in the value of variables and parameters in the quadrant with a negative NMDS value will cause an increase in the value of the variables and parameters in the quadrant with a positive NMDS value [18].

The suitability of the results of the NMDS model to represent the real situation was obtained with the stress value and the correlation coefficient of variance (R2). The stress value is obtained by comparing the distance on the graph with the real similarity distance. The stress test was carried out 20 times and got a stress value of 0.103 (10.3%) which means the NMDS model is quite good [19]. The correlation coefficient of variance indicates the proportion of variance from the optimal scale of the data, which is contributed by a multidimensional scaling procedure of the goodness of fit measure where the R2 value of the model is 0.99; indicating that the model is acceptable and can represent the input data sufficiently good.

3.4.2 Permanova. The relationship between the three locations of Rungan, Pahandut Seberang and Bereng Bengkel was analysed by Permanova (permutational multivariate analysis of variance using distance matrices). The observed variables were water quality (5 parameters), sanitation (51 variables), hygiene (11 variables), and physical water quality (6 variables), which is obtained from interview with 96 respondents and authors’ observation of their homes. All variables are combined so that it can be seen that there is a significant difference in the three locations. The results of the detailed analysis of Permanova are presented in Figure 3.

![Figure 3. Result Permanova analysis in research locations](image-url)
Further tests using Tukey's HSD (Honest Significant Different) in detail are presented in Table 5.

|       | diff    | lwr     | upr     | p adi   |
|-------|---------|---------|---------|---------|
| PS-BB | -0.04165150 | -0.09671008 | 0.01340709 | 0.1746122 |
| R-BB  | -0.12107776 | -0.17613635 | -0.06601917 | 0.0000030 |
| R-PS  | -0.07942627 | -0.13448485 | -0.02436768 | 0.0025251 |

Table 5. Results of Tukey's HSD advanced test analysis

Tukey's test was used to compare all pairs of mean treatments after the analysis of variety test was carried out. Assuming the null hypothesis (H0) that there is no significant difference between one location and another, this test determines whether the null hypothesis is accepted or rejected. With a 90% confidence interval, the sig value > 0.10 to be able to conclude that the null hypothesis (H0) is accepted [20]. Table 5 shows that the conditions in Pahandut Seberang and Bereng Bengkel were not significantly different with a test value of (0.1746122), where the value was 0.1746122 > 0.10, so H0 was accepted and Ha was rejected. This fact shows that there is no significant difference between Pahandut Seberang and Bereng Bengkel. This is probably due to the location of Pahandut Seberang and Bereng Bengkel which are downstream of Tumbang Rungan, so that the water quality of Pahandut Seberang will affect the water quality at Bereng Bengkel. This is in line with Mubarok and Suprayogi (2018) who state that the samples took in downstream of the river are worse than those downstream due to pollutant inputs and river flow [21].

The test between Tumbang Rungan and Bereng Workshop has a value of (0.0000030), where 0.0000030 < 0.10, so H0 is rejected, and Ha is accepted. This fact shows that there is a difference between Tumbang Rungan and Bereng Bengkel. This may be caused by several factors, including differences in geographical location (Tumbang Rungan is upstream and Bereng Bengkel is downstream), the population size (Bereng Bengkel is denser), and the level of community knowledge indicates the relationship between water quality, sanitation, and hygiene and water quality laboratory tests that are physically seen from these locations. The test between Tumbang Rungan and Pahandut Seberang has a value of (0.0025251), where 0.0025251 < 0.10, so that H0 is rejected and Ha is accepted. This fact shows that there is a difference between Tumbang Rungan and Pahandut Seberang. This may be due to several factors as previously stated.

4. Conclusion

This study concludes that domestic waste problems, illegal gold miners and clean and healthy living behaviors are risk factors for environmental health sanitation at the research site. Based on river water quality checks, the highest BOD value is found on the riverbanks in Pahandut Seberang, while the lowest one is found in Bereng Bengkel. It indicates that there are still people with poor sanitation behavior, such as doing open defecation, treat drinking water and food unhealthy, and dispose of garbage and household waste in river bodies. The highest COD value is found in Pahandut Seberang while the lowest is in Tumbang Rungan, which indicates the exceed amount of chemicals discharged into river bodies, such as from materials used by illegal gold miners and detergent disposal used for washing. The highest E.Coli value was found in Pahandut Seberang while the lowest was found in Bereng Bengkel. There are still many residents who even have a toilet, but do not have a septic tank.

Based on these conclusions, it is recommended to develop appropriate technology to answer the needs of the residents, such as constructing floating septic tank and building garbage dump on the banks of the river. The support of traditional and religious leaders is needed to change unhealthy community behaviors, such as open defecation and throwing household waste in river bodies. Finally, synchronization of regulations is needed so that community empowerment on the banks of the river with their distinctive lives can be properly achieved.
References

[1] Gudda F O, Moturi W N, Oduor O S, Muchiri E W and Ensink J 2019 Pit latrine fill-up rates: variation determinants and public health implications in informal settlements, Nakuru-Kenya *BMC Public Health* **19** 1–13

[2] Patel A, Dean J, Edge S, Wilson K and Ghassemi E 2019 Double burden of rural migration in Canada? Considering the social determinants of health related to immigrant settlement outside the Cosmopolis *Int. J. Environ. Res. Public Health* **16** 678

[3] Departemen Kesehatan RI 2004 *Higiene Sanitasi Makanan dan Minuman* (Indonesia)

[4] Matsumoto H, Tsuzuki K and Susanti L 2017 Bioclimatic Analysis in Pre-Design Stage of Passive House in Indonesia *Buildings* **7** 24

[5] von Seidlein L, Ikonomidis K, Mshamu S, Nkya T E, Mukaka M, Pell C, Lindsay S W, Deen J L, Kisinza W N and Knudsen J B 2017 Affordable house designs to improve health in rural Africa: a field study from northeastern Tanzania *Lancet Planet. Heal.* **1** e188–99

[6] Bieler A 2017 Fighting for public water: The first successful European Citizens’ Initiative, “Water and sanitation are a human right” *Interface a J. about Soc. movements* **9**

[7] Voon T and Mitchell A D 2018 Community Interests and the Right to Health in Trade and Investment Law *Community Interest Across Int. Law* (Oxford Univ. Press. 2018) 249–77

[8] Shaffer R M, Sellers S P, Baker M G, de Buen Kalman R, Frostad J, Suter M K, Anenberg S C, Ballbus J, Basu N and Bellinger D C 2019 Improving and expanding estimates of the global burden of disease due to environmental health risk factors *Environ. Health Perspect.* **127** 105001

[9] Koehler K, Latshaw M, Matte T, Kass D, Frumkin H, Fox M, Hobbs B F, Wills-Karp M and Burke T A 2018 Building healthy community environments: a public health approach *Public Health Rep.* **133** 35S–43S

[10] Duijster D, Monse B, Dimaisip-Nabuab J, Djuharnoko P, Heinrich-Weltzien R, Hobdell M, Kromeyer-Hauschild K, Kuntheirth Y, Mijares-Majini M C and Siegmund N 2017 ‘Fit for school’–a school-based water, sanitation and hygiene programme to improve child health: results from a longitudinal study in Cambodia, Indonesia and Lao PDR *BMC Public Health* **17** 1–15

[11] Nastiti A, Muntalif B S, Roosmini D, Sudradjat A, Meijerink S V and Smits A J M 2017 Coping with poor water supply in peri-urban Bandung, Indonesia: towards a framework for understanding risks and aversion behaviours *Environ. Urban.* **29** 69–88

[12] Cissé G 2019 Food-borne and water-borne diseases under climate change in low-and middle-income countries: Further efforts needed for reducing environmental health exposure risks *Acta Trop.* **194** 181–8

[13] Pasaribu D M R, Arly F E and Gunadi W D 2019 Penilaian Kualitas Air Minum Produk Smart Water Station Berdasarkan Parameter Mikrobiologi Menggunakan Metode Most Probable Number di Fakultas Kedokteran UKRIDA *J. Kedokt. Meditek* **25** 66–74

[14] Putro B E and Masrofah I 2019 Kualitas Fisik dan Kimia Sungai Citarum yang bermuara ke Waduk Cirata di Wilayah Kabupaten Cianjur *J. Ilm. Univ. Batanghari Jambi* **19** 628–33

[15] Zhang H, Xu L, Huang T, Yan M, Liu K, Miao Y, He H, Li S and Sekar R 2021 Combined effects of seasonality and stagnation on tap water quality: changes in chemical parameters, metabolic activity and co-existence in bacterial community *J. Hazard. Mater.* **403** 124018

[16] Badan Pusat Statistik Provinsi Kalimantan Tengah 2018 *Kalimantan Tengah Dalam Angka, 2018* (Indonesia)

[17] Capolongo S, Rebecchi A, Dettori M, Appolloni L, Azara A, Buffoli M, Capasso L, Casuccio A, Oliveri Conti G and D’Amico A 2018 Healthy design and urban planning strategies, actions, and policy to achieve salutogenic cities *Int. J. Environ. Res. Public Health* **15** 2698

[18] Asmawi S, Rifa’i M A, Mahyudin I and Ruslan M 2020 Protection of Turbidity on Reefs along the Southeast Coast of the Kalimantan during the 2015 El Niño *J. Wetl. Environ. Manag.* **8** 45–62

[19] Mukherjee J, Moniruzzaman M, Chakraborty S B, Lek S and Ray S 2017 Towards a physiological response of fishes under variable environmental conditions: An approach through neural network
Ecol. Indic. 78 381–94

[20] Kelter R 2020 Bayesian alternatives to null hypothesis significance testing in biomedical research: a non-technical introduction to Bayesian inference with JASP BMC Med. Res. Methodol. 20 1–12

[21] Mubarok L R and Suprayogi S 2018 Kajian Karakteristik Pencemar Bagian Hulu Sungai Belik, Daerah Istimewa Yogyakarta J. Bumi Indones. 7