

# IMPACT OF DOMESTIC ACTIVITIES AND TOURISM ON THE AYUNG RIVER BASIN, GIANYAR, BALI

## IMPACTO DAS ATIVIDADES DOMÉSTICAS E DO TURISMO NA BACIA DO RIO AYUNG, GIANYAR, BALI

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### **Abstract**

Watersheds are very important resources for human life. The Ayung River located in the Ubud area plays an important role for tourism, agriculture and raw water sources for upstream areas and greatly supports the economy. Water is a natural resource that is needed for the livelihoods of many people, even by all living things. Therefore, water resources must be protected so that they can continue to be utilized properly by humans and other living things. Water pollution is indicated by a decrease in water quality to a certain level that causes the water to not function according to its intended use. The Ayung River as a source of community economy must be controlled from domestic pollution sources. This study aims to analyze the pollution index of the Ayung River and determine the dominant parameters that affect the pollution index. The research method uses a quantitative approach using primary data sources taken directly in the field and secondary data sources using data from the government and previous studies. The results of the study showed that the pollution index for class I water allocation for all water samples taken was in a lightly polluted condition. While the allocation

### **Resumo**

*Bacias hidrográficas são recursos muito importantes para a vida humana. O Rio Ayung, localizado na região de Ubud, desempenha um papel importante no turismo, na agricultura e nas fontes de água bruta para as áreas a montante, além de sustentar significativamente a economia. A água é um recurso natural necessário para a subsistência de muitas pessoas, inclusive de todos os seres vivos. Portanto, os recursos hídricos devem ser protegidos para que possam continuar a ser utilizados adequadamente por humanos e outros seres vivos. A poluição da água é indicada pela diminuição da qualidade da água a um determinado nível, o que faz com que ela não funcione de acordo com o uso pretendido. O Rio Ayung, como fonte de economia comunitária, deve ser controlado a partir de fontes de poluição doméstica. Este estudo tem como objetivo analisar o índice de poluição do Rio Ayung e determinar os parâmetros dominantes que o afetam. O método de pesquisa utiliza uma abordagem quantitativa, utilizando fontes de dados primários obtidos diretamente em campo e fontes de dados secundários, utilizando dados do governo e de estudos anteriores. Os*



of class II, III, and IV water for all water samples taken was in a condition that met the quality standards. The condition of the water pollution index is influenced by the high parameter e. coli that is on the threshold of the water quality standard for class I, II, III, and IV. While the coliform parameter is on the threshold of the water quality standard for class I and class II.

**Keywords:** Tourism. Domestic. Pollutant. Quality. Water.

*resultados do estudo mostraram que o índice de poluição para alocação de água classe I para todas as amostras de água coletadas estava em uma condição levemente poluída. Enquanto a alocação de água das classes II, III e IV para todas as amostras coletadas estava em condições que atendiam aos padrões de qualidade, a condição do índice de poluição da água é influenciada pelo alto parâmetro E. coli, que está no limite do padrão de qualidade da água para as classes I, II, III e IV. Já o parâmetro coliforme está no limite do padrão de qualidade da água para as classes I e II.*

**Palavras-chave:** Turismo. Doméstico. Poluente. Qualidade. Água.

## 1 INTRODUCTION

A river basin is a land area that is a single unit with a river and its tributaries, which functions to accommodate, store and channel water from rainfall to lakes or to the sea naturally, where the boundary on land is a topographic separator and the boundary at sea to the waters that are still affected by land activities. A river basin is also defined as an area that is bounded by mountain ridges and water will be channeled through small rivers to the main river (Alam et al., 2016). Rivers have a very important role in maintaining ecological and environmental sustainability (Zhang et al., 2018). A river basin is a land area that is a single unit with a river and its tributaries, which functions to accommodate, store and channel water from rainfall to lakes or to the sea naturally, where the boundary on land is a topographic separator and the boundary at sea to the waters that are affected by land activities (Yuliastuti, 2011). As is well known, the function of a river basin is as a supplier of water with good quantity and quality, especially for people in downstream areas. Reduced water supply will reduce the water carrying capacity and land carrying capacity in the upstream area (Sudipa, 2021).

Land conversion from forest to agricultural or non-agricultural land will affect the quantity and quality of water management in river basins, which will be more felt by people in downstream areas (Farida et al., 2004). The current general perception is that the conversion of forests to agricultural land results in a decrease in the function of forests in regulating water management, preventing flooding, landslides and erosion in the river basin. Changes in river conditions can be caused by the entry of pollutant sources from domestic waste (Supardiono et al., 2021). Forests are always associated with positive

functions for water management in river basin ecosystems. Damage to river basins due to increasing human intervention and needs and land conversion that is not in accordance with the principles of land suitability and capability causes various natural disasters, this condition causes an increase in critical and damaged river basins (Ardhani, 2014).

A river basin is an ecosystem where elements of organisms and the biophysical environment and chemical elements interact dynamically and in it there is a balance of inflow and outflow of materials and energy (Aslam, 2013). River basin management can also be called a form of regional development that places river basins as a unit of natural resource management which in general is to achieve the goal of increasing optimum and sustainable agricultural and forestry production by minimizing damage so that the distribution of river water flow originating from the river basin can be evenly distributed throughout the year (Sudarma et al., 2016). This biophysical integration causes river basins to be viewed as a complete whole consisting of water sources, water bodies, lakes, and reservoirs that cannot be separated from one another (Fauzi et al., 2016).

The Ayung River Basin is the largest river basin in Bali Province. The Ayung River Basin has an area of 29,717.17 ha and passes through 6 regencies/cities in Bali Province, namely Badung Regency, Gianyar Regency, Bangli Regency, Tabanan Regency, Buleleng Regency, and Denpasar City. Meanwhile, the Ayung River itself has a river length of around 62.5 km and the area of the Ayung River Basin is 288.37 km<sup>2</sup>, crossing 3 regencies, namely Badung Regency, Gianyar and Denpasar City. One of the areas crossed by the Ayung River is the Ubud area of Gianyar Regency. The Ayung River Basin is used for irrigation so that almost all farmers feel the benefits and are used for those involved in the management of food crops, plantations, livestock, fisheries, and forestry (Sallata, 2015). In addition to being used for agricultural activities in a broad sense, the Ayung River Basin Basin located in the Ubud District, Gianyar Regency is used for tourism purposes, especially rafting and kayaking tourism.

The Ayung River Basin has experienced physical, chemical and microbiological pressures originating from agricultural waste such as organic material runoff (Sagala et al., 2020). Waste comes from fertilizers and pesticides, household waste, livestock waste, hotel waste located on the side of the Ayung River Basin which run off during the rainy season which enters the Ayung River Basin (Kusumawardhani, 2020). The Ayung River is used as a source of raw drinking water for the upstream area and its carrying capacity is maintained (Sudipa et al., 2020). The purpose of this study was to determine the impact

of domestic and tourism activities on the Ayung River Basin (DAS) in the Ubud District, Gianyar Regency.

## 2 METHOD

The materials used in this study were maps, sterile bottles, GPS, DO meters, and cameras. The tools and methods used for the analysis of the water quality of the Ayung River are presented in Table 1 and the parameters of the analysis of the water quality of the Ayung River are presented in Table 2.

**Table 1.**

*Analyzed Water Quality Parameters, Methods, and Tools Used*

| No       | Parameters          | Unit      | Analysis Methods  | Equipment          |
|----------|---------------------|-----------|-------------------|--------------------|
| <b>A</b> | <b>Physics</b>      |           |                   |                    |
| 1        | Temperature         | °C        | Mercury Expansion | Thermometer        |
| 2        | Physics             | ppm       | Gravimetry        | Analytical Balance |
| <b>B</b> | <b>Chemistry</b>    |           |                   |                    |
| 1        | DO                  | ppm       | Electrochemistry  | DOm                |
| 2        | pH                  | -         | Electrometer      | pHm                |
| 3        | BOD5                | ppm       | Spectrophotometry | Spektrofotometer   |
| 4        | COD                 | ppm       | Spectrophotometry | Spectrophotometer  |
| 5        | NO3                 | ppm       | Spectrophotometry | Spectrophotometer  |
| 6        | NO2                 | ppm       | Spectrophotometry | Spectrophotometer  |
| 7        | NH3                 | ppm       | Spectrophotometry | Spectrophotometer  |
| 8        | PO4                 | ppm       | Spectrophotometry | Spectrophotometer  |
| 9        | Oil & Fat           | ppm       | Gravimetry        | Analytical Balance |
| <b>C</b> | <b>Microbiology</b> |           |                   |                    |
| 1        | Faecal coliform     | MPN/100ml | MPN               | Test Tube          |

Source: Bali Governor Regulation No. 16 of 2016

Water quality greatly influences the water pollution index (Yani et al., 2019). Determination of pollution status is determined by using the pollution index as stated in the Decree of the Minister of State for the Environment Number 51 of 2004 (Yuniarti et al., 2019). as follows:

$$PI_j = \sqrt{\frac{\left(\frac{Ci}{Lij}\right)_M^2 + \left(\frac{Ci}{Lij}\right)_R^2}{2}} \dots\dots\dots(1)$$

Information:

$L_i$  : Water quality concentration for water quality standards for water use (j)

$C_i$  : Water quality concentration from survey results

$P_{ij}$  : Pollution index for designation (j)

$(C_i/L_{ij})_M$ :  $C_i/L_{ij}$  Maximum

$(C_i/L_{ij})_R$  :  $C_i/L_{ij}$  Average

The status of water quality standards is stated as follows:

1.  $0 \leq P_{ij} \leq 1.0$ : According to quality standards (good condition)
2.  $1.0 < P_{ij} < 5.0$ : Lightly polluted water
3.  $5.0 < P_{ij} \leq 10$ : Moderately polluted water
4.  $P_{ij} > 10$ : Heavily polluted

**Table 2.**

*River Water Quality Analysis Parameters*

| No        | Parameters                         | Unit               | Bali Governor Regulation No. 16 of 2016 |             |             |             |
|-----------|------------------------------------|--------------------|---|-------------|-------------|-------------|
|           |                                    |                    | Class I                                 | Class II    | Class III   | Class IV    |
| <b>A.</b> | <b>Physics</b>                     |                    |   |             |             |             |
| 1         | Temperature                        | $^{\circ}\text{C}$ | Deviation 3                             | Deviation 3 | Deviation 3 | Deviation 5 |
| 2         | Physics                            | ppm                | 1000                                    | 1000        | 1000        | 2000        |
| <b>B.</b> | <b>Chemistry</b>                   |                    |   |             |             |             |
| 1         | pH                                 | ppm                | 6 - 9                                   | 6 - 9       | 6 - 9       | 5 - 9       |
| 2         | Fe                                 | ppm                | 0,3                                     | (-)         | (-)         | (-)         |
| 3         | Mn                                 | ppm                | 0,1                                     | (-)         | (-)         | (-)         |
| 4         | Cu                                 | ppm                | 0,02                                    | 0,02        | 0,02        | 0,02        |
| 5         | Zn                                 | ppm                | 0,05                                    | 0,05        | 0,05        | 2           |
| 6         | Cr                                 | ppm                | 0,05                                    | 0,05        | 0,05        | 1           |
| 7         | Cd                                 | ppm                | 0,01                                    | 0,01        | 0,01        | 0,01        |
| 8         | Hg                                 | ppm                | 0,001                                   | 0,002       | 0,002       | 0,005       |
| 9         | Pb                                 | ppm                | 0,03                                    | 0,03        | 0,03        | 1           |
| 10        | As                                 | ppm                | 0,05                                    | 1           | 1           | 1           |
| 11        | Se                                 | ppm                | 0,01                                    | 0,05        | 0,05        | 0,05        |
| 12        | Ammonia ( $\text{NH}_3\text{-N}$ ) | ppm                | 0,5                                     | (-)         | (-)         | (-)         |
| 13        | Nitrat ( $\text{NO}_3\text{-N}$ )  | ppm                | 10                                      | 10          | 20          | 20          |
| 14        | Nitrit ( $\text{NO}_2\text{-N}$ )  | ppm                | 0,06                                    | 0,06        | 0,06        | (-)         |
| 15        | Detergent                          | ppm                | 0,2                                     | 0,2         | 1           | 5           |
| <b>C.</b> | <b>Microbiology</b>                |                    |   |             |             |             |
| 1         | Total coliform                     | MPN/100ml          | 1000                                    | 5000        | 10000       | 10000       |
| 2         | Faecal coliform                    | MPN/100ml          | 100                                     | 1000        | 2000        | 2000        |

Source: Bali Governor Regulation No. 16 of 2016

### 3 RESULT AND DISCUSSION

Ayung River water samples were taken in May 2024. The results of the physical, chemical, and microbiological parameter quality tests of water samples taken during the dry season are as follows:

#### 3.1 Ayung River Water Sample in Front of Putri Wulandari Hotel (PW)

The first water sample taken was at coordinates -8.465068, 115.242234 or in front of the Putri Wulandari Hotel. The results of the river water quality analysis can be seen in Table 3.

**Table 3.**

*Analysis of River Water Quality Parameters in Front of Putri Wulandari Hotel*

| No                     | Parameters                   | Unit           | Result      | Bali Governor Regulation No. 16 of 2016 |             |             |             |
|------------------------|------------------------------|----------------|-------------|---|-------------|-------------|-------------|
|                        |                              |                |             | Class I                                 | Class II    | Class III   | Class IV    |
| <b>A. Physics</b>      |                              |                |             |   |             |             |             |
| 1                      | Temperature                  | <sup>o</sup> C | 25,1        | Deviation 3                             | Deviation 3 | Deviation 3 | Deviation 5 |
| 2                      | Physics                      | ppm            | 95,22       | 1000                                    | 1000        | 1000        | 2000        |
| <b>B. Chemistry</b>    |                              |                |             |   |             |             |             |
| 1                      | pH                           | ppm            | 7,94        | 6 - 9                                   | 6 - 9       | 6 - 9       | 5 - 9       |
| 2                      | Fe                           | ppm            | 0,298       | 0,3                                     | (-)         | (-)         | (-)         |
| 3                      | Mn                           | ppm            | <0,01       | 0,1                                     | (-)         | (-)         | (-)         |
| 4                      | Cu                           | ppm            | <0,0153     | 0,02                                    | 0,02        | 0,02        | 0,02        |
| 5                      | Zn                           | ppm            | <0,0075     | 0,05                                    | 0,05        | 0,05        | 2           |
| 6                      | Cr                           | ppm            | <0,003      | 0,05                                    | 0,05        | 0,05        | 1           |
| 7                      | Cd                           | ppm            | <0,001      | 0,01                                    | 0,01        | 0,01        | 0,01        |
| 8                      | Hg                           | ppm            | <0,0005     | 0,001                                   | 0,002       | 0,002       | 0,005       |
| 9                      | Pb                           | ppm            | <0,0036     | 0,03                                    | 0,03        | 0,03        | 1           |
| 10                     | As                           | ppm            | <0,0003     | 0,05                                    | 1           | 1           | 1           |
| 11                     | Se                           | ppm            | <0,0006     | 0,01                                    | 0,05        | 0,05        | 0,05        |
| 12                     | Ammonia (NH <sub>3</sub> -N) | ppm            | <0,001      | 0,5                                     | (-)         | (-)         | (-)         |
| 13                     | Nitrat (NO <sub>3</sub> -N)  | ppm            | 1,664       | 10                                      | 10          | 20          | 20          |
| 14                     | Nitrit (NO <sub>2</sub> -N)  | ppm            | <0,001      | 0,06                                    | 0,06        | 0,06        | (-)         |
| 15                     | Detergent                    | ppm            | <0,05       | 0,2                                     | 0,2         | 1           | 5           |
| <b>C. Microbiology</b> |                              |                |             |   |             |             |             |
| 1                      | Total coliform               | MPN/100ml      | <b>3300</b> | 1000                                    | 5000        | 10000       | 10000       |
| 2                      | Faecal coliform              | MPN/100ml      | <b>3300</b> | 100                                     | 1000        | 2000        | 2000        |

Source: Bali Governor Regulation No. 16 of 2016

From the calculation results of the index for water allocation, the following results were obtained:

- Class I water allocation with a pollution index value of 1.65, where the water is in a lightly polluted condition.
- Class II water allocation with a pollution index value of 0.29, where the water is in good condition and meets the quality standards.
- Class III water allocation with a pollution index value of 0.17, where the water is in good condition and meets the quality standards.
- Class IV water allocation with a pollution index value of 0.14, where the water is in good condition and meets the quality standards.

The results of the analysis of water samples taken in front of the Putri Wulandari Hotel compared to the water quality for the River water quality standards can be explained as follows:

- a) The results of the Physical Parameter analysis show that it is below the quality standard threshold, both for class I, II, III, and IV water allocations.
- b) The results of the Chemical Parameter analysis show that it is below the quality standard threshold, both for class I, II, III, and IV water allocations.
- c) The results of the Microbiological Parameter analysis show that the Total Coliform Parameter is still above the standard quality threshold for class I water and below the standard quality threshold for class II, III, and IV water, and Faecal coliform is above the standard quality threshold, both for class I, II, III, and IV water.

### **3.2 Ayung River Water Sample in Front of the Kupu-kupu Barong Hotel (KKB)**

The second water sample taken was at coordinates -8.478144, 115.244721 or in front of the Kupukupu Barong Hotel. The results of the river water quality analysis can be seen in Table 4.

**Table 4.***Analysis of River Water Quality Parameters in Front of the Kupu-Kupu Barong Hotel*

| No                     | Parameters                   | Unit           | Result      | Bali Governor Regulation No. 16 of 2016 |             |             |             |
|------------------------|------------------------------|----------------|-------------|---|-------------|-------------|-------------|
|                        |                              |                |             | Class I                                 | Class II    | Class III   | Class IV    |
| <b>A. Physics</b>      |                              |                |             |   |             |             |             |
| 1                      | Temperature                  | <sup>0</sup> C | 25,4        | Deviation 3                             | Deviation 3 | Deviation 3 | Deviation 5 |
| 2                      | Physics                      | ppm            | 112,32      | 1000                                    | 1000        | 1000        | 2000        |
| <b>B. Chemistry</b>    |                              |                |             |   |             |             |             |
| 1                      | pH                           | ppm            | 7,98        | 6 - 9                                   | 6 - 9       | 6 - 9       | 5 - 9       |
| 2                      | Fe                           | ppm            | 0,312       | 0,3                                     | (-)         | (-)         | (-)         |
| 3                      | Mn                           | ppm            | <0,01       | 0,1                                     | (-)         | (-)         | (-)         |
| 4                      | Cu                           | ppm            | <0,0153     | 0,02                                    | 0,02        | 0,02        | 0,02        |
| 5                      | Zn                           | ppm            | <0,0075     | 0,05                                    | 0,05        | 0,05        | 2           |
| 6                      | Cr                           | ppm            | <0,003      | 0,05                                    | 0,05        | 0,05        | 1           |
| 7                      | Cd                           | ppm            | <0,001      | 0,01                                    | 0,01        | 0,01        | 0,01        |
| 8                      | Hg                           | ppm            | <0,0005     | 0,001                                   | 0,002       | 0,002       | 0,005       |
| 9                      | Pb                           | ppm            | <0,0036     | 0,03                                    | 0,03        | 0,03        | 1           |
| 10                     | As                           | ppm            | <0,0003     | 0,05                                    | 1           | 1           | 1           |
| 11                     | Se                           | ppm            | <0,0006     | 0,01                                    | 0,05        | 0,05        | 0,05        |
| 12                     | Ammonia (NH <sub>3</sub> -N) | ppm            | <0,001      | 0,5                                     | (-)         | (-)         | (-)         |
| 13                     | Nitrat (NO <sub>3</sub> -N)  | ppm            | 2,84        | 10                                      | 10          | 20          | 20          |
| 14                     | Nitrit (NO <sub>2</sub> -N)  | ppm            | <0,001      | 0,06                                    | 0,06        | 0,06        | (-)         |
| 15                     | Detergent                    | ppm            | <0,05       | 0,2                                     | 0,2         | 1           | 5           |
| <b>C. Microbiology</b> |                              |                |             |   |             |             |             |
| 1                      | Total coliform               | MPN/100ml      | <b>4200</b> | 1000                                    | 5000        | 10000       | 10000       |
| 2                      | Faecal coliform              | MPN/100ml      | <b>3500</b> | 100                                     | 1000        | 2000        | 2000        |

Source: Bali Governor Regulation No. 16 of 2016

From the calculation results of the index for water allocation, the following results were obtained:

- Class I water allocation with a pollution index value of 1.66, where the water is in a lightly polluted condition.
- Class II water allocation with a pollution index value of 0.32, where the water is in good condition and meets the quality standards.
- Class III water allocation with a pollution index value of 0.20, where the water is in good condition and meets the quality standards.
- Class IV water allocation with a pollution index value of 0.16, where the water is in good condition and meets the quality standards.

The results of the analysis of water samples taken in front of the Kupu-Kupu Barong Hotel compared to the water quality for the river water quality standards can be explained as follows:

- a) The results of the Physical Parameter analysis show that it is below the threshold of the quality standard, both for class I, II, III, and IV water allocations.
- b) The results of the Chemical Parameter analysis show that it is on the threshold of the quality standard, both for class I, II, III, and IV water allocations.
- c) The results of the Microbiological Parameter analysis show that the Total Coliform Parameter is still above the standard quality threshold for class I water and below the standard quality threshold for class II, III, and IV water, and Faecal coliform is above the standard quality threshold, both for class I, II, III, and IV water.

### 3.3 Ayung river water sample in front of the Amandari Hotel (AD)

The third water sample taken was at coordinates -8.488342, 115.243211 or in front of the Amandari Hotel. The results of the river water quality analysis can be seen in Table 5.

**Table 5.**

*Analysis of River Water Quality Parameters in Front of Amandari Hotel*

| No        | Parameters                   | Unit      | Result      | Bali Governor Regulation No. 16 of 2016 |             |             |             |
|-----------|------------------------------|-----------|-------------|---|-------------|-------------|-------------|
|           |                              |           |             | Class I                                 | Class II    | Class III   | Class IV    |
| <b>A.</b> | <b>Physics</b>               |           |             |   |             |             |             |
| 1         | Temperature                  | °C        | 25,8        | Deviation 3                             | Deviation 3 | Deviation 3 | Deviation 5 |
| 2         | Physics                      | ppm       | 148,62      | 1000                                    | 1000        | 1000        | 2000        |
| <b>B.</b> | <b>Chemistry</b>             |           |             |   |             |             |             |
| 1         | pH                           | ppm       | 8           | 6 - 9                                   | 6 - 9       | 6 - 9       | 5 - 9       |
| 2         | Fe                           | ppm       | 0,45        | 0,3                                     | (-)         | (-)         | (-)         |
| 3         | Mn                           | ppm       | <0,01       | 0,1                                     | (-)         | (-)         | (-)         |
| 4         | Cu                           | ppm       | <0,0153     | 0,02                                    | 0,02        | 0,02        | 0,02        |
| 5         | Zn                           | ppm       | <0,0075     | 0,05                                    | 0,05        | 0,05        | 2           |
| 6         | Cr                           | ppm       | <0,003      | 0,05                                    | 0,05        | 0,05        | 1           |
| 7         | Cd                           | ppm       | <0,001      | 0,01                                    | 0,01        | 0,01        | 0,01        |
| 8         | Hg                           | ppm       | <0,0005     | 0,001                                   | 0,002       | 0,002       | 0,005       |
| 9         | Pb                           | ppm       | <0,0036     | 0,03                                    | 0,03        | 0,03        | 1           |
| 10        | As                           | ppm       | <0,0003     | 0,05                                    | 1           | 1           | 1           |
| 11        | Se                           | ppm       | <0,0006     | 0,01                                    | 0,05        | 0,05        | 0,05        |
| 12        | Ammonia (NH <sub>3</sub> -N) | ppm       | <0,001      | 0,5                                     | (-)         | (-)         | (-)         |
| 13        | Nitrat (NO <sub>3</sub> -N)  | ppm       | 4,3         | 10                                      | 10          | 20          | 20          |
| 14        | Nitrit (NO <sub>2</sub> -N)  | ppm       | <0,001      | 0,06                                    | 0,06        | 0,06        | (-)         |
| 15        | Detergent                    | ppm       | <0,05       | 0,2                                     | 0,2         | 1           | 5           |
| <b>C.</b> | <b>Microbiology</b>          |           |             |   |             |             |             |
| 1         | Total coliform               | MPN/100ml | <b>5600</b> | 1000                                    | 5000        | 10000       | 10000       |
| 2         | Faecal coliform              | MPN/100ml | <b>4200</b> | 100                                     | 1000        | 2000        | 2000        |

Source: Bali Governor Regulation No. 16 of 2016

From the calculation results of the index for water allocation, the following results were obtained:

- Class I water allocation with a pollution index value of 1.66, where the water is in good condition and meets the quality standards.
- Class II water allocation with a pollution index value of 0.39, where the water is in good condition and meets the quality standards.
- Class III water allocation with a pollution index value of 0.23, where the water is in good condition and meets the quality standards.
- Class IV water allocation with a pollution index value of 0.18, where the water is in good condition and meets the quality standards.

The results of the analysis of water samples taken in front of the Amandari Hotel compared to the water quality for the river water quality standards can be explained as follows:

- a) The results of the Physical Parameter analysis show that it is below the threshold of the quality standards, both for class I, II, III, and IV water allocations.
- b) The results of the Chemical Parameter analysis show that it is on the threshold of the quality standards, both for class I, II, III, and IV water allocations.
- c) The results of the Microbiological Parameter analysis show that the Total Coliform Parameter is still above the standard quality threshold for class I and II water, and below the standard quality threshold for class III and IV water, and Faecal coliform is above the standard quality threshold, both for class I, II, III, and IV water.

### **3.4 Ayung river water sample in front of Four Season Hotel (FS)**

The fourth water sample taken was at coordinates -8.499981, 115.240509 or in front of the Four Season Hotel. The results of the river water quality analysis can be seen in Table 6.

**Table 6.***Analisis Paramater Kualitas Air Sungai di Depan Hotel Four Season*

| No        | Parameters                   | Unit      | Result      | Bali Governor Regulation No. 16 of 2016 |             |             |             |
|-----------|------------------------------|-----------|-------------|---|-------------|-------------|-------------|
|           |                              |           |             | Class I                                 | Class II    | Class III   | Class IV    |
| <b>A.</b> | <b>Physics</b>               |           |             |   |             |             |             |
| 1         | Temperature                  | °C        | 26,1        | Deviation 3                             | Deviation 3 | Deviation 3 | Deviation 5 |
| 2         | Physics                      | ppm       | 184,32      | 1000                                    | 1000        | 1000        | 2000        |
| <b>B.</b> | <b>Chemistry</b>             |           |             |   |             |             |             |
| 1         | pH                           | ppm       | 8,2         | 6 - 9                                   | 6 - 9       | 6 - 9       | 5 - 9       |
| 2         | Fe                           | ppm       | 0,48        | 0,3                                     | (-)         | (-)         | (-)         |
| 3         | Mn                           | ppm       | <0,01       | 0,1                                     | (-)         | (-)         | (-)         |
| 4         | Cu                           | ppm       | <0,0153     | 0,02                                    | 0,02        | 0,02        | 0,02        |
| 5         | Zn                           | ppm       | <0,0075     | 0,05                                    | 0,05        | 0,05        | 2           |
| 6         | Cr                           | ppm       | <0,003      | 0,05                                    | 0,05        | 0,05        | 1           |
| 7         | Cd                           | ppm       | <0,001      | 0,01                                    | 0,01        | 0,01        | 0,01        |
| 8         | Hg                           | ppm       | <0,0005     | 0,001                                   | 0,002       | 0,002       | 0,005       |
| 9         | Pb                           | ppm       | <0,0036     | 0,03                                    | 0,03        | 0,03        | 1           |
| 10        | As                           | ppm       | <0,0003     | 0,05                                    | 1           | 1           | 1           |
| 11        | Se                           | ppm       | <0,0006     | 0,01                                    | 0,05        | 0,05        | 0,05        |
| 12        | Ammonia (NH <sub>3</sub> -N) | ppm       | <0,001      | 0,5                                     | (-)         | (-)         | (-)         |
| 13        | Nitrat (NO <sub>3</sub> -N)  | ppm       | 6,4         | 10                                      | 10          | 20          | 20          |
| 14        | Nitrit (NO <sub>2</sub> -N)  | ppm       | <0,001      | 0,06                                    | 0,06        | 0,06        | (-)         |
| 15        | Detergent                    | ppm       | <0,05       | 0,2                                     | 0,2         | 1           | 5           |
| <b>C.</b> | <b>Microbiology</b>          |           |             |   |             |             |             |
| 1         | Total coliform               | MPN/100ml | <b>6800</b> | 1000                                    | 5000        | 10000       | 10000       |
| 2         | Faecal coliform              | MPN/100ml | <b>5100</b> | 100                                     | 1000        | 2000        | 2000        |

Source: Bali Governor Regulation No. 16 of 2016

From the calculation results of the index for water allocation, the following results were obtained:

- Class I water allocation with a pollution index value of 1.66, where the water is in a lightly polluted condition.
- Class II water allocation with a pollution index value of 0.47, where the water is in good condition and meets the quality standards.
- Class III water allocation with a pollution index value of 0.27, where the water is in good condition and meets the quality standards.
- Class IV water allocation with a pollution index value of 0.21, where the water is in good condition and meets the quality standards.

The results of the analysis of water samples taken in front of the Four Season Hotel compared to the water quality for the River water quality standards can be explained as follows:

- a) The results of the Physical Parameter analysis show that it is below the threshold of the quality standard, both for class I, II, III, and IV water allocations.

b) The results of the Chemical Parameter analysis show that it is on the threshold of the quality standard, both for class I, II, III, and IV water allocations.

c) The results of the Microbiological Parameter analysis show that the Total Coliform Parameter is still above the standard quality threshold for class I and II water, and below the standard quality threshold for class III and IV water, and Faecal coliform is above the standard quality threshold, both for class I, II, III, and IV water.

### 3.5 Ayung river water sample in front of the Samaya Hotel (SMY)

The fifth water sample taken was at coordinates -8.513174, 115.233658 or in front of the Samaya Hotel. The results of the river water quality analysis can be seen in Table 7.

**Table 7.**

*Analysis of River Water Quality Parameters in Front of the Samaya Hotel*

| No        | Parameters                   | Unit      | Result      | Bali Governor Regulation No. 16 of 2016 |             |             |             |
|-----------|------------------------------|-----------|-------------|---|-------------|-------------|-------------|
|           |                              |           |             | Class I                                 | Class II    | Class III   | Class IV    |
| <b>A.</b> | <b>Physics</b>               |           |             |   |             |             |             |
| 1         | Temperature                  | °C        | 26          | Deviation 3                             | Deviation 3 | Deviation 3 | Deviation 5 |
| 2         | Physics                      | ppm       | 203,12      | 1000                                    | 1000        | 1000        | 2000        |
| <b>B.</b> | <b>Chemistry</b>             |           |             |   |             |             |             |
| 1         | pH                           | ppm       | 7,98        | 6 - 9                                   | 6 - 9       | 6 - 9       | 5 - 9       |
| 2         | Fe                           | ppm       | 0,363       | 0,3                                     | (-)         | (-)         | (-)         |
| 3         | Mn                           | ppm       | <0,01       | 0,1                                     | (-)         | (-)         | (-)         |
| 4         | Cu                           | ppm       | <0,0153     | 0,02                                    | 0,02        | 0,02        | 0,02        |
| 5         | Zn                           | ppm       | <0,0075     | 0,05                                    | 0,05        | 0,05        | 2           |
| 6         | Cr                           | ppm       | <0,003      | 0,05                                    | 0,05        | 0,05        | 1           |
| 7         | Cd                           | ppm       | <0,001      | 0,01                                    | 0,01        | 0,01        | 0,01        |
| 8         | Hg                           | ppm       | <0,0005     | 0,001                                   | 0,002       | 0,002       | 0,005       |
| 9         | Pb                           | ppm       | <0,0036     | 0,03                                    | 0,03        | 0,03        | 1           |
| 10        | As                           | ppm       | <0,0003     | 0,05                                    | 1           | 1           | 1           |
| 11        | Se                           | ppm       | <0,0006     | 0,01                                    | 0,05        | 0,05        | 0,05        |
| 12        | Ammonia (NH <sub>3</sub> -N) | ppm       | <0,001      | 0,5                                     | (-)         | (-)         | (-)         |
| 13        | Nitrat (NO <sub>3</sub> -N)  | ppm       | 5,2         | 10                                      | 10          | 20          | 20          |
| 14        | Nitrit (NO <sub>2</sub> -N)  | ppm       | <0,001      | 0,06                                    | 0,06        | 0,06        | (-)         |
| 15        | Detergent                    | ppm       | <0,05       | 0,2                                     | 0,2         | 1           | 5           |
| <b>C.</b> | <b>Microbiology</b>          |           |             |   |             |             |             |
| 1         | Total coliform               | MPN/100ml | <b>7000</b> | 1000                                    | 5000        | 10000       | 10000       |
| 2         | Faecal coliform              | MPN/100ml | <b>5300</b> | 100                                     | 1000        | 2000        | 2000        |

Source: Bali Governor Regulation No. 16 of 2016

From the calculation results of the index for water allocation, the following results were obtained:

- Class I water allocation with a pollution index value of 1.66, where the water is in a lightly polluted condition.
- Class II water allocation with a pollution index value of 0.47, where the water is in good condition and meets the quality standards.
- Class III water allocation with a pollution index value of 0.27, where the water is in good condition and meets the quality standards.
- Class IV water allocation with a pollution index value of 0.21, where the water is in good condition and meets the quality standards.

The results of the analysis of water samples taken in front of the Samaya Hotel compared to the water quality for the river water quality standards can be explained as follows:

- The results of the Physical Parameter analysis show that it is below the threshold of the quality standard, both for class I, II, III, and IV water allocations.
- The results of the Chemical Parameter analysis show that it is on the threshold of the quality standard, both for class I, II, III, and IV water allocations.
- The results of the Microbiological Parameter analysis show that the Total Coliform Parameter is still above the standard quality threshold for class I and II water, and below the standard quality threshold for class III and IV water, and Faecal coliform is above the standard quality threshold, both for class I, II, III, and IV water.

### 3.6 Ayung river water sample in front of the Bale Teba Hotel (BT)

The sixth water sample taken was at coordinates -8.540174, 115.217952 or in front of Bale Teba Hotel. The results of the river water quality analysis can be seen in Table 8.

**Table 8.**

*Analysis of River Water Quality Parameters in Front of Bale Teba Hotel*

| No                  | Parameters  | Unit | Result | Bali Governor Regulation No. 16 of 2016 |             |             |             |
|---------------------|-------------|------|--------|---|-------------|-------------|-------------|
|                     |             |      |        | Class I                                 | Class II    | Class III   | Class IV    |
| <b>A. Physics</b>   |             |      |        |   |             |             |             |
| 1                   | Temperature | °C   | 26,3   | Deviation 3                             | Deviation 3 | Deviation 3 | Deviation 5 |
| 2                   | Physics     | ppm  | 268,6  | 1000                                    | 1000        | 1000        | 2000        |
| <b>B. Chemistry</b> |             |      |        |   |             |             |             |
| 1                   | pH          | ppm  | 8,2    | 6 - 9                                   | 6 - 9       | 6 - 9       | 5 - 9       |
| 2                   | Fe          | ppm  | 0,43   | 0,3                                     | (-)         | (-)         | (-)         |

|           |                              |           |             |       |       |       |       |
|-----------|------------------------------|-----------|-------------|-------|-------|-------|-------|
| 3         | Mn                           | ppm       | <0,01       | 0,1   | (-)   | (-)   | (-)   |
| 4         | Cu                           | ppm       | <0,0153     | 0,02  | 0,02  | 0,02  | 0,02  |
| 5         | Zn                           | ppm       | <0,0075     | 0,05  | 0,05  | 0,05  | 2     |
| 6         | Cr                           | ppm       | <0,003      | 0,05  | 0,05  | 0,05  | 1     |
| 7         | Cd                           | ppm       | <0,001      | 0,01  | 0,01  | 0,01  | 0,01  |
| 8         | Hg                           | ppm       | <0,0005     | 0,001 | 0,002 | 0,002 | 0,005 |
| 9         | Pb                           | ppm       | <0,0036     | 0,03  | 0,03  | 0,03  | 1     |
| 10        | As                           | ppm       | <0,0003     | 0,05  | 1     | 1     | 1     |
| 11        | Se                           | ppm       | <0,0006     | 0,01  | 0,05  | 0,05  | 0,05  |
| 12        | Ammonia (NH <sub>3</sub> -N) | ppm       | <0,001      | 0,5   | (-)   | (-)   | (-)   |
| 13        | Nitrat (NO <sub>3</sub> -N)  | ppm       | 6,8         | 10    | 10    | 20    | 20    |
| 14        | Nitrit (NO <sub>2</sub> -N)  | ppm       | <0,001      | 0,06  | 0,06  | 0,06  | (-)   |
| 15        | Detergent                    | ppm       | <0,05       | 0,2   | 0,2   | 1     | 5     |
| <b>C.</b> | <b>Microbiology</b>          |           |             |       |       |       |       |
| 1         | Total coliform               | MPN/100ml | <b>7600</b> | 1000  | 5000  | 10000 | 10000 |
| 2         | Faecal coliform              | MPN/100ml | <b>5600</b> | 100   | 1000  | 2000  | 2000  |

Source: Bali Governor Regulation No. 16 of 2016

From the calculation results of the index for water allocation, the following results were obtained:

- Class I water allocation with a pollution index value of 1.66, where the water is in a lightly polluted condition.
- Class II water allocation with a pollution index value of 0.47, where the water is in good condition and meets the quality standards.
- Class III water allocation with a pollution index value of 0.27, where the water is in good condition and meets the quality standards.
- Class IV water allocation with a pollution index value of 0.21, where the water is in good condition and meets the quality standards.

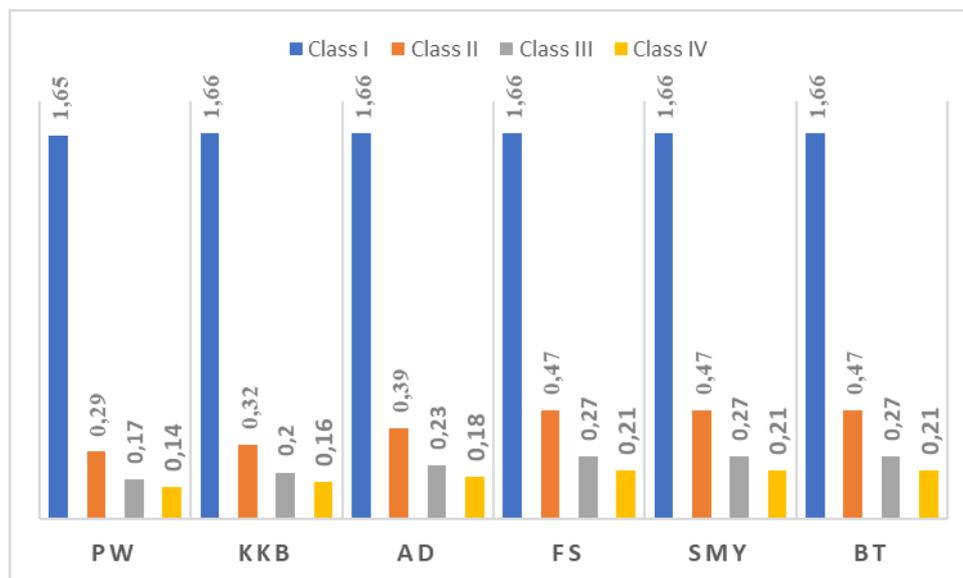
The results of the analysis of water samples taken in front of the Bale Teba Hotel compared to the water quality for the river water quality standards can be explained as follows:

- The results of the Physical Parameter analysis show that it is below the threshold of the quality standard, both for class I, II, III, and IV water allocations.
- The results of the Chemical Parameter analysis show that it is on the threshold of the quality standard, both for class I, II, III, and IV water allocations.
- The results of the Microbiological Parameter analysis show that the Total Coliform Parameter is still above the standard quality threshold for class I and II water, and below the standard quality threshold for class III and IV water, and Faecal coliform is above the standard quality threshold, both for class I, II, III, and IV water.

From the results of the pollution index analysis on each water sample taken above, it shows that there is a tendency for the pollution index to increase from upstream to downstream based on class. The increase in the pollution index is caused by the accumulation of incoming pollutants that accumulate in the downstream area, especially microbiological parameters, namely total coliform and e. coli. In the upstream to downstream areas of the Ayung River, there are many economic activities ranging from rafting activities, hotels and villas, agricultural activities, domestic activities and livestock activities that produce waste in the form of human and animal waste that is dumped into the Ayung River or run off into the Ayung River during the rainy season. Most of the pollution index of each water sample of the Ayung River taken is influenced by the total coliform and e. coli parameters. The pollution index of each sample of the Ayung River can be seen in Fig. 1.

**Figure 1.**

*Pollution Index for Each Ayung River Sample*

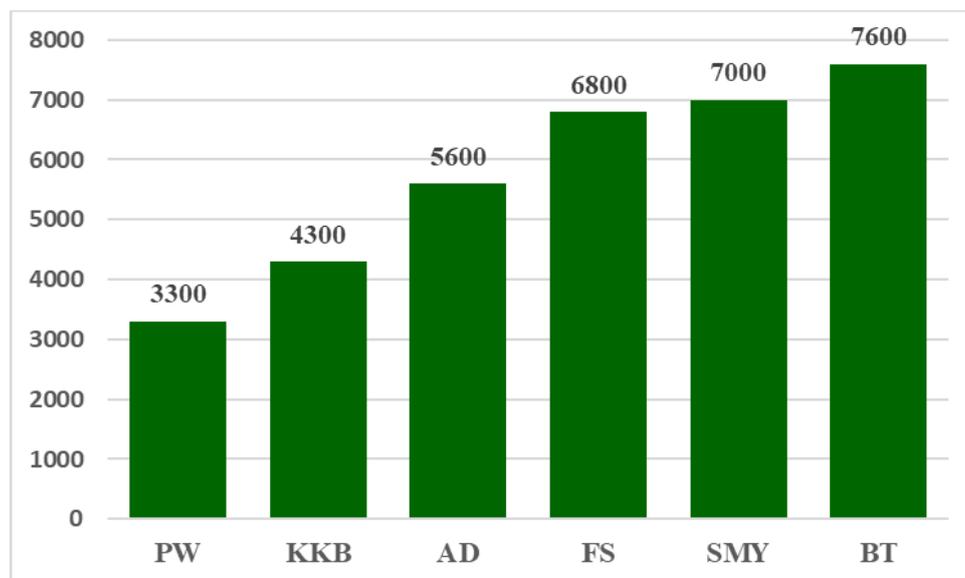


One of the factors that affect the pollution index of the Ayung River is the high levels of coliform contained in the waters of the Ayung River. The results of the study showed that the coliform content of each sampling point had exceeded the environmental quality standards based on Bali Governor Regulation No. 16 of 2016 concerning Environmental Quality Standards and Environmental Damage Standard Criteria, namely 1000 MPN / 100 ml for class I water, 5000 MPN / 100 ml for class II water, 10000 MPN

/ 100 ml for class III water, and 10000 MPN / 100 ml for class IV water. The range of coliform concentrations is from 3300 MPN / 100 ml to 7600 MPN / 100 ml. The highest coliform concentration occurred during the first sampling, namely the river water in front of the Putri Wulandari Hotel, which was 3300 MPN/100 ml and the highest coliform concentration occurred during the sixth sampling, namely the sample in front of the Bale Teba Hotel, which was 7600 MPN/100 ml and exceeded the threshold for water quality standards for class I and II based on Bali Governor Regulation No. 16 of 2016 concerning Environmental Quality Standards and Environmental Damage Standard Criteria. This proves that the Ayung River has experienced quite severe biological pollution (Alam et al., 2016). The concentration of coliform at each sampling point in the Ayung River can be seen in Fig. 2.

**Figure 2.**

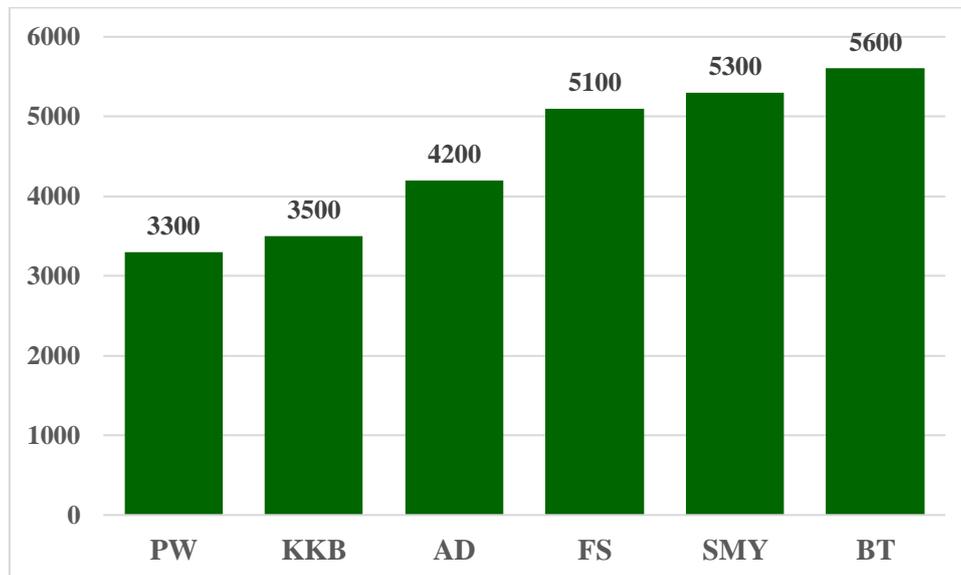
*Coliform Concentration at Sampling Points in the Ayung River*



Biological pollution can be identified by the discovery of microbial (pathogenic) bacteria as an indicator of water pollution. The presence of coliform bacteria in water indicates the presence of enterogenic or toxigenic microbes that are harmful to health (Anisafitri et al., 2020). The presence of microbiomes in the Ayung River is caused by human activities on land such as household activities, livestock, trade, decomposition of organic waste and other businesses. The disposal of organic waste, human and animal

waste that enters the Batujai Reservoir causes the accumulation of pathogenic bacteria (Salle, 2013).

*Escherichia coli* is a bacteria that is part of the microflora that is normally present in the digestive tract of humans and animals. *Escherichia coli* is included in heterotrophic bacteria that obtain food in the form of organic substances from their environment because they cannot compose the organic substances they need themselves (Rahmawati., et al., 2024). *Escherichia coli* is also an indicator bacteria of water quality because its presence in water indicates that the water is contaminated by feces which may also contain other pathogenic microorganisms (Widyawati et al., 2020). *Escherichia coli* becomes pathogenic if the number of these bacteria in the digestive tract increases or is outside the intestine. *Escherichia coli* produces enterotoxins which cause some cases of diarrhea. The concentration of *Escherichia coli* in samples taken in the Ayung River ranged from 3300 MPN/100 ml to 5600 MPN/100 ml. The highest concentration of *Escherichia coli* occurred during the first sample collection, namely the river water in front of the Putri Wulandari Hotel, which was 3300 MPN/100 ml and the highest concentration of *Escherichia coli* occurred during the sixth sample collection, namely the sample in front of the Bale Teba Hotel, which was 5600 MPN/100 ml and exceeded the threshold for water quality standards for all classes based on Bali Governor Regulation No. 16 of 2016 concerning Environmental Quality Standards and Environmental Damage Standard Criteria, namely 100 MPN/100 ml for class I water, 1000 MPN/100 ml for class II water, 2000 MPN/100 ml for class III water, and 2000 MPN/100 ml for class IV water. The concentration of *Escherichia coli* at each sampling point in the Ayung River can be seen in Fig. 3.

**Figure 3.***Concentration of Escherichia coli at Sampling Points in the Ayung River*

Under normal conditions, Coliform and *Escherichia coli* can grow in the digestive tract but can be pathogenic and can attack animals and humans in certain conditions such as digestive disorders and immunosuppression in the host. Poor sanitation from livestock management results in *Escherichia coli* contamination which is an environmental contaminant bacteria, namely environmental pollution bacteria (Mundi, 2018).

The presence of Coliform and *E. coli* contamination bacteria can be suspected to be caused by community activities that use springs as places to bathe and wash. Low community hygiene allows for bacterial contamination (Saputri et al., 2020). The existence of springs or rivers also allows for many farms where animal waste may enter rivers or waterways which eventually enter sea waters and the possibility of poor sanitation quality which can increase fecal deposits that can pollute river water.

#### 4 CONCLUSION

The pollution index for class I water allocation for all water samples taken is in a lightly polluted condition. While the allocation of class II, III, and IV water for all water samples taken is in a condition that meets the quality standards. The condition of the water pollution index is influenced by the high *e. coli* parameter which is on the threshold of the quality standards for class I, II, III, and IV water allocation. While the coliform

parameter is on the threshold of the quality limits for class I and class II water allocation.

## REFERENCES

- Alam O. T. Y., Sarminingsih A. N. W., (2016), Pengaruh Waduk Jatibarang terhadap Kualitas Air Sungai Garang di Intake PDAM Semarang, *Jurnal Teknik Lingkungan*, 5(2), 1–9.
- Anisafitri J., Khairuddin K., Rasmi D. A. C., (2020), Analisis Total Bakteri Coliform Sebagai Indikator Pencemaran Air Pada Sungai Unus Lombok, *Jurnal Pijar Mipa*, 15(3), 266–272, <https://doi.org/10.29303/jpm.v15i3.1622>.
- Ardhani D., (2014). Pengelolaan Sungai Batanghari Kabupaten Dharmayasa Berdasarkan Daya Tampung Beban Pencemaran Dengan Metode Qual2Kw, Thesis Magister Ilmu Lingkungan. Universitas Diponegoro, Semarang.
- Aslam M. S., (2013), Sustainability of Community-Based Drinking Water Systems in Developing Countries, Thesis, McGill University, Montreal, Quebec, Canada.
- Farida, Noordwijk M. V., (2004). Analisis Debit Sungai Akibat Alih Guna Lahan dan Aplikasi Model Gerriver Pada DAS Way Besai, Sumberjaya. *Agrivita*, 26(1), 39–47.
- Fauzi R. M. Z., Maryono., (2016), Kajian Erosi Dan Hasil Sedimen Untuk Konservasi Lahan DAS Kreo Hulu, *Jurnal Pembangunan Wilayah & Kota*, 12(4), 429–445, <https://doi.org/10.14710/pwk.v12i4.13508>.
- Kusmawati I., (2016), Analisa Daya Dukung Lahan Dan Daya Tampung Air di Sungai Pudu Kecamatan Mandau Kabupaten Bengkalis Provinsi Riau, *Journal of Env. Engineering & Waste Management*, 1(1), 35–45.
- Kusumawardhani N. P., (2020), Analysis of water carrying capacity for regional planning development in Malang Regency, *Journal of Architecture and Urbanism Research*, 3(2), 166-174
- Mundi N., (2018), Karakterisasi Profil Resistensi Antibiotik Pada *Escherichia coli* yang Diisolasi Dari Daging Ayam yang Dijual di Beberapa Pasar di Surabaya, Thesis, Fakultas Kedokteran Hewan, Universitas Airlangga.
- Peraturan Gubernur Bali Nomor 16 Tahun 2016 tentang Baku Mutu Lingkungan Hidup Dan Kriteria Baku Kerusakan Lingkungan Hidup.
- Peraturan Pemerintah Republik Indonesia No. 82 Tahun 2001 tentang Pengelolaan Kualitas Air dan Pengendalian Pencemaran Air.
- Putri Dwi, N.A., Afdal, Dwi Puryanti, 2014. Profil Pencemaran Air Sungai Siak Kota Pekanbaru Dari Tinjauan Fisis Dan Kimia. *Jurnal Fisika Unand Vol. 3, No. 3, Juli 2014*, ISSN 2302-8491. *Journal*. 21(3): 891-896.
- Rahmawati A. N., Utami D. W., Saryanti, D., Kurniaaji B., (2024), Analisis Most Probable Number (MPN) Coliform dan *Escherichia coli* Pada Air Sumur Bor di Pemukiman Warga Kelurahan Pucangsawit Surakarta, *Jurnal Kesehatan Lingkungan Indonesia*, 23(2), 146–152, <https://doi.org/10.14710/jkli.23.2.146-152>.
- Sagala N., Tendean M., Sulastriningsih H. S., (2020). Analisis Kontribusi Limbah Domestik Terhadap Kualitas Air Sungai Tondano-Sawangan Sulawesi Utara, *Jurnal*

- Episentrum, 1(2), 6-11.
- Salle, A. J., (2013), Studi Pendahuluan Klasifikasi Ukuran Butir Sedimen di Danau Laut Tawar, Takengon, Kabupaten Aceh Tengah, Provinsi Aceh. Banda Aceh, *Jurnal Ilmu Ilmu Perairan, Pesisir, dan Pertanian*. 2(2), 92-96.
- Sallata M. K., (2015), Konservasi dan Pengelolaan Sumber Daya Air Berdasarkan Keberadaannya sebagai Sumber Daya Alam, *Info Teknis Eboni*, 12(1), 75–86.
- Saputri E. T., Efendy M., (2020), Kepadatan Bakteri Coliform Sebagai Indikator Pencemaran Biologis di Perairan Pesisir Sepuluh Kabupaten Bangkalan, *Juvenil: Jurnal Ilmiah Kelautan dan Perikanan*, 1(2), 243–249, <https://doi.org/10.21107/juvenil.v1i2.7579>.
- Sudarma I. Made., Widyantara W., (2016), Persepsi Masyarakat Terhadap Ekosistem Daerah Aliran Sungai Ayung Menuju Sumberdaya Air Berkelanjutan, *Bumi Lestari*, 16 (2), 78-91.
- Sudipa N., Mahendra M. S., Adnyana W. S., Pujaastawa, I. B., (2020), Daya Dukung Air di Kawasan Pariwisata Nusa Penida, Bali, *Jurnal Sumberdaya Alam dan Lingkungan*: 7 (3):117-123.
- Sudipa N., (2021), Status Daya Dukung Lahan untuk Keberlanjutan Pangan di Kabupaten Klungkung, *Jurnal Ilmu Pertanian Indonesia*, 26(4), 597–604. <https://doi.org/10.18343/jipi.26.4.597>.
- Supardiono, Arthana W., Adnyana W. S., Suyasa W. B., Sudipa N., (2021) Analysis of water quality in batujai reservoir due to community and business activities in central lombok regency. *Journal Environmental Management and Tourism*, 12, 30–42.
- Widyawati A., Joko, T., Setiani O., (2020), Identifikasi Keberadaan Coliform dan E. coli pada Air Bersih di Pelabuhan Tanung Emas Semarang, *Jurnal Kesehatan Masyarakat*, 8(4), 517–523, <https://ejournal3.undip.ac.id/index.php/jkm/article/view/27574>.
- Yani A., Amin M., Rohman F., Suarsini E., Haerunnisa., (2019), Water quality and pollution index of lake tempe in south Sulawesi, Indonesia, *Pollut. Res.* 38(3), 568–574.
- Yuliasuti E., (2011), Kajian Kualitas Air Sungai Ngringo Karanganyar dalam Upaya Pengendalian Pencemaran Air, Tesis. Universitas Diponegoro, Semarang.
- Yuniarti Y., Biyatmoko, D., (2019). Analisis Kualitas Air Dengan Penentuan Status Mutu Air Sungai Jaing Kabupaten Tabalong, Jukung (*Jurnal Teknik Lingkungan*), 5(2), 52-69.
- Zhang H., Jin G., Yu Y., (2018), Review of river basin water resource management in China. *Water*, 10, 425, <https://doi.org/10.3390/w10040425>.